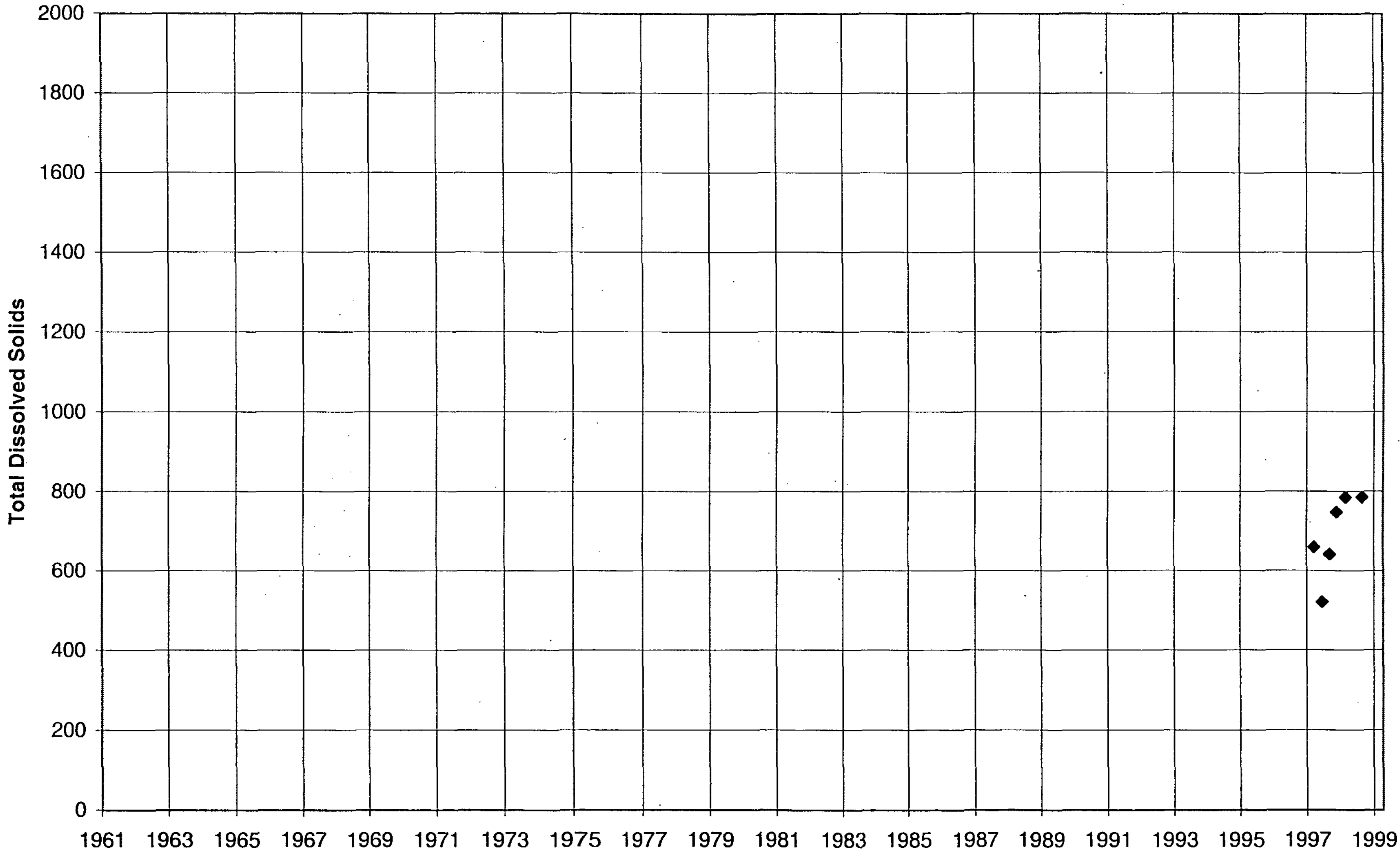
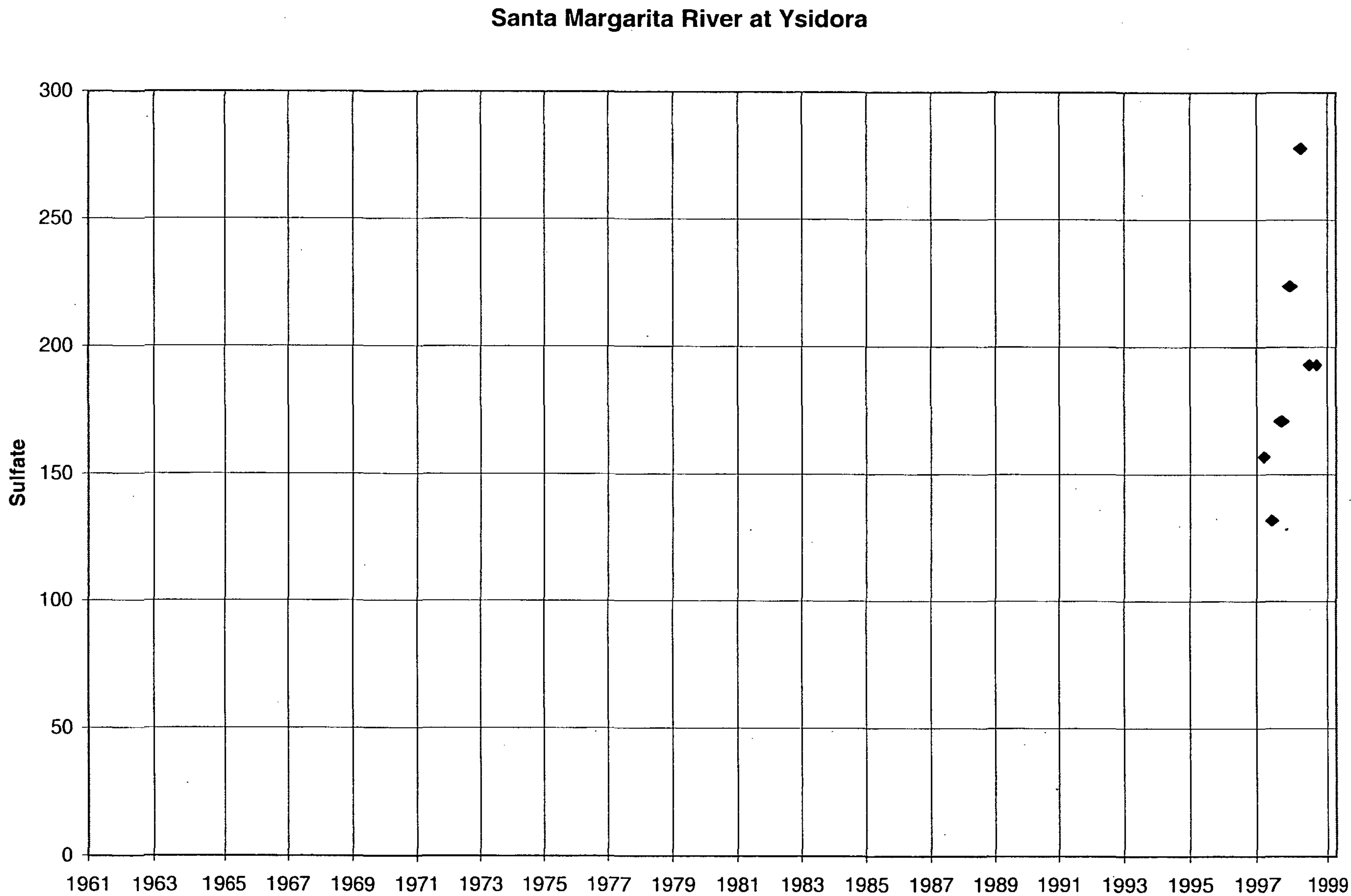
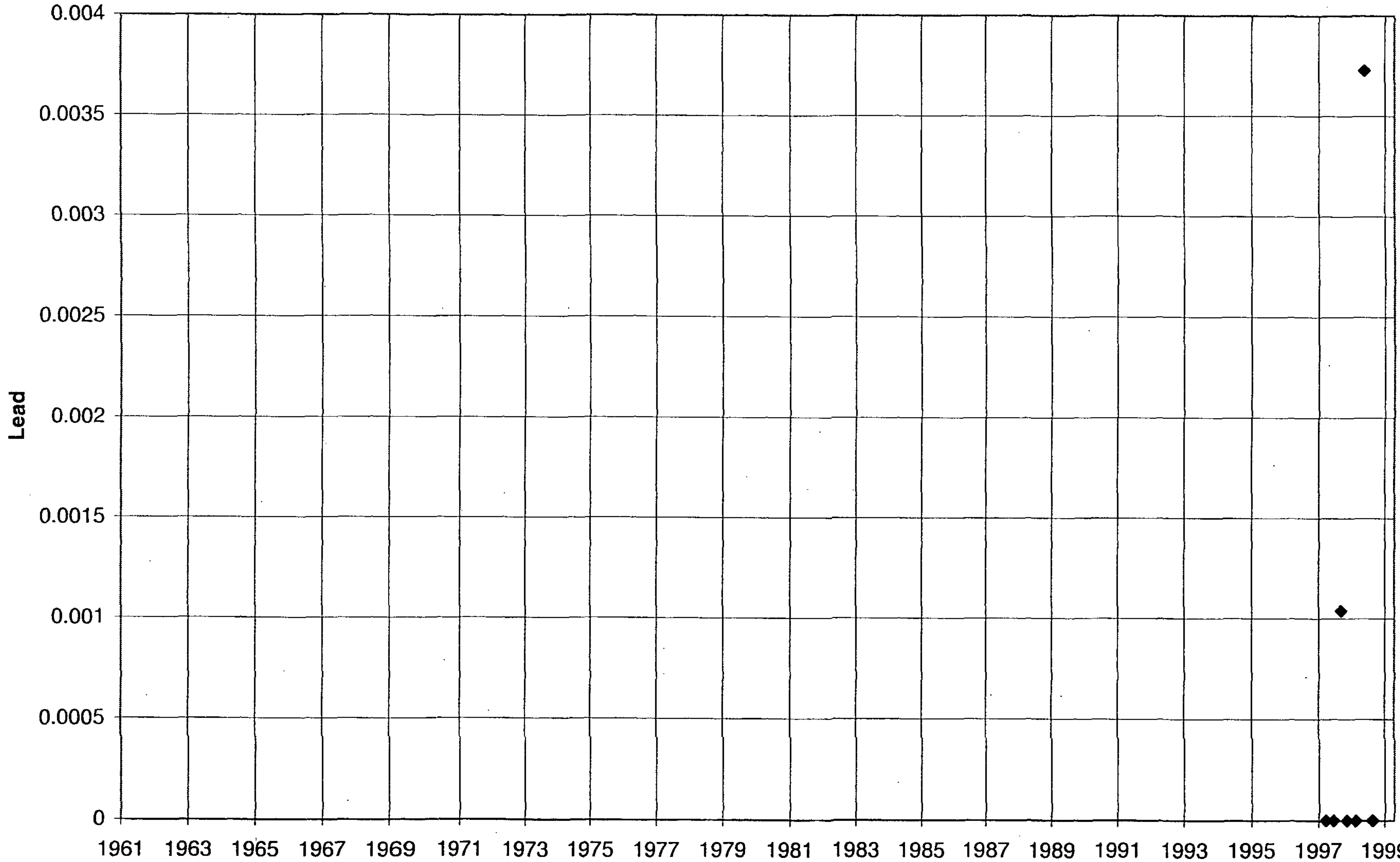
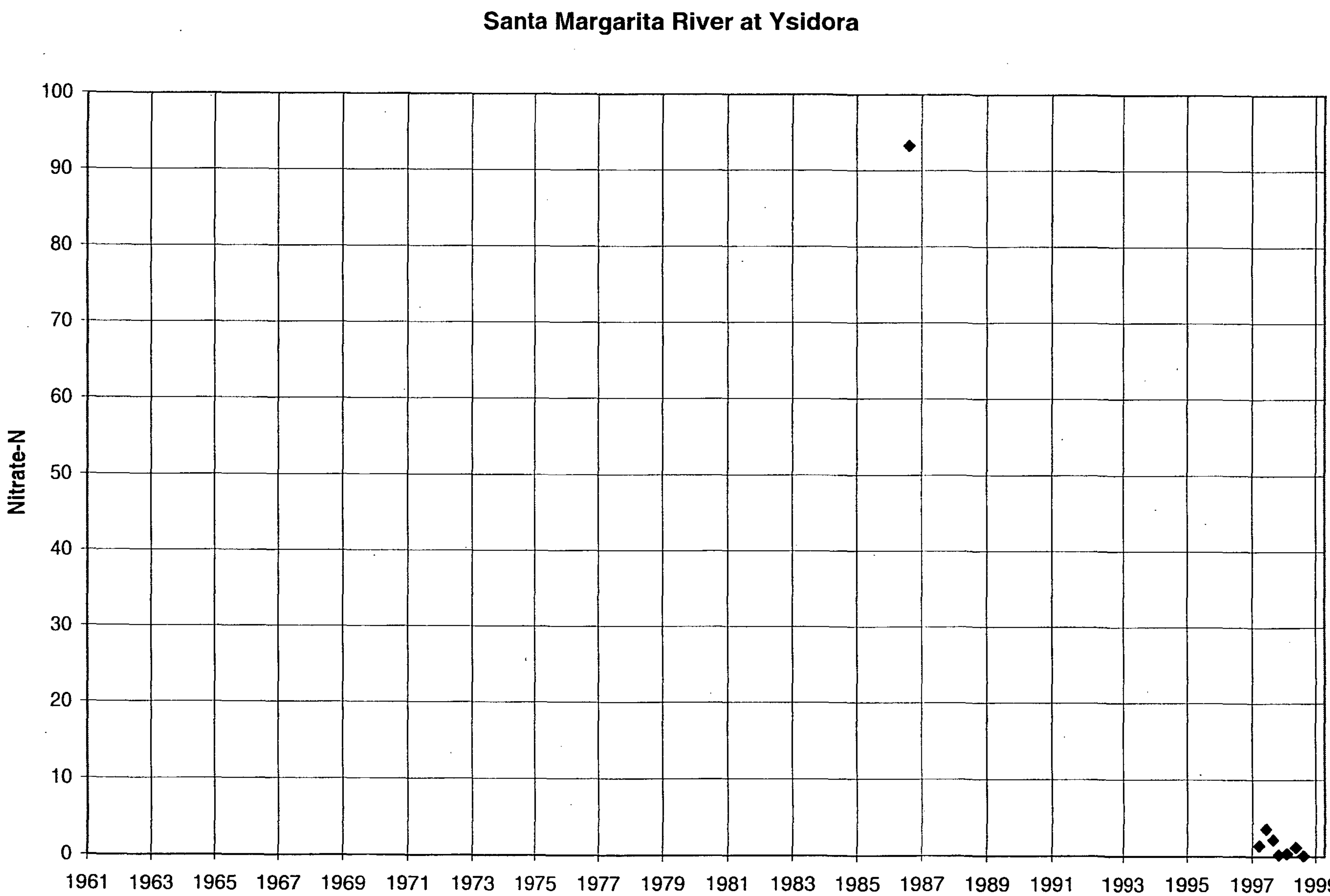
Santa Margarita River at Ysidora




Santa Margarita River at Ysidora
Sulfate
300
250
200
150
100
50
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999

Santa Margarita River at Ysidora

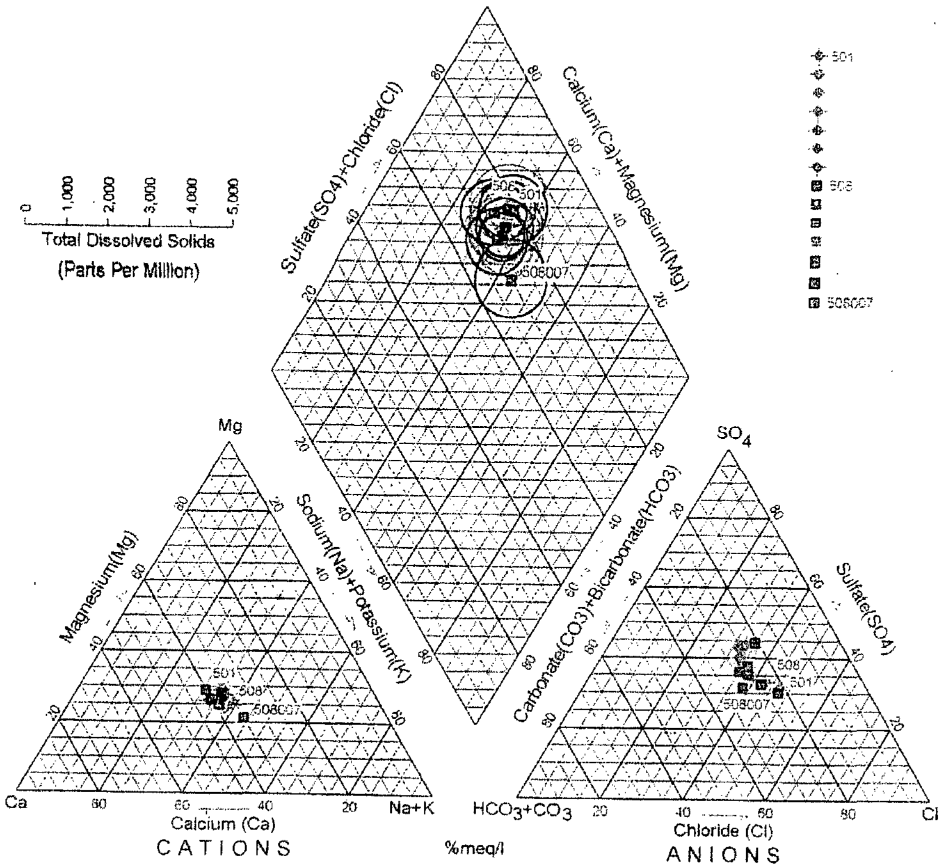




Santa Margarita River at Ysidora
Nitrate-N
100
90
80
70
60
50
40
30
20
10
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999

Santa Margarita River Stations (Sta 501 and 508)

1997 through 1999



Prepared By: SKR
Checked By: KRM

SWDIV
NAVFACENGCOM
SAN DIEGO, CALIFORNIA

LAW Crandall
LAWGIBB Group Member
A Division of Law Engineering and Environmental Services, Inc.

PIPER DIAGRAM
STATIONS 501 & 508
SANTA MARGARITA
RIVER WATERSHED

PROJECT: 70300-7-0193

Figure: 10

Table 1

Toxic Substances Monitoring Program

Preliminary Summary of 1997 Data: Trace Elements in Fish (ppm, wet weight)

Station Number	Station Name	Species Code	Tissue	Sample Date	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
105.11.08	Klamath R/Klamath Glen	SCP	W	08/27/97	0.022	0.0110	0.080	0.3800	0.0150	0.037	0.1050	0.170	0.0010	7.07
106.12.03	Trinity R/Willow Creek	RBT	W	08/28/97	0.019	0.0170	0.065	0.3800	0.0030	0.016	0.1670	0.300	0.0010	14.60
108.10.00	Big Lagoon	STB	W	08/27/97	0.327	0.0040	0.032	1.5000	0.0210	0.052	0.0150	0.250	0.0100	15.80
111.12.01	Eel R/Scotia	SCP	W	08/26/97	0.004	0.0120	0.036	0.3200	0.0110	0.030	0.0130	0.190	0.0010	7.34
114.11.05	Russian R/Duncans Mills	SKR	F	08/08/97	0.047	<0.0001	<0.001	0.1400	0.0005	0.155	<0.0002	0.090	0.0010	2.53
114.11.23	Russian R/Wohler Brg	LMB	F	08/07/97	0.016	<0.0001	<0.001	0.1300	<0.0001	0.257	<0.0002	0.120	<0.0003	3.05
114.11.23	Russian R/Wohler Brg	LMB	L	08/07/97	0.083	0.0200	0.355	2.1300	<0.0001	NA	0.0190	0.980	0.0010	19.90
114.21.10	Laguna de Santa Rosa/Stony Pt	SKR	F	08/07/97	<0.004	<0.0001	<0.001	0.1400	0.0030	0.075	0.0030	0.100	<0.0003	3.06
114.23.00	Mark West Creek	BG	F	08/07/97	0.022	<0.0001	0.001	0.1200	<0.0001	0.107	<0.0002	0.110	<0.0003	3.91
114.23.00	Mark West Creek	BG	L	08/07/97	0.282	0.0380	0.378	1.9800	0.0100	NA	0.0320	0.820	0.0030	19.30
114.24.12	Lake Sonoma	LMB	F	09/30/97	0.040	<0.0001	<0.001	0.1200	<0.0001	0.472	<0.0002	0.150	0.0010	2.59
114.24.12	Lake Sonoma	LMB	L	09/30/97	0.364	0.1750	0.369	5.9000	0.0010	NA	0.0260	2.030	0.0300	20.90
114.24.17	Lake Sonoma/Upper Warm Spr Arm	LMB	F	09/30/97	0.027	<0.0001	<0.001	0.1100	0.0010	0.370	0.0010	0.140	<0.0003	2.39
114.24.17	Lake Sonoma/Upper Warm Spr Arm	LMB	L	09/30/97	0.174	0.0590	0.480	4.9700	0.0400	NA	0.0310	1.730	0.0060	22.40
315.31.00	Devereaux Slough	LJM	F	08/21/97	5.980	<0.0001	<0.001	0.0900	0.0010	0.061	0.0020	0.680	<0.0003	5.37
315.31.00	Devereaux Slough	LJM	L	08/21/97	5.060	0.0440	0.888	0.7100	<0.0001	NA	0.0540	0.830	0.0010	9.60
403.11.02	Rio de Santa Clara/Oxnard Drain	GAM	W	07/16/97	0.104	0.0100	0.053	0.8700	0.0300	0.012	0.0580	0.350	0.0140	14.70
403.11.02	Rio de Santa Clara/Oxnard Drain	GAM	W	07/16/97	0.113	0.0110	0.052	0.9500	0.0340	0.011	0.0050	0.370	0.0150	16.30
403.11.04	Revolon Slough	FHM	W	07/16/97	0.171	0.0520	0.074	0.8000	0.0150	0.014	<0.0002	1.190	0.0050	15.70
403.11.91	Mugu Lagoon	GSS	F	07/16/97	2.760	0.0030	<0.001	0.1400	0.0004	0.117	0.0020	0.160	0.0010	1.65
403.11.91	Mugu Lagoon	GSS	L	07/16/97	22.300	1.0100	0.911	3.1300	<0.0001	NA	0.0120	2.190	0.3380	9.22
403.12.06	Calleguas Creek	FHM	W	07/16/97	0.078	0.0140	0.059	0.5900	0.0210	0.014	0.0180	0.440	0.0070	17.10
403.12.06	Calleguas Creek	FHM	W	07/16/97	0.052	0.0170	0.072	0.6100	0.0230	0.012	0.0400	0.440	0.0080	16.40

404.21.07	Malibou Lake	LMB	F	07/17/97	0.040	<0.0001	<0.001	0.0900	<0.0001	0.061	0.0010	0.870	<0.0003	2.27
404.21.07	Malibou Lake	LMB	L	07/17/97	0.166	0.6200	0.279	6.4100	<0.0001	NA	0.0380	3.110	0.0040	20.40
404.26.01	Sherwood Lake	LMB	F	07/17/97	0.007	<0.0001	<0.001	0.0800	0.0002	0.214	<0.0002	0.110	<0.0003	2.04
404.26.01	Sherwood Lake	LMB	L	07/17/97	0.110	0.1100	0.440	35.6000	0.0020	NA	0.0180	1.330	0.0020	35.00
405.12.90	Harbor Park Lake	CP	F	07/15/97	0.006	<0.0001	0.072	0.3300	<0.0001	0.004	0.0010	0.330	<0.0003	8.38
405.12.90	Harbor Park Lake	LMB	F	07/15/97	<0.004	<0.0001	0.003	0.0800	<0.0001	0.029	0.0010	0.250	<0.0003	2.24
405.12.90	Harbor Park Lake	LMB	L	07/15/97	0.081	0.0310	0.440	5.9400	0.0110	NA	0.0330	1.860	0.0100	19.40
405.15.91	San Gabriel R/Coyote Cr	TL	W	07/18/97	0.092	0.0030	0.048	0.9100	0.0410	0.004	0.0660	0.280	0.0880	14.60
405.21.17	Lake Balboa	TL	W	07/18/97	0.108	0.0400	0.165	2.1200	0.0770	0.003	0.0770	0.240	0.1110	11.20
405.23.08	Big Tujunga Wash	RCH	W	07/18/97	0.042	0.0020	0.036	1.4900	0.0060	0.109	<0.0002	0.170	0.0020	18.90
508.10.45	Sacramento R/Keswick Dam	RBT	F	12/23/97	<0.004	0.0010	0.020	0.2500	<0.0001	0.017	0.0070	0.150	<0.0003	2.49
508.10.45	Sacramento R/Keswick Dam	RBT	L	12/23/97	0.632	0.5440	0.386	151.0000	0.0130	NA	0.2670	10.800	0.2290	22.10
603.20.33	Bishop Creek	BN	F	09/11/97	0.134	0.0002	<0.001	0.1700	<0.0001	0.039	<0.0002	0.430	<0.0003	3.87
603.20.33	Bishop Creek	BN	L	09/11/97	0.368	0.1380	0.406	47.0000	<0.0001	NA	0.0160	4.770	0.4510	35.50

L = Liver. F = Filet. W = Whole Body. < = Below Indicated Detection Limit. NA = Not Analyzed.
Species codes are listed in Table 3.

Table 1

Toxic Substances Monitoring Program

Preliminary Summary of 1997 Data: Trace Elements in Fish (ppm, wet weight)

Station Number	Station Name	Species Code	Tissue	Sample Date	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
633.20.07	Unnamed Tributary to Red Lake Cr	BK	F	09/16/97	0.091	0.0020	0.010	0.2200	<0.0001	0.020	<0.0002	0.600	<0.0003	3.60
633.20.07	Unnamed Tributary to Red Lake Cr	BK	L	09/16/97	0.195	0.7070	0.474	6.0500	<0.0001	NA	0.0130	2.930	0.0420	26.00
634.10.00	Upper Truckee River/d/s HWY 50	BN	F	09/17/97	0.011	<0.0001	0.003	0.1900	<0.0001	0.037	0.0005	0.060	<0.0003	2.66
634.10.00	Upper Truckee River/d/s HWY 50	BN	L	09/17/97	0.141	0.0280	0.150	39.7000	<0.0001	NA	0.0100	2.810	0.2800	27.00
634.10.06	Saxon Cr/d/s Meyers Landfill	RBT	F	09/17/97	<0.004	<0.0001	<0.001	0.2300	<0.0001	0.031	<0.0002	0.050	<0.0003	3.01
634.10.06	Saxon Cr/d/s Meyers Landfill	RBT	L	09/17/97	<0.004	0.0150	0.406	25.4000	<0.0001	NA	0.0060	0.610	0.3260	24.00
635.20.30	Bear Creek	RBT	F	09/23/97	0.017	0.0004	0.008	0.2300	<0.0001	0.021	0.0030	0.130	<0.0003	3.35
635.20.30	Bear Creek	RBT	L	09/23/97	0.160	0.0810	0.464	34.9000	0.0060	NA	0.0030	2.500	0.3180	39.40
636.00.18	Independence Cr	BN	F	09/23/97	0.051	<0.0001	<0.001	0.2000	<0.0001	0.024	<0.0002	0.060	<0.0003	3.27
636.00.18	Independence Cr	BN	L	09/23/97	0.129	0.0280	0.469	37.2000	0.0030	NA	0.0060	2.200	0.5850	29.60
719.47.00	Coachella Valley Stormwater Ch	TL	F	11/17/97	NA	NA	NA	NA	NA	NA	NA	1.020	NA	NA
723.10.01	Alamo R/Calipatria	CCF	F	11/20/97	NA	NA	NA	NA	NA	NA	NA	1.060	NA	NA
723.10.02	New R/Westmorland	CCF	F	11/20/97	0.026	<0.0001	0.004	0.1700	0.0003	0.024	0.0004	0.360	0.0002	2.76
723.10.02	New R/Westmorland	CCF	L	11/20/97	0.187	0.0150	0.422	1.5600	0.0270	NA	0.0060	3.230	0.0020	19.30
723.10.58	New R/Inter Boundary	CP	F	12/10/97	0.058	<0.0001	0.004	0.2400	0.0001	0.037	0.0010	0.460	0.0020	5.93
728.00.90	Salton Sea/South	TL	F	11/20/97	0.642	<0.0001	<0.001	0.1300	<0.0001	0.003	0.0030	1.310	<0.0003	2.34
728.00.90	Salton Sea/South	TL	L	11/20/97	1.030	0.0320	0.302	1.2600	0.0320	NA	0.3050	6.650	0.0080	25.20
728.00.92	Salton Sea/North	ORC	F	11/18/97	0.718	<0.0001	0.008	0.1600	<0.0001	0.011	0.0030	1.360	<0.0003	1.78
728.00.92	Salton Sea/North	ORC	L	11/18/97	0.666	0.0020	0.764	0.7600	<0.0001	NA	0.0100	2.040	0.0020	16.40
801.11.05	Delhi Channel	PRS	W	06/18/97	0.085	0.0040	0.006	0.6800	0.0200	0.011	0.0020	1.090	0.0040	10.70
801.11.07	San Diego Cr/Michelson Dr	PRS	W	06/19/97	0.134	0.0290	0.043	0.6500	0.0260	0.046	<0.0002	1.550	0.0040	13.60
801.11.09	San Diego Cr/Barranca Pkwy	PRS	W	06/19/97	0.148	0.0230	0.036	0.4800	0.0200	0.014	<0.0002	1.060	0.0060	13.60
801.11.89	Lower Newport Bay/Rhine Ch	CM	F	07/11/97	0.427	0.0010	<0.001	0.6600	0.0050	0.024	0.0002	0.320	<0.0003	4.05

Table 1
Toxic Substances Monitoring Program
Preliminary Summary of 1997 Data

					As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Silver	Zinc
801.11.89	Lower Newport Bay/Rhine Ch	CM	L	07/11/97	1.080	0.0520	0.394	4.3800	0.0770	NA	0.0160	3.260	0.0020	22.20
801.11.96	Peters Canyon Channel	PRS	W	06/19/97	0.057	0.0480	0.029	0.4100	0.0100	0.015	<0.0002	0.850	0.0010	23.70
801.11.96	Peters Canyon Channel	PRS	W	06/19/97	0.063	0.0470	0.034	0.4300	0.0150	0.012	<0.0002	0.880	0.0010	23.30
801.11.99	Upper Newport Bay/Newport Dunes	DT	F	06/20/97	1.480	<0.0001	<0.001	0.1100	<0.0001	0.028	0.0004	0.700	0.0010	3.83
801.11.99	Upper Newport Bay/Newport Dunes	DT	L	06/20/97	5.180	0.1850	0.677	22.1000	0.0090	NA	0.0290	2.540	0.0340	73.00
902.11.01	Santa Margarita R/Stuart Mesa Rd	GAM	W	06/24/97	0.058	0.0030	0.006	0.4700	0.0020	0.018	<0.0002	0.160	0.0060	16.40
906.40.01	Rose Cr/d/s Mission Bay Dr	GAM	W	06/23/97	0.065	0.0020	0.023	0.5800	0.0560	0.012	<0.0002	0.210	0.0030	16.90
906.40.01	Rose Cr/d/s Mission Bay Dr	GAM	W	06/23/97	0.057	0.0020	0.024	0.6400	0.0620	0.012	<0.0002	0.220	0.0030	16.40
907.11.03	San Diego R/u/s Taylor St	BG	F	06/23/97	0.023	<0.0001	0.004	0.1200	<0.0001	0.015	<0.0002	0.340	<0.0003	2.69
907.11.03	San Diego R/u/s Taylor St	BG	L	06/23/97	0.221	0.0160	0.502	1.0800	<0.0001	NA	0.0100	2.060	0.0010	16.30
909.12.03	Sweetwater R/Interstate 805	LMB	W	06/22/97	0.012	0.0010	0.004	0.1800	0.0090	0.022	<0.0002	0.130	0.0005	10.80
910.20.05	Otay R/Apache Service Pond	BG	F	06/22/97	0.031	<0.0001	<0.001	0.0700	0.0003	0.053	<0.0002	0.360	<0.0003	3.29
910.20.05	Otay R/Apache Service Pond	BG	L	06/22/97	0.237	0.0140	0.576	1.5600	<0.0001	NA	0.0220	2.220	0.0010	20.90
911.11.04	Tijuana R/Dairy Mart Rd	GAM	W	06/22/97	0.052	0.0010	0.017	0.4100	0.0190	0.012	<0.0002	0.330	0.0110	12.80

L = Liver. F = Filet. W = Whole Body. < = Below Indicated Detection Limit. NA = Not Analyzed.
Species codes are listed in Table 3.

TABLE 2

Toxic Substances Monitoring Program

Preliminary Summary of 1997 Data: Organic Chemicals in Fish (ppb, wet weight)

Station Number	Station Name	Species Code	Tissue Type	Sample Date	Aldrin	alpha-Chlordene	cis-Chlordane	gamma-Chlordene	trans-Chlordane	cis-Nonachlor	trans-Nonachlor	Oxychlordane	Total Chlordane	Chlorpyrifos	Dacthal
105.11.08	Klamath R/Klamath Glen	SCP	W	08/27/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
106.12.03	Trinity R/Willow Creek	RBT	W	08/28/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
108.10.00	Big Lagoon	STB	W	08/27/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
111.12.01	Eel R/Scotia	SCP	W	08/26/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
114.11.05	Russian R/Duncans Mills	SKR	F	08/08/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
114.11.23	Russian R/Wohler Brg	SMB	W	08/07/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
114.21.10	Laguna de Santa Rosa/Stony Pt	SKR	F	08/07/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
114.23.00	Mark West Creek	BG	W	08/07/97	<5.0	<5.0	<5.0	<5.0	<5.0	6.8	20.0	<5.0	26.8	<10.0	<5.0
114.24.12	Lake Sonoma	LMB	F	09/30/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
114.24.17	Lake Sonoma/Upper Warm Spr Arm	LMB	F	09/30/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0

Station Number	Dieldrin	o,p' DDD	p,p' DDD	o,p' DDE	p,p' DDE	o,p' DDT	p,p' DDT	p,p' DDMU	p,p' DDMS	Total DDT	Dicofol	Diazinon	Endosulfan I	Endosulfan II	Endosulfan Sulfate	Total Endosulfan	Endrin	Ethion
105.11.08	<5.0	<10.0	<10.0	<10.0	<5.0	<10.0	<10.0	<15.0	NA	ND	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
106.12.03	<5.0	<10.0	<10.0	<10.0	<5.0	<10.0	<10.0	<15.0	NA	ND	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
108.10.00	<5.0	<10.0	<10.0	<10.0	<5.0	<10.0	<10.0	<15.0	NA	ND	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
111.12.01	<5.0	<10.0	<10.0	<10.0	<5.0	<10.0	<10.0	<15.0	NA	ND	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
114.11.05	<5.0	<10.0	<10.0	<10.0	5.0	<10.0	<10.0	<15.0	NA	5.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
114.11.23	<5.0	<10.0	<10.0	<10.0	12.0	<10.0	<10.0	<15.0	NA	12.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
114.21.10	<5.0	<10.0	<10.0	<10.0	<5.0	<10.0	<10.0	<15.0	NA	ND	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
114.23.00	<5.0	<10.0	12.0	<10.0	48.0	<10.0	<10.0	<15.0	NA	60.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
114.24.12	<5.0	<10.0	<10.0	<10.0	<5.0	<10.0	<10.0	<15.0	NA	ND	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
114.24.17	<5.0	<10.0	<10.0	<10.0	<5.0	<10.0	<10.0	<15.0	NA	ND	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0

Toxaphene Station Group Number A	alpha- Chemical HCH	beta- HCH	delta- HCH	gamma- HCH (Lindane)	Total HCH	Hepta- chlor	Hepta- chlor- epoxide	Hexa- chloro- benzene	Methoxy- chlor	Oxa- diazon	Ethyl Para- thion	Methyl Para- thion	PCB 1248	PCB 1254	PCB 1260	Total PCB
105.11.08	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND
<100.0	ND															
106.12.03	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND
<100.0	ND															
108.10.00	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND
<100.0	ND															
111.12.01	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND
<100.0	ND															
114.11.05	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND
<100.0	ND															
114.11.23	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND
<100.0	ND															
114.21.10	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND
<100.0	ND															
114.23.00	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND
<100.0	26.8															
114.24.12	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND
<100.0	ND															
114.24.17	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND
<100.0	ND															

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F = Filet.
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Species codes are listed in Table 3.

TABLE 2

Toxic Substances Monitoring Program

Preliminary Summary of 1997 Data: Organic Chemicals in Fish (ppb, wet weight)

Station Number	Station Name	Species Code	Tissue Type	Sample Date	Aldrin	alpha-Chlordene	cis-Chlordane	gamma-Chlordene	trans-Chlordane	cis-Nonachlor	trans-Nonachlor	Oxychlordane	Total Chlordane	Chlorpyrifos	Dacthal
315.31.00	Devereaux Slough	LJM	F	08/21/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
403.11.02	Rio de Santa Clara/Oxnard Drain	GAM	W	07/16/97	<5.0	<5.0	<5.0	<5.0	11.0	47.0	140.0	67.0	265.0	<10.0	330.0
403.11.02	Rio de Santa Clara/Oxnard Drain	GAM	W	07/16/97	<5.0	<5.0	5.8	<5.0	14.0	50.0	140.0	73.0	282.8	<10.0	380.0
403.11.04	Revolon Slough	FHM	W	07/16/97	<5.0	<5.0	55.0	6.1	37.0	35.0	96.0	36.0	265.1	18.0	560.0
403.11.91	Mugu Lagoon	GSS	F	07/16/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
403.12.06	Calleguas Creek	FHM	W	07/16/97	<5.0	<5.0	27.0	<5.0	14.0	17.0	39.0	<5.0	97.0	<10.0	18.0
403.12.06	Calleguas Creek	FHM	W	07/16/97	<5.0	<5.0	31.0	<5.0	16.0	17.0	47.0	6.7	117.7	<10.0	18.0
404.21.07	Malibou Lake	LMB	F	07/17/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
404.26.01	Sherwood Lake	LMB	F	07/17/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
405.12.90	Harbor Park Lake	CP	F	07/15/97	<5.0	9.9	57.0	9.0	47.0	45.0	99.0	10.0	276.9	<10.0	<5.0

Station Number	Dieldrin	o,p' DDD	p,p' DDD	o,p' DDE	p,p' DDE	o,p' DDT	p,p' DDT	p,p' DDMU	p,p' DDMS	Total DDT	Dicofol	Diazinon	Endosulfan I	Endosulfan II	Endosulfan Sulfate	Total Endosulfan	Endrin	Ethion
315.31.00	<5.0	<10.0	<10.0	<10.0	7.4	<10.0	<10.0	<15.0	NA	7.4	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
403.11.02	26.0	70.0	820.0	29.0	3600.0	20.0	310.0	170.0	NA	5019.0	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
403.11.02	25.0	75.0	910.0	29.0	3600.0	19.0	330.0	180.0	NA	5143.0	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
403.11.04	63.0	100.0	450.0	48.0	4800.0	200.0	200.0	140.0	NA	5938.0	NA	79.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
403.11.91	<5.0	<10.0	<10.0	<10.0	43.0	<10.0	<10.0	<15.0	NA	43.0	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
403.12.06	15.0	84.0	300.0	59.0	3900.0	150.0	85.0	100.0	NA	4678.0	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
403.12.06	16.0	94.0	300.0	64.0	4100.0	170.0	100.0	120.0	NA	4948.0	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
404.21.07	<5.0	<10.0	<10.0	<10.0	<5.0	<10.0	<10.0	<15.0	NA	ND	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
404.26.01	<5.0	<10.0	<10.0	<10.0	5.0	<10.0	<10.0	<15.0	NA	5.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
405.12.90	6.5	12.0	96.0	<10.0	220.0	<10.0	<10.0	<15.0	NA	328.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	30.0

Station Group Number A	alpha-HCH	beta-HCH	delta-HCH	gamma-HCH (Lindane)	Total HCH	Hepta-chlor	Hepta-chlor-epoxide	Hexa-chloro-benzene	Methoxy-chlor	Oxa-diazon	Ethyl Para-thion	Methyl Para-thion	PCB 1248	PCB 1254	PCB 1260	Total PCB	Toxaphene	Chemical
315.31.00	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	ND
403.11.02	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	110.7	<50.0	110.7	814.0	1105.0
403.11.02	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	99.1	<50.0	99.1	1010.0	1317.8
403.11.04	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	4.3	<15.0	9.5	<10.0	<10.0	<50.0	495.0	<50.0	495.0	12000.0	12328.1
403.11.91	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	ND
403.12.06	<2.0	<10.0	<5.0	7.0	7.0	<5.0	<5.0	3.4	<15.0	6.0	<10.0	<10.0	<50.0	284.0	61.0	345.0	5000.0	5119.0
403.12.06	<2.0	<10.0	<5.0	7.0	7.0	<5.0	<5.0	3.5	<15.0	6.7	<10.0	<10.0	<50.0	291.0	54.5	345.5	5400.0	5540.7
404.21.07	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	ND
404.26.01	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	ND
405.12.90	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	9.6	<10.0	<10.0	<50.0	275.0	169.0	444.0	<100.0	283.4

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TABLE 2

Toxic Substances Monitoring Program

Preliminary Summary of 1997 Data: Organic Chemicals in Fish (ppb, wet weight)

Station Number	Station Name	Species Code	Tissue Type	Sample Date	Aldrin	alpha-Chlordene	cis-Chlordane	gamma-Chlordene	trans-Chlordane	cis-Nonachlor	trans-Nonachlor	Oxychlordane	Total Chlordane	Chlorpyrifos	Dacthal
405.12.90	Harbor Park Lake	LMB	F	07/15/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	6.3	<5.0	6.3	<10.0	<5.0
405.15.91	San Gabriel R/Coyote Cr	TL	W	07/18/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
405.21.17	Lake Balboa	TL	W	07/18/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
405.23.08	Big Tujunga Wash	RCH	W	07/18/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	6.0	<5.0	6.0	<10.0	<5.0
634.10.06	Saxon Cr/d/s Meyers Landfill	RBT	F	09/17/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
719.47.00	Coachella Valley Stormwater Ch	TL	F	11/17/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
723.10.01	Alamo R/Calipatria	CCF	F	11/20/97	<5.0	<5.0	6.7	<5.0	<5.0	<5.0	9.5	<5.0	16.2	73.0	620.0
723.10.02	New R/Westmorland	CCF	F	11/20/97	<5.0	<5.0	8.6	<5.0	6.7	<5.0	8.4	<5.0	23.7	63.0	1100.0
723.10.58	New R/Inter Boundary	CP	F	12/10/97	<5.0	<5.0	7.3	<5.0	6.0	<5.0	<5.0	<5.0	13.3	<10.0	<5.0
728.00.90	Salton Sea/South	TL	F	11/20/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0

Station Number	Dieldrin	o,p' DDD	p,p' DDD	o,p' DDE	p,p' DDE	o,p' DDT	p,p' DDT	p,p' DDMU	p,p' DDMS	Total DDT	Dicofol	Diazinon	Endosulfan I	Endosulfan II	Endosulfan Sulfate	Total Endosulfan	Endrin	Ethion
405.12.90	<5.0	<10.0	<10.0	<10.0	14.0	<10.0	<10.0	<15.0	NA	14.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
405.15.91	<5.0	<10.0	<10.0	<10.0	<5.0	<10.0	<10.0	<15.0	NA	ND	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
405.21.17	<5.0	<10.0	<10.0	<10.0	51.0	<10.0	<10.0	<15.0	NA	51.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
405.23.08	<5.0	<10.0	<10.0	<10.0	12.0	<10.0	<10.0	<15.0	NA	12.0	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
634.10.06	<5.0	<10.0	<10.0	<10.0	<5.0	<10.0	<10.0	<15.0	NA	ND	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
719.47.00	<5.0	<10.0	<10.0	<10.0	16.0	<10.0	<10.0	<15.0	NA	16.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
723.10.01	23.0	17.0	53.0	17.0	2500.0	<10.0	<10.0	34.0	NA	2621.0	NA	<50.0	8.2	<70.0	<85.0	8.2	<15.0	<20.0
723.10.02	17.0	<10.0	32.0	<10.0	450.0	<10.0	<10.0	<15.0	NA	482.0	NA	<50.0	8.0	<70.0	<85.0	8.0	<15.0	<20.0
723.10.58	<5.0	<10.0	20.0	<10.0	60.0	<10.0	<10.0	<15.0	NA	80.0	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
728.00.90	<5.0	<10.0	<10.0	<10.0	31.0	<10.0	<10.0	<15.0	NA	31.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0

Station Number	alpha-HCH	beta-HCH	delta-HCH	gamma-HCH (Lindane)	Total HCH	Hepta-chlor	Hepta-chlor-epoxide	Hexa-chloro-benzene	Methoxy-chlor	Oxa-diazon	Ethyl Para-thion	Methyl Para-thion	PCB 1248	PCB 1254	PCB 1260	Total PCB	Toxaphene	Chemical Group A
405.12.90	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	6.3
405.15.91	<2.0	<10.0	<5.0	6.5	6.5	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	6.5
405.21.17	<2.0	<10.0	<5.0	9.0	9.0	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	9.0
405.23.08	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	6.0
634.10.06	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	ND
719.47.00	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	ND
723.10.01	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	2.6	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	340.0	387.4
723.10.02	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	3.8	<15.0	<5.0	<10.0	<10.0	<50.0	130.0	110.0	240.0	390.0	438.7
723.10.58	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	6.3	<15.0	<5.0	<10.0	<10.0	66.0	51.0	<50.0	117.0	<100.0	13.3
728.00.90	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	ND

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Station Number	Station Name	Species Code	Tissue Type	Sample Date	Aldrin	alpha-Chlordene	cis-Chlordane	gamma-Chlordene	trans-Chlordane	cis-Nonachlor	trans-Nonachlor	Oxychlordane	Total Chlordane	Chlorpyrifos	Dacthal
728.00.92	Salton Sea/North	ORC	F	11/18/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	25.3
801.11.05	Delhi Channel	PRS	W	06/18/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	8.9	<5.0	8.9	<10.0	<5.0
801.11.07	San Diego Cr/Michelson Dr	PRS	W	06/19/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
801.11.09	San Diego Cr/Barranca Pkwy	PRS	W	06/19/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
801.11.89	Lower Newport Bay/Rhine Ch	CM	F	07/11/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
801.11.96	Peters Canyon Channel	PRS	W	06/19/97	<5.0	<5.0	9.4	<5.0	5.9	<5.0	11.0	<5.0	26.3	71.0	<5.0
801.11.96	Peters Canyon Channel	PRS	W	06/19/97	<5.0	<5.0	11.0	<5.0	6.9	5.0	13.0	5.0	40.9	83.0	<5.0
801.11.99	Upper Newport Bay/Newport Dunes	DT	F	06/20/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
902.11.01	Santa Margarita R/Stuart Mesa Rd	GAM	W	06/24/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
906.40.01	Rose Cr/d/s Mission Bay Dr	GAM	W	06/23/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	11.0	5.5	16.5	<10.0	<5.0

Station Number	Dieldrin	o,p' DDD	p,p' DDD	o,p' DDE	p,p' DDE	o,p' DDT	p,p' DDT	p,p' DDMU	p,p' DDMS	Total DDT	Dicofol	Diazinon	Endosulfan I	Endosulfan II	Endosulfan Sulfate	Total Endosulfan	Endrin	Ethion
728.00.92	<5.0	<10.0	<10.0	<10.0	190.0	<10.0	<10.0	<15.0	NA	190.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
801.11.05	5.5	<10.0	30.0	<10.0	160.0	<10.0	<10.0	<15.0	NA	190.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
801.11.07	11.0	<10.0	29.0	<10.0	160.0	<10.0	<10.0	<15.0	NA	189.0	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
801.11.09	<5.0	<10.0	11.0	<10.0	85.0	<10.0	<10.0	<15.0	NA	96.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
801.11.89	<5.0	<10.0	11.0	<10.0	130.0	<10.0	<10.0	<15.0	NA	141.0	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
801.11.96	9.6	<10.0	47.0	<10.0	740.0	22.0	38.0	35.0	NA	882.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
801.11.96	11.0	<10.0	54.0	<10.0	800.0	24.0	52.0	37.0	NA	967.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
801.11.99	<5.0	<10.0	12.0	<10.0	140.0	<10.0	<10.0	<15.0	NA	152.0	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
902.11.01	<5.0	<10.0	17.0	<10.0	74.0	<10.0	<10.0	<15.0	NA	91.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
906.40.01	5.8	<10.0	<10.0	<10.0	8.7	<10.0	<10.0	<15.0	NA	8.7	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0

Table 2
1997

Station Group Number A	alpha-HCH	beta-HCH	delta-HCH	gamma-HCH (Lindane)	Total HCH	Hepta-chlor	Hepta-chlor-epoxide	Hexa-chloro-benzene	Methoxy-chlor	Oxa-diazon	Ethyl Para-thion	Methyl Para-thion	PCB 1248	PCB 1254	PCB 1260	Total PCB	Toxaphene	Chemical
728.00.92	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	ND
801.11.05	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	8.7	<10.0	<10.0	<50.0	89.7	<50.0	89.7	495.0	509.4
801.11.07	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	76.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	121.0	132.0
801.11.09	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	100.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	ND
801.11.89	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	272.0	74.9	346.9	<100.0	ND
801.11.96	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	42.0	<10.0	<10.0	<50.0	57.5	<50.0	57.5	405.0	440.9
801.11.96	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	48.0	<10.0	<10.0	<50.0	67.6	<50.0	67.6	447.0	498.9
801.11.99	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	ND
902.11.01	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	ND
906.40.01	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	68.0	<10.0	<10.0	<50.0	74.2	<50.0	74.2	<100.0	22.3

NA Means that the sample was not analyzed for the chemical.
ND Means that the chemical was not detected.
< Means that the chemical was not detected above the indicated limit of detection.

F = Filet.
W = Whole Body.
Species codes are listed in Table 3.

TABLE 2

Toxic Substances Monitoring Program

Preliminary Summary of 1997 Data: Organic Chemicals in Fish (ppb, wet weight)

Station Number	Station Name	Species Code	Tissue Type	Sample Date	Aldrin	alpha-Chlordene	cis-Chlordane	gamma-Chlordene	trans-Chlordane	cis-Nonachlor	trans-Nonachlor	Oxychlordane	Total Chlordane	Chlorpyrifos	Dacthal
906.40.01	Rose Cr/d/s Mission Bay Dr	GAM	W	06/23/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	11.0	5.2	16.2	<10.0	<5.0
907.11.03	San Diego R/u/s Taylor St	BG	F	06/23/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
909.12.03	Sweetwater R/Interstate 805	LMB	W	06/22/97	<5.0	<5.0	5.8	<5.0	<5.0	10.0	31.0	5.8	52.6	<10.0	<5.0
910.20.05	Otay R/Apache Service Pond	BG	F	06/22/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0
911.11.04	Tijuana R/Dairy Mart Rd	GAM	W	06/22/97	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	ND	<10.0	<5.0

Station Number	Dieldrin	o,p' DDD	p,p' DDD	o,p' DDE	p,p' DDE	o,p' DDT	p,p' DDT	p,p' DDMU	p,p' DDMS	Total DDT	Dicofol	Diazinon	Endosulfan I	Endosulfan II	Endosulfan Sulfate	Total Endosulfan	Endrin	Ethion
906.40.01	5.8	<10.0	<10.0	<10.0	8.6	<10.0	<10.0	<15.0	NA	8.6	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0
907.11.03	<5.0	<10.0	<10.0	<10.0	<5.0	<10.0	<10.0	<15.0	NA	ND	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
909.12.03	<5.0	<10.0	<10.0	<10.0	39.0	<10.0	<10.0	<15.0	NA	39.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
910.20.05	<5.0	<10.0	<10.0	<10.0	50.0	<10.0	<10.0	<15.0	NA	50.0	NA	<50.0	<5.0	NA	NA	ND	<15.0	<20.0
911.11.04	<5.0	<10.0	14.0	<10.0	40.0	<10.0	<10.0	<15.0	NA	54.0	NA	<50.0	<5.0	<70.0	<85.0	ND	<15.0	<20.0

Station Number	alpha-HCH	beta-HCH	delta-HCH	gamma-HCH (Lindane)	Total HCH	Heptachlor	Heptachlor-epoxide	Hexachlorobenzene	Methoxychlor	Oxadiazon	Ethyl Parathion	Methyl Parathion	PCB 1248	PCB 1254	PCB 1260	Total PCB	Toxaphene	Chemical Group A
906.40.01	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	67.0	<10.0	<10.0	<50.0	83.3	<50.0	83.3	<100.0	22.0
907.11.03	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	ND
909.12.03	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	11.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	52.6
910.20.05	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	<50.0	<50.0	<50.0	ND	<100.0	ND
911.11.04	<2.0	<10.0	<5.0	<2.0	ND	<5.0	<5.0	<2.0	<15.0	<5.0	<10.0	<10.0	55.1	61.7	<50.0	116.8	<100.0	ND

NA Means that the sample was not analyzed for the chemical.
ND Means that the chemical was not detected.
< Means that the chemical was not detected above the indicated limit of detection.

F = Filet.
W = Whole Body.
Species codes are listed in Table 3.

TABLE 3

Toxic Substances Monitoring Program

1997 Freshwater Fish Code List *

Species Code	Common Name	Species Name	Family Name
BG	Blue gill	*Lepomis macrochirus*	Centrarchidae
BK	Brook Trout	*Salvelinus fontinalis*	Salmonidae
BN	Brown Trout	*Salmo trutta*	Salmonidae
CCF	Channel Catfish	*Ictalurus punctatus*	Ictaluridae
CP	Carp	*Cyprinus carpio*	Cyprinidae
FHM	Fathead Minnow	*Pimephales promelas*	Cyprinidae
GAM	Mosquitofish	*Gambusia affinis*	Poeciliidae
LMB	Largemouth Bass	*Micropterus salmoides*	Centrarchidae
PRS	Red Shiner	*Cyprinella lutrensis*	Cyprinidae
RBT	Rainbow Trout	*Oncorhynchus mykiss*	Salmonidae
RCH	California Roach	*Hesperoleucus symmetricus*	Cyprinidae
SCP	Sculpin	*Cottus sp.*	Cottidae
SKR	Sucker	*Catostomus sp.*	Catostomidae
SMB	Smallmouth Bass	*Micropterus dolomieu*	Centrarchidae
STB	Threespine Stickleback	*Gasterosteus aculeatus*	Gasterosteidae
TL	Tilapia	*Tilapia sp.*	Cichlidae

1997 Marine Fish Code List *

Species Code	Common Name	Species Name	Family Name
CM	Chub Mackerel	*Scomber japonicus*	Scombridae
DT	Diamond Turbot	*Hypsopsetta guttulata*	Pleuronectidae
GSS	Gray Smoothhound Shark	*Mustelus californicus*	Carcharhinidae
LJM	Longjaw Mudsucker	*Gillichthys mirabilis*	Gobiidae
ORC	Orangemouth Corvina	*Cynoscion xanthulus*	Sciaenidae

* Common and scientific fish names were obtained from Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N. Lea, and W.B. Scott. 1991. Common and Scientific Names of Fishes from the United States and Canada. American Fisheries Society Special Publication 20, Bethesda, Maryland.

Table 1

Toxic Substances Monitoring Program

Preliminary Summary of 1999 Data: Trace Elements in Fish and Clams (ppm, wet weight)

Station Number	Station Name	Species Code	Tissue	Sample Date	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
801.11.89	Lower Newport Bay/Rhine Ch	YFC	L	08/10/99	NA	NA	0.089	5.3300	0.1290	NA	NA	NA	0.0060	23.90
801.11.96	Peters Canyon Channel	PRS	W	08/05/99	0.179	0.0350	0.121	1.2300	0.0300	0.048	0.1370	4.110	<0.0020	45.80
801.11.96	Peters Canyon Channel	PRS	W	08/05/99	0.190	0.0360	0.171	1.2900	0.0380	0.040	0.1390	4.240	0.0030	44.70
801.11.99	Upper Newport Bay/Newport Dunes	ORC	F	08/04/99	1.300	<0.0020	NA	NA	NA	0.050	0.0170	0.760	NA	NA
801.11.99	Upper Newport Bay/Newport Dunes	ORC	L	08/04/99	NA	NA	0.088	6.2600	0.0080	NA	NA	NA	<0.0020	18.40
901.12.##	Aliso Cr/Pacific Park Dr	PRS	W	08/27/99	0.245	0.2240	0.110	1.3000	0.0710	<0.015	0.1950	1.610	<0.0020	32.50
902.11.01	Santa Margarita R/Stuart Mesa Rd	CKF	W	08/25/99	0.221	0.0050	0.050	1.1200	0.0320	<0.015	0.1900	0.248	0.0270	28.30
902.22.03	Rainbow Creek	GSF	F	08/26/99	0.031	<0.0020	NA	NA	NA	0.051	0.0080	0.388	NA	NA
902.22.03	Rainbow Creek	GSF	L	08/26/99	NA	NA	0.067	2.4500	0.0100	NA	NA	NA	<0.0020	16.70
902.32.##	Murrietta Cr/u/s Temecula Cr	BLB	F	08/26/99	0.036	<0.0020	NA	NA	NA	0.059	0.0370	0.287	NA	NA
902.32.##	Murrietta Cr/u/s Temecula Cr	BLB	L	08/26/99	NA	NA	0.100	9.2500	0.0070	NA	NA	NA	0.0290	19.20
904.10.##	Loma Alta Cr/College Blvd	GAM	W	08/26/99	0.217	0.0220	0.236	3.6900	0.0770	0.061	0.1990	0.371	0.0340	37.70
904.21.02	Buena Vista Lagoon	LMB	F	08/25/99	0.072	<0.0020	NA	NA	NA	0.054	0.0100	0.392	NA	NA
904.21.02	Buena Vista Lagoon	LMB	L	08/25/99	NA	NA	0.122	3.8300	0.0210	NA	NA	NA	0.0060	21.90
904.31.##	Agua Hedionda Cr/El Camino Real	GAM	W	08/24/99	0.386	0.0250	0.220	1.3400	0.0380	<0.015	0.1520	0.461	0.0050	25.90
904.51.03	San Marcos Cr	LMB	F	08/24/99	0.045	<0.0020	NA	NA	NA	0.046	0.0230	0.335	NA	NA
904.51.03	San Marcos Cr	LMB	L	08/24/99	NA	NA	0.193	3.0800	<0.0020	NA	NA	NA	<0.0020	16.00
904.61.07	Escondido Cr/Elfin Forest Park	GSF	F	08/24/99	0.064	0.0010	NA	NA	NA	0.050	0.3410	0.496	NA	NA
904.61.07	Escondido Cr/Elfin Forest Park	GSF	L	08/24/99	NA	NA	0.070	2.4400	0.0100	NA	NA	NA	0.0050	17.30
907.11.03	San Diego R/u/s Taylor St	LMB	F	08/23/99	0.096	<0.0020	NA	NA	NA	0.035	0.0150	0.854	NA	NA
907.11.03	San Diego R/u/s Taylor St	LMB	L	08/23/99	NA	NA	0.112	5.9400	0.0130	NA	NA	NA	0.0130	23.10

L = Liver. F = Filet. W = Whole Body. < = Below Indicated Detection Limit. NA = Not Analyzed.
Species codes are listed in Table 3.

TABLE 2

Toxic Substances Monitoring Program

Preliminary Summary of 1999 Data: Organic Chemicals in Fish and Clams (ppb, wet weight)

Station Number	Station Name	Species Code	Tissue Type	Sample Date	Aldrin	alpha-Chlordene	cis-Chlordane	gamma-Chlordene	trans-Chlordane	cis-Nonachlor	trans-Nonachlor	Oxychlordane	Total Chlordane	Chlorpyrifos	Dacthal
801.11.09	San Diego Cr/Barranca Pkwy	PRS	W	08/05/99	<1.0	<1.0	4.2	<1.0	2.3	2.3	5.7	2.1	16.6	<2.0	<2.0
801.11.89	Lower Newport Bay/Rhine Ch	YFC	F	08/10/99	<1.0	<1.0	<2.0	<1.0	<2.0	<2.0	<1.0	<1.0	ND	<2.0	<2.0
801.11.96	Peters Canyon Channel	PRS	W	08/05/99	<1.0	<1.0	3.2	<1.0	2.6	2.9	9.1	1.4	19.3	4.2	<2.0
801.11.96	Peters Canyon Channel	PRS	W	08/05/99	<1.0	<1.0	3.3	<1.0	2.8	3.2	9.8	1.5	20.7	5.2	<2.0
801.11.99	Upper Newport Bay/Newport Dunes	ORC	F	08/04/99	<1.0	<1.0	<2.0	<1.0	<2.0	<2.0	1.9	<1.0	1.9	<2.0	<2.0
901.12.##	Aliso Cr/Pacific Park Dr	PRS	W	08/27/99	<1.0	<1.0	5.4	1.2	2.0	<2.0	5.3	3.6	17.5	4.3	4.1
902.11.01	Santa Margarita R/Stuart Mesa Rd	CKF	W	08/25/99	<1.0	<1.0	<2.0	<1.0	<2.0	<2.0	<1.0	<1.0	ND	<2.0	<2.0
902.22.03	Rainbow Creek	GSF	F	08/26/99	<1.0	<1.0	<2.0	<1.0	<2.0	<2.0	<1.0	<1.0	ND	<2.0	<2.0
902.32.##	Murrietta Cr/u/s Temecula Cr	BLB	F	08/26/99	<1.0	<1.0	<2.0	<1.0	<2.0	<2.0	2.0	<1.0	2.0	<2.0	<2.0
904.10.##	Loma Alta Cr/College Blvd	GAM	W	08/26/99	<1.0	<1.0	<2.0	<1.0	<2.0	<2.0	1.6	<1.0	1.6	<2.0	<2.0

Station Number	Dieldrin	o,p' DDD	p,p' DDD	o,p' DDE	p,p' DDE	o,p' DDT	p,p' DDT	p,p' DDMU	p,p' DDMS	Total DDT	Dicofol	Diazinon	Endosulfan I	Endosulfan II	Endosulfan Sulfate	Total Endosulfan	Endrin	Ethion
801.11.09	4.1	3.2	27.0	<2.0	139.0	<3.0	<5.0	8.9	NA	178.1	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0
801.11.89	<2.0	<2.0	<2.0	<2.0	22.8	<3.0	<5.0	<3.0	NA	22.8	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0
801.11.96	3.3	5.8	24.4	2.7	503.0	<3.0	<5.0	10.9	NA	546.8	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0
801.11.96	3.4	5.8	25.8	2.8	516.0	3.1	<5.0	11.4	NA	564.9	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0
801.11.99	<2.0	<2.0	6.0	<2.0	54.5	<3.0	<5.0	3.3	NA	63.9	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0
901.12.##	8.8	<2.0	<2.0	<2.0	9.4	<3.0	<5.0	<3.0	NA	9.4	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0
902.11.01	<2.0	2.6	4.8	<2.0	15.2	<3.0	<5.0	<3.0	NA	22.5	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0
902.22.03	<2.0	<2.0	<2.0	<2.0	<2.0	<3.0	<5.0	<3.0	NA	ND	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0
902.32.##	<2.0	<2.0	<2.0	<2.0	2.9	<3.0	<5.0	<3.0	NA	2.9	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0
904.10.##	<2.0	<2.0	<2.0	<2.0	7.6	<3.0	<5.0	<3.0	NA	7.6	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0

Station Number	alpha-HCH	beta-HCH	delta-HCH	gamma-HCH (Lindane)	Total HCH	Heptachlor	Heptachlorepoxide	Hexachlorobenzene	Methoxychlor	Oxadiazon	Ethyl Parathion	Methyl Parathion	PCB 1248	PCB 1254	PCB 1260	Total PCB	Toxaphene	Chemical Group A
801.11.09	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	0.7	<5.0	329.0	<2.0	<4.0	<25.0	71.0	14.0	85.0	81.4	102.1
801.11.89	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	<0.3	<5.0	<3.0	<2.0	<4.0	<25.0	39.0	<10.0	39.0	<20.0	ND
801.11.96	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	0.6	<5.0	59.6	<2.0	<4.0	<25.0	26.0	15.0	41.0	72.0	94.6
801.11.96	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	0.6	<5.0	62.7	<2.0	<4.0	<25.0	29.0	15.0	44.0	80.5	104.6
801.11.99	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	<0.3	<5.0	<3.0	<2.0	<4.0	<25.0	21.0	<10.0	21.0	<20.0	1.9
901.12.##	<1.0	<2.0	<2.0	<1.0	ND	<2.0	2.9	0.4	<5.0	41.9	<2.0	<4.0	<25.0	22.0	<10.0	22.0	<20.0	29.2
902.11.01	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	<0.3	<5.0	5.2	<2.0	<4.0	<25.0	<10.0	<10.0	ND	<20.0	ND
902.22.03	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	<0.3	<5.0	<3.0	<2.0	<4.0	<25.0	<10.0	<10.0	ND	<20.0	ND
902.32.##	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	<0.3	<5.0	<3.0	<2.0	<4.0	<25.0	<10.0	<10.0	ND	<20.0	2.0
904.10.##	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	<0.3	<5.0	4.9	<2.0	<4.0	<25.0	21.0	<10.0	21.0	<20.0	1.6

NA Means that the sample was not analyzed for the chemical.
ND Means that the chemical was not detected.
< Means that the chemical was not detected above the indicated limit of detection.

F = Filet.
W = Whole Body.
Species codes are listed in Table 3.

TABLE 2

Toxic Substances Monitoring Program

Preliminary Summary of 1999 Data: Organic Chemicals in Fish and Clams (ppb, wet weight)

Station Number	Station Name	Species Code	Tissue Type	Sample Date	Aldrin	alpha-Chlordene	cis-Chlordane	gamma-Chlordene	trans-Chlordane	cis-Nonachlor	trans-Nonachlor	Oxychlordane	Total Chlordane	Chlorpyrifos	Dacthal
904.21.02	Buena Vista Lagoon	LMB	F	08/25/99	<1.0	<1.0	<2.0	<1.0	<2.0	<2.0	<1.0	<1.0	ND	<2.0	<2.0
904.31.##	Agua Hedionda Cr/El Camino Real	GAM	W	08/24/99	<1.0	<1.0	<2.0	<1.0	<2.0	<2.0	4.7	2.6	7.2	<2.0	<2.0
904.51.03	San Marcos Cr	LMB	F	08/24/99	<1.0	<1.0	<2.0	<1.0	<2.0	<2.0	<1.0	<1.0	ND	<2.0	<2.0
904.61.07	Escondido Cr/Elfin Forest Park	GSF	F	08/24/99	<1.0	<1.0	<2.0	<1.0	<2.0	<2.0	<1.0	<1.0	ND	<2.0	<2.0
907.11.03	San Diego R/u/s Taylor St.	LMB	F	08/23/99	<1.0	<1.0	<2.0	<1.0	<2.0	<2.0	3.0	<1.0	3.0	<2.0	<2.0

Station Number	Dieldrin	o,p' DDD	p,p' DDD	o,p' DDE	p,p' DDE	o,p' DDT	p,p' DDT	p,p' DDMU	p,p' DDMS	Total DDT	Dicofol	Diazinon	Endosulfan I	Endosulfan II	Endosulfan Sulfate	Total Endosulfan	Endrin	Ethion
904.21.02	<2.0	<2.0	<2.0	<2.0	2.2	<3.0	<5.0	<3.0	NA	2.2	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0
904.31.##	<2.0	<2.0	3.3	<2.0	42.8	<3.0	<5.0	<3.0	NA	46.1	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0
904.51.03	<2.0	<2.0	<2.0	<2.0	<2.0	<3.0	<5.0	<3.0	NA	ND	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0
904.61.07	<2.0	<2.0	<2.0	<2.0	<2.0	<3.0	<5.0	<3.0	NA	ND	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0
907.11.03	<2.0	<2.0	<2.0	<2.0	4.8	<3.0	<5.0	<3.0	NA	4.8	NA	<20.0	<2.0	NA	NA	ND	<2.0	<6.0

Station Number	alpha-HCH	beta-HCH	delta-HCH	gamma-HCH (Lindane)	Total HCH	Heptachlor	Heptachlor-epoxide	Hexachlorobenzene	Methoxychlor	Oxadiazon	Ethyl Parathion	Methyl Parathion	PCB 1248	PCB 1254	PCB 1260	Total PCB	Toxaphene	Chemical Group A
904.21.02	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	<0.3	<5.0	<3.0	<2.0	<4.0	<25.0	<10.0	<10.0	ND	<20.0	ND
904.31.##	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	<0.3	<5.0	<3.0	<2.0	<4.0	<25.0	<10.0	<10.0	ND	<20.0	7.2
904.51.03	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	<0.3	<5.0	<3.0	<2.0	<4.0	<25.0	<10.0	<10.0	ND	<20.0	ND
904.61.07	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	<0.3	<5.0	<3.0	<2.0	<4.0	<25.0	<10.0	<10.0	ND	<20.0	ND
907.11.03	<1.0	<2.0	<2.0	<1.0	ND	<2.0	<1.0	<0.3	<5.0	<3.0	<2.0	<4.0	<25.0	18.0	<10.0	18.0	<20.0	3.0

NA Means that the sample was not analyzed for the chemical.
ND Means that the chemical was not detected.
< Means that the chemical was not detected above the indicated limit of detection.

F = Filet.
W = Whole Body.
Species codes are listed in Table 3.

TABLE 3

Toxic Substances Monitoring Program
1999 Species Code List

Freshwater Fish *

Species Code	Common Name	Species Name	Family Name
AC	Arroyo Chub	*Gila orcutti*	Cyprinidae
BB	Brown Bullhead	*Ameiurus nebulosus*	Ictaluridae
BCR	Black Crappie	*Pomoxis nigromaculatus*	Centrarchidae
BG	Bluegill	*Lepomis macrochirus*	Centrarchidae
BK	Brook Trout	*Salvelinus fontinalis*	Salmonidae
BLB	Black Bullhead	*Ameiurus melas*	Ictaluridae
BN	Brown Trout	*Salmo trutta*	Salmonidae
CCF	Channel Catfish	*Ictalurus punctatus*	Ictaluridae
CP	Carp	*Cyprinus carpio*	Cyprinidae
GAM	Mosquitofish	*Gambusia affinis*	Poeciliidae
GSF	Green Sunfish	*Lepomis cyanellus*	Centrarchidae
LMB	Largemouth Bass	*Micropterus salmoides*	Centrarchidae
PCP	Prickly Sculpin	*Cottus asper*	Cottidae
PRS	Red Shiner	*Cyprinella lutrensis*	Cyprinidae
RBT	Rainbow Trout	*Oncorhynchus mykiss*	Salmonidae
RCH	California Roach	*Hesperoleucus symmetricus*	Cyprinidae
SKR	Sucker	*Catostomus sp.*	Catostomidae
SPM	Sacramento Pike Minnow	*Ptychocheilus grandis*	Cyprinidae
STB	Threespine Stickleback	*Gasterosteus aculeatus*	Gasterosteidae
TL	Tilapia	*Tilapia sp.*	Cichlidae

Marine Fish *

Species Code	Common Name	Species Name	Family Name
CKF	California Killifish	*Fundulus parvipinnis*	Cyprindontidae
ORC	Orangemouth Corvina	*Cynoscion xanthulus*	Sciaenidae
SSP	Shiner Perch	*Cymatogaster aggregata*	Embiotocidae
STF	Starry Flounder	*Platichthys stellatus*	Pleuronectidae
YFC	Yellowfin Croaker	*Umbrina roncador*	Sciaenidae

Non-Fish

Species Code	Common Name	Species Name	Family Name
TFC	Asiatic Clam (transplant)	*Corbicula manilensis*	Corbiculidae

* Common and scientific fish names were obtained from Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N. Lea, and W.B. Scott. 1991. Common and Scientific Names of Fishes from the United States and Canada. American Fisheries Society Special Publication 20, Bethesda, Maryland.

Sampling Date	Station Name	Station ID	Detection Limit / Hydrologic Subarea	Station Location	Ammonia-N	Nitrate, as N	Nitrite-N	Total Kjeldahl Nitrogen	Orthophosphate-P	Total Phosphate as P (revised)	Total Phosphate as PO_4	Total Dissolved Solids	Turbidity, NTU	Calcium	Sodium	Magnesium	Potassium	Chloride	Sulfate	Total Hardness	Ec, umhos	Antimony	Arsenic
					0.14	0.20	0.01	0.1	0.02	5.0		10.0		0.10	0.25	0.15	0.56	1.0	40.0	1.0		0.005	0.0
5/20/98	LAC-CB-T1	DFG-978-300	—	Loma Alta Creek at College Blvd	0.23	0.61	0.04	0.70	0.12	0.40		2800	0.98										
5/20/98	BVC-SVW-T3	DFG-978-301	—	Buena Vista Creek at South Vista Way	<.14	2.50	0.02	0.42	0.22	0.22		1378	0.79										
5/20/98	SLRR-FR-T1	DFG-978-302	✓	San Luis Rey River at Foussat Road	<.14	2.40	0.01	0.39	0.58	0.24		850	5.10										
5/20/98	LAC-ECR-A	DFG-978-303	✓	Loma Alta Creek at El Camino Real	<.14	0.27	0.00	0.36	0.44	0.14		2459	0.58										
6/2/98	SR-79	DFG-978-304	✓	Sweetwater River at Hwy 79 near Interstate 8	<.14	0.33	0.00	0.29	0.13	0.13		224	1.90										
6/2/98	SR-94	DFG-978-305	✓	Sweetwater River upstream of Hwy 94 (Campo Road)	<.14	0.36	0.01	0.16	0.07	0.06		397	2.80										
6/2/98	SR-WS	DFG-978-306	✓	Sweetwater River downstream of Willow Street	<.14	0.35	0.01	0.40	0.05	0.20		825	0.76										
6/2/98	SDR-MD	DFG-978-307	7.11✓	San Diego River up stream of Mission Dam	0.19	0.35	0.02	0.38	0.22	0.09		1038	3.70										
6/2/98	SDR-MT	DFG-978-308	7.11✓	San Diego River at Mission Trails Regional Park	<.14	0.28	0.01	0.49	0.14	0.05		1046	0.77										
6/2/98	SDR-FVR	DFG-978-309	7.11✓	San Diego River at Fashion Valley Road	<.14	0.23	0.00	0.42	0.23	0.06		1217	5.00										
6/3/98	LPC-BMR	DFG-978-310	—	Los Penasquitos Creek upstream of Black Mountain Road	<.14	0.34	0.01	0.76	0.30	0.55		1678	0.67										
6/3/98	LPC-CCR	DFG-978-311	✓	Los Penasquitos Creek at Cobblestone Creek Road.	<.14	1.10	0.03	1.90	0.17	0.55		1633	3.80										
6/3/98	RC-HP	DFG-978-312	— 6.20	Rattlesnake Creek at Hilleary Park, off Community Road	<.14	1.50	0.02	1.50	0.46	0.67		1412	0.54										
6/3/98	EC-HRB	DFG-978-313	4.60✓	Escondido Creek below Harmony Grove Bridge.	<.14	7.20	0.07	0.46	0.46	0.37		1196	0.99										
6/3/98	EC-EF	DFG-978-314	✓ 4.60	Escondido Creek at intersection Elfin Forest and Harmony Grove (end of Elfin Forest Resort).	<.14	6.90	0.02	0.55	0.77	0.29		1145	0.38									ND	3.8
6/3/98	EC-LCA	DFG-978-315	—	Encinitas Creek at Green Valley Road	<.14	0.34	<.01	0.54	0.34	0.32		2082	3.70										
6/3/98	SMC-RSFR	DFG-978-316	4.51	San Marcos Creek at Rancho Santa Fe Road	<.14	0.00	0.01	0.60	0.42	0.52		780	0.99										
6/3/98	SMC-M	DFG-978-317	4.51✓	San Marcos Creek at McMahr	<.14	6.20	0.04	0.62	0.49	0.56		1346	13.80										
6/9/98	MC-WB	DFG-978-318	✓	Murrieta Creek at Calle Del Oso Rd	<.14	1.29	<.01	0.31	0.21	0.28		709	0.38									ND	3.0
6/9/98	MC-GS	DFG-978-319	✓	Murrieta Ck behind cement factory	<.14	0.32	0.01	0.44	0.09	0.06		753	2.31									ND	3.1
6/9/98	TC-I15	DFG-978-320	✓	Temecula Ck east of confluence, west of I-15	<.14	1.40	0.01	0.44	0.30	0.17		840	0.67										

Sampling Date	Station Name	Station ID	Hydrologic Subarea	Station Location	Beryllium	Cadmium	Chromium, Total	Chromium, Dissolved	Copper	Lead, Total	Lead, Dissolved	Mercury	Nickel	Selenium	Silver	Thallium	Zinc, Total	Zinc, Dissolved	Ceriodaphnia-survival	Ceriodaphnia-reproduction	Pimephales-survival	Pimephales-growth
			Detection Limit		0.0005	0.0005	0.4	0.01	0.01	0.001	0.001	0.0005	0.01	0.002	0.01	0.001	0.01	0.01				
5/20/98	LAC-CB-T1	DFG-978-300		Loma Alta Creek at College Blvd																		
5/20/98	BVC-SVW-T3	DFG-978-301		Buena Vista Creek at South Vista Way																		
5/20/98	SLRR-FR-T1	DFG-978-302		San Luis Rey River at Foussat Road																		
5/20/98	LAC-ECR-A	DFG-978-303		Loma Alta Creek at El Camino Real																		
6/2/98	SR-79	DFG-978-304		Sweetwater River at Hwy 79 near Interstate 8																		
6/2/98	SR-94	DFG-978-305		Sweetwater River upstream of Hwy 94 (Campo Road)																		
6/2/98	SR-WS	DFG-978-306		Sweetwater River downstream of Willow Street																		
6/2/98	SDR-MD	DFG-978-307	7.11	San Diego River up stream of Mission Dam																		
6/2/98	SDR-MT	DFG-978-308	7.11	San Diego River at Mission Trails Regional Park																		
6/2/98	SDR-FVR	DFG-978-309	7.11	San Diego River at Fashion Valley Road																		
6/3/98	LPC-BMR	DFG-978-310		Los Penasquitos Creek upstream of Black Mountain Road																		
6/3/98	LPC-CCR	DFG-978-311		Los Penasquitos Creek at Cobblestone Creek Road.																		
6/3/98	RC-HP	DFG-978-312	6.20	Rattlesnake Creek at Hilleary Park, off Community Road																		
6/3/98	EC-HRB	DFG-978-313	4.60	Escondido Creek below Harmony Grove Bridge.																		
6/3/98	EC-EF	DFG-978-314	4.60	Escondido Creek at intersection Elfin Forest and Harmony Grove (end of Elfin Forest Resort).	ND	ND	11.0		13.7	150		ND	2.4	ND	ND	ND	72.8					
6/3/98	EC-LCA	DFG-978-315		Encinitas Creek at Green Valley Road																		
6/3/98	SMC-RSFR	DFG-978-316	4.51	San Marcos Creek at Rancho Santa Fe Road	These are in units of mg/kg wet weight.																	
6/3/98	SMC-M	DFG-978-317	4.51	San Marcos Creek at McMahr																		
6/9/98	MC-WB	DFG-978-318		Murrieta Creek at Calle Del Oso Rd	ND	1.1	16.2		26.3	36.7		0.068	9.4	ND	ND	ND	182					
6/9/98	MC-GS	DFG-978-319		Murrieta Ck behind cement factory	ND	ND	2.8		6.1	9.2		ND	1.9	ND	ND	3.0	53.8					
6/9/98	TC-I15	DFG-978-320		Temecula Ck east of confluence, west of I-15																		

			Detection Limit		0.14	0.20	0.01	0.1	0.02	5.0		10.0		0.10	0.25	0.15	0.56	1.0	40.0	1.0		0.005	0.0
Sampling Date	Station Name	Station ID	Hydrologic Subarea	Station Location	Ammonia-N	Nitrate, as N	Nitrite-N	Total Kjeldahl Nitrogen	Orthophosphate-P	Total Phosphate as P (revised)	Total Phosphate as PO_4	Total Dissolved Solids	Turbidity, NTU	Calcium	Sodium	Magnesium	Potassium	Chloride	Sulfate	Total Hardness	Ec, umhos	Antimony	Arsenic
6/9/98	RC-WGR	DFG-978-321	✓	Rainbow Creek at Willow Glen Rd	<.14	11.47	0.02	0.44	0.95	0.77		810	0.30										
6/9/98	SMR-WGR	DFG-978-322	—	Santa Margarita at Willow Glen Rd (Stage Coach Ln).	<.14	3.76	0.02	0.47	0.11	0.62		913	0.46										
6/9/98	SMR-SCD	DFG-978-323	✓	SMR at DeLuz/ Pico Rd near Sandia Ck	<.14	4.69	0.01	0.34	0.18	0.35		923	0.50										
6/9/98	SC-SCR	DFG-978-324	—	Sandia Ck at Sandia Ck Rd, 0.5 to 1 mile above confluence	<.14	5.83	0.01	0.17	0.24	0.30		817	1.80									ND	7.8
6/9/98	SMR-CP	DFG-978-325	✓	Santa Margarita River below diversion weir on Camp Pendleton	<.14	2.71	0.01	0.34	0.23	0.41		667	3.77									ND	5.9
6/9/98	SMR-SMB	DFG-978-326	✓	SMR at Stuart Mesa Rd bridge on Camp Pendleton	<.14	1.63	0.01	0.28	0.23	0.35		713	3.60									ND	2.3
6/10/98	BVR-ED	DFG-978-327	✓	San Marcos Creek at Rancheros Drive	<.14	14.70	0.05	0.53	0.14	0.95		1372	0.49										
6/10/98	AHC-SA	DFG-978-328	—	Agua Hedionda Ck at Sycamore Ave	0.17	15.30	0.08	0.58	1.00	0.90		1144	1.10										
6/10/98	SMC-SP	DFG-978-329	✓	Buena Vista Ck at Wildwood Park	0.23	3.40	0.09	0.62	0.12	0.75		1360	1.70										
6/10/98	AC-CCR	DFG-978-330	—	Aliso Ck along Country Club Rd	3.30	3.10	1.00	0.81	1.10	0.93		1712	4.10									ND	1.2
6/10/98	AC-PPD	DFG-978-331	✓	Aliso Ck at Pacific Park Dr/ Oso Pkwy	0.18	1.00	0.03	0.56	0.15	0.81		1961	1.10										
6/10/98	AHC-ECR	DFG-978-332	✓	Agua Hedionda Ck at El Camino Real	<.14	5.80	0.02	0.53	0.44	0.61		1716	0.55										
6/11/98	SLRR-395	DFG-978-333	✓	San Luis Rey River at old Hwy 395 (Couser Canyon Rd)	<.14	4.20	0.03	0.42	0.75	0.99		970	3.73										These ar
6/29/98		LLP-978-405-BUV	✓	Buena Vista Creek	<.14	1.20	0.02	0.64	0.83		7.1	1133	1.3	120	254	80.7	3.6	454	281	570	1965	ND	ND
6/29/98		LLP-978-405-AGH	✓	Agua Hedionda Creek	<.14	4.50	0.03	0.76	0.25		4.2	1624	0.6	168	255	97.9	3.3	465	363	745	2300	ND	ND
6/29/98		LLP-978-405-ESC	✓	Escondido Creek	<.14	3.60	0.01	0.76	0.25		4.6	1382	4.4	109	251	87.5	3.4	322	342	570	1969	ND	ND

Sampling Date	Station Name	Station ID	Hydrologic Subarea	Station Location	Beryllium	Cadmium	Chromium, Total	Chromium, Dissolved	Copper	Lead, Total	Lead, Dissolved	Mercury	Nickel	Selenium	Silver	Thallium	Zinc, Total	Zinc, Dissolved	Ceriodaphnia-survival	Ceriodaphnia-reproduction	Pimephales-survival	Pimephales-growth
			Detection Limit		0.0005	0.0005	0.4	0.01	0.01	0.001	0.001	0.0005	0.01	0.002	0.01	0.001	0.01	0.01				
6/9/98	RC-WGR	DFG-978-321		Rainbow Creek at Willow Glen Rd																		
6/9/98	SMR-WGR	DFG-978-322		Santa Margarita at Willow Glen Rd (Stage Coach Ln).																		
6/9/98	SMR-SCD	DFG-978-323		SMR at DeLuz/ Pico Rd near Sandia Ck																		
6/9/98	SC-SCR	DFG-978-324		Sandia Ck at Sandia Ck Rd, 0.5 to 1 mile above confluence	ND	ND	17.0		20.0	1.7		ND	7.7	ND	ND	ND	26.2					
6/9/98	SMR-CP	DFG-978-325		Santa Margarita River below diversion weir on Camp Pendleton	ND	ND	5.7		4.0	6.7		ND	2.8	ND	ND	1.5	24.3					
6/9/98	SMR-SMB	DFG-978-326		SMR at Stuart Mesa Rd bridge on Camp Pendleton	ND	0.44	14.7		9.1	12.3		ND	5.5	ND	ND	ND	81.1					
6/10/98	BVR-ED	DFG-978-327		San Marcos Creek at Rancheros Drive																		
6/10/98	AHC-SA	DFG-978-328		Agua Hedionda Ck at Sycamore Ave																		
6/10/98	SMC-SP	DFG-978-329		Buena Vista Ck at Wildwood Park																		
6/10/98	AC-CCR	DFG-978-330		Aliso Ck along Country Club Rd	ND	ND	7.6		2.2	ND		ND	3.4	ND	ND	1.2	16.0					
6/10/98	AC-PPD	DFG-978-331		Aliso Ck at Pacific Park Dr/ Oso Pkwy																		
6/10/98	AHC-ECR	DFG-978-332		Agua Hedionda Ck at El Camino Real																		
6/11/98	SLRR-395	DFG-978-333		San Luis Rey River at old Hwy 395 (Couser Canyon Rd)	are in units of milligrams per liter.																	
6/29/98		LLP-978-405-BUV		Buena Vista Creek	ND	ND	0.0	0.01	ND	ND	ND	ND	ND	ND	ND	ND	0.04	0.02	No Difference			
6/29/98		LLP-978-405-AGH		Agua Hedionda Creek	ND	ND	0.0	0.01	ND	ND	ND	ND	ND	ND	ND	ND	0.03	0.02	No Difference			
6/29/98		LLP-978-405-ESC		Escondido Creek	ND	ND	0.0	0.01	ND	ND	0.002	ND	ND	ND	ND	ND	0.06	0.04	No Difference			

QA/QC ?

From: Linda Pardy
To: Tracy_Weddle@nps.gov
Date: 3/5/01 2:45PM
Subject: Re: Cabrillo National Monument Water Quality Data

Tracy, FYI. In reply to your email:
The source of 1998 water quality data was the San Diego Regional Water Quality Control Board (Regional Board). The Regional Board collected water samples at selected sites throughout the Region to scan sites for elevated levels of the sampled parameters. The June 1998 sampling was limited to those samples/constituents shown. The samples were delivered to the lab by the Regional Board. The contract lab which did the analyses was Truesdail Laboratories, Inc is located at 14201 Franklin Ave, Tustin, CA 92780-7008. The project manager at that time for the testing was Divina B. Pascual. Their phone number was 714 730-6239. -Linda

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Linda Pardy, Environmental Specialist
California Regional Water Quality Control Board
San Diego Region
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>>> <Tracy_Weddle@nps.gov> 03/05/01 10:18AM >>>
Ms. Pardy,

I am currenty establishing a baseline water quality report for Cabrillo National Monument for the National Park Service. I am taking over the work of Brett Atkinson, whom you spoke to previously. Brett prepared the data which you sent him for these reports, but there is one bit of information missing before these reports can be completed and the data uploaded to the EPA database STORET. A paragraph description is needed, describing the source of data and purpose for data collection and monitoring. I have looked on your agency's website to try and determine this, but there are so may projects that I could not determine where the data you sent came from. Could you please describe to me what the monitoring was for, the extent of monitoring, and any other information you feel is significant? I am attaching a copy of the data you sent in case you are unsure about what data I'm referring to. Thank you for your help!

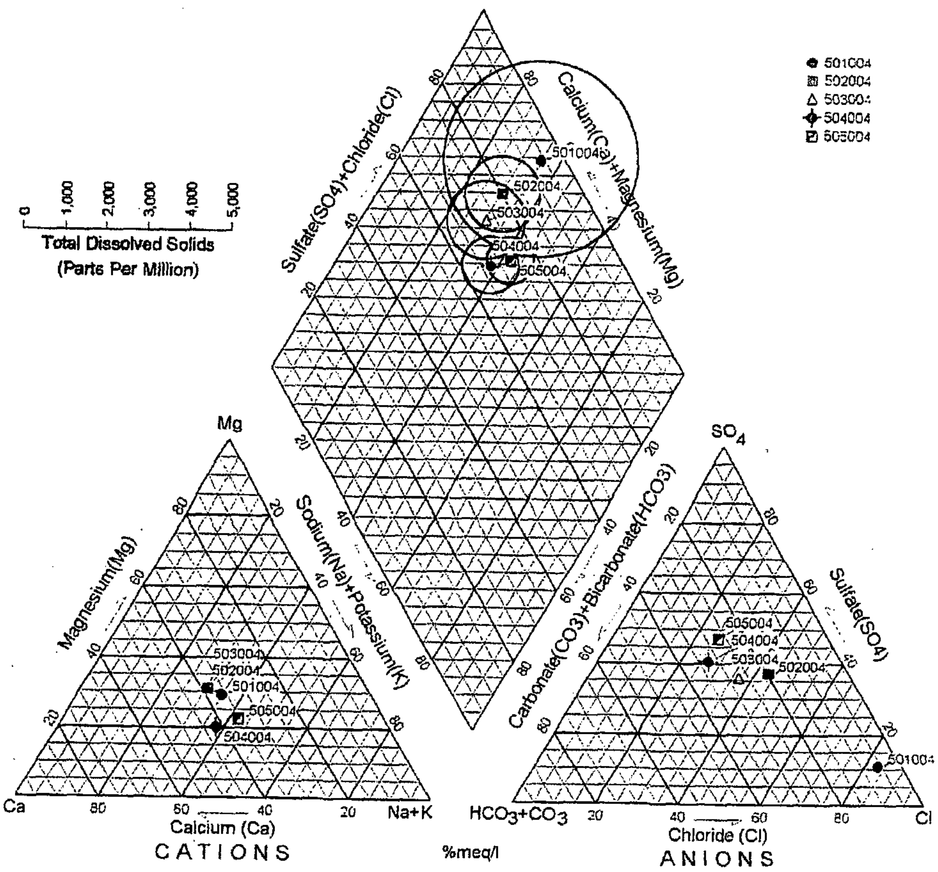
Sincerely,

Tracy Weddle
Water Quality Data Analyst
National Park Service
Water Resources Division
1201 Oakridge Drive, Suite 250
Fort Collins, CO 80525

SMR near Fallbrook
Sandia
Rainbow
SMR near Temec.
Murrieta

Stations 501, 502, 503, 504, and 505

August 4, 1998

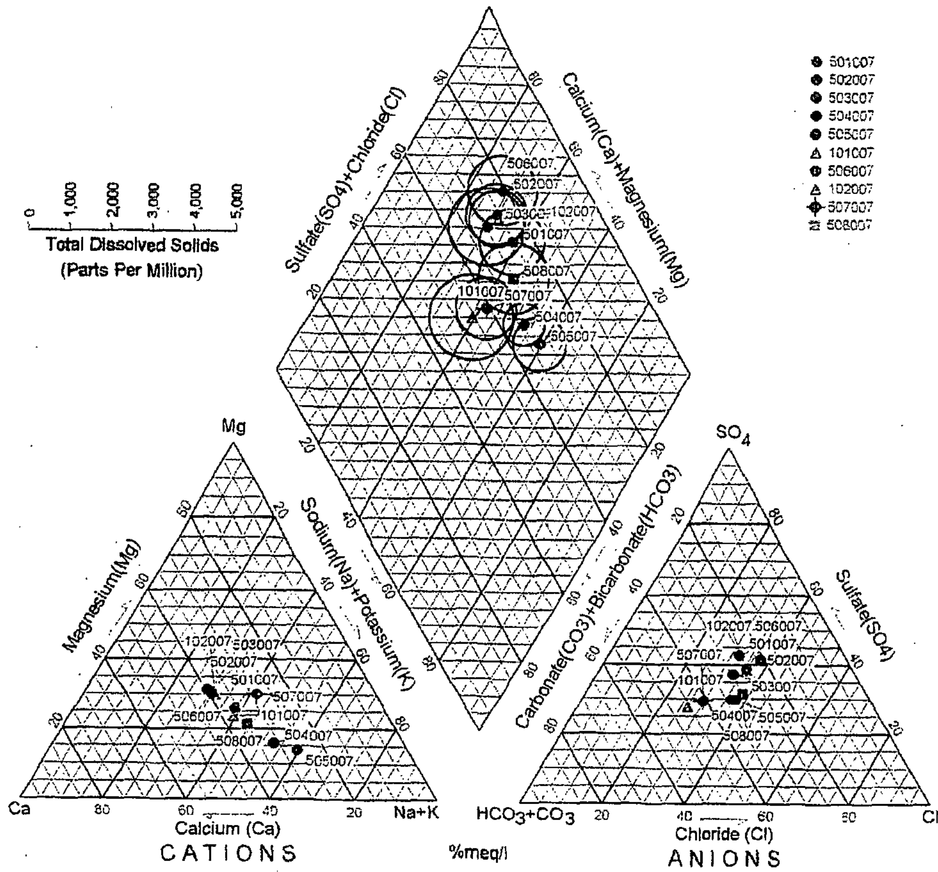


Prepared By: SKR
Checked By: KRM

SWDIV NAVFACENGCOM SAN DIEGO, CALIFORNIA	LAW Crandall LAWGIBB Group Member A Division of Law Engineering and Environmental Services, Inc.	PIPER DIAGRAM STATIONS 501,502,503,504 & 505 SANTA MARGARITA RIVER WATERSHED PROJECT: 70300-7-0193 Figure: 9

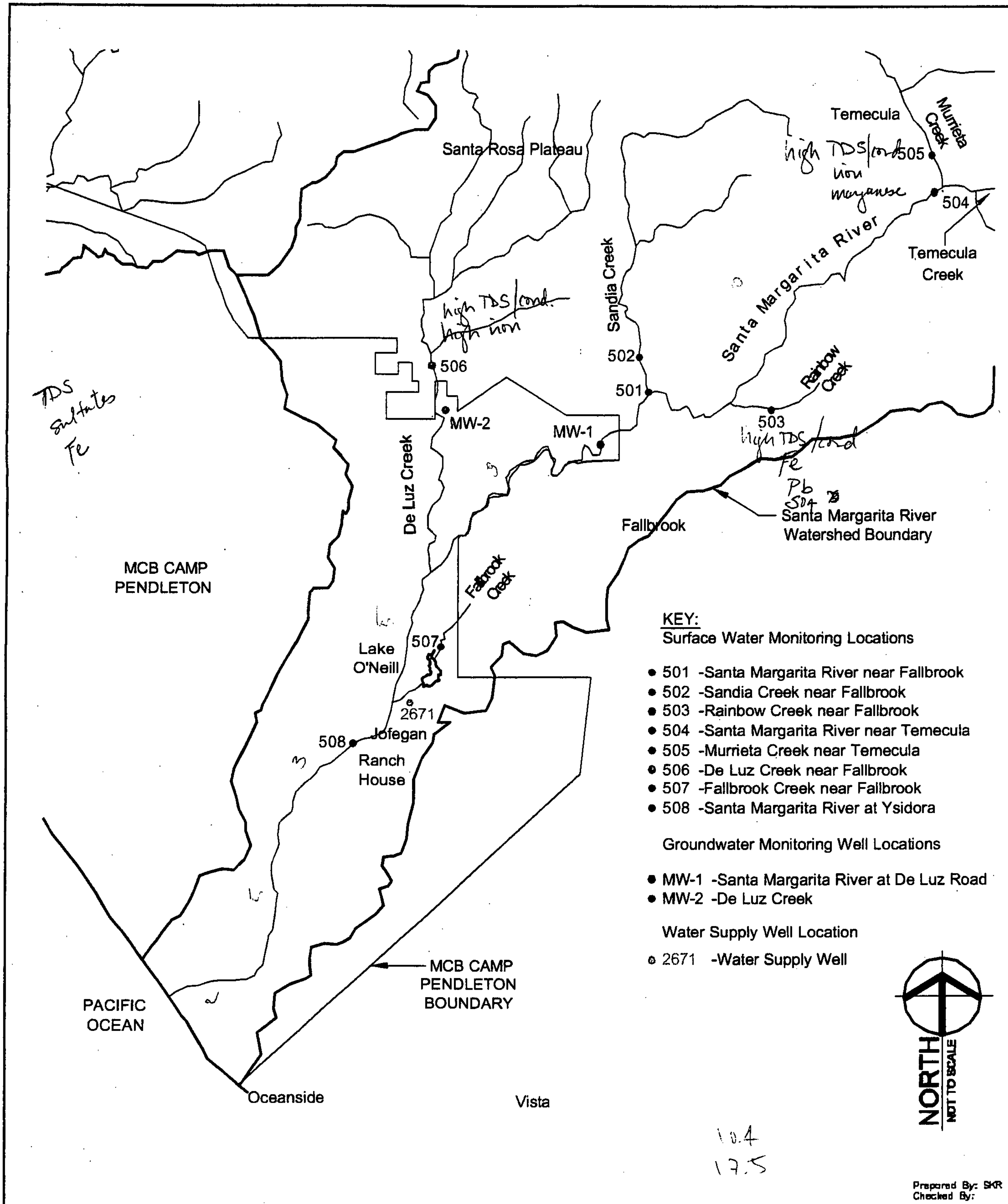
Santa Margarita River Watershed Stations

May 11, 1999



Prepared By: SKR
Checked By: KRM

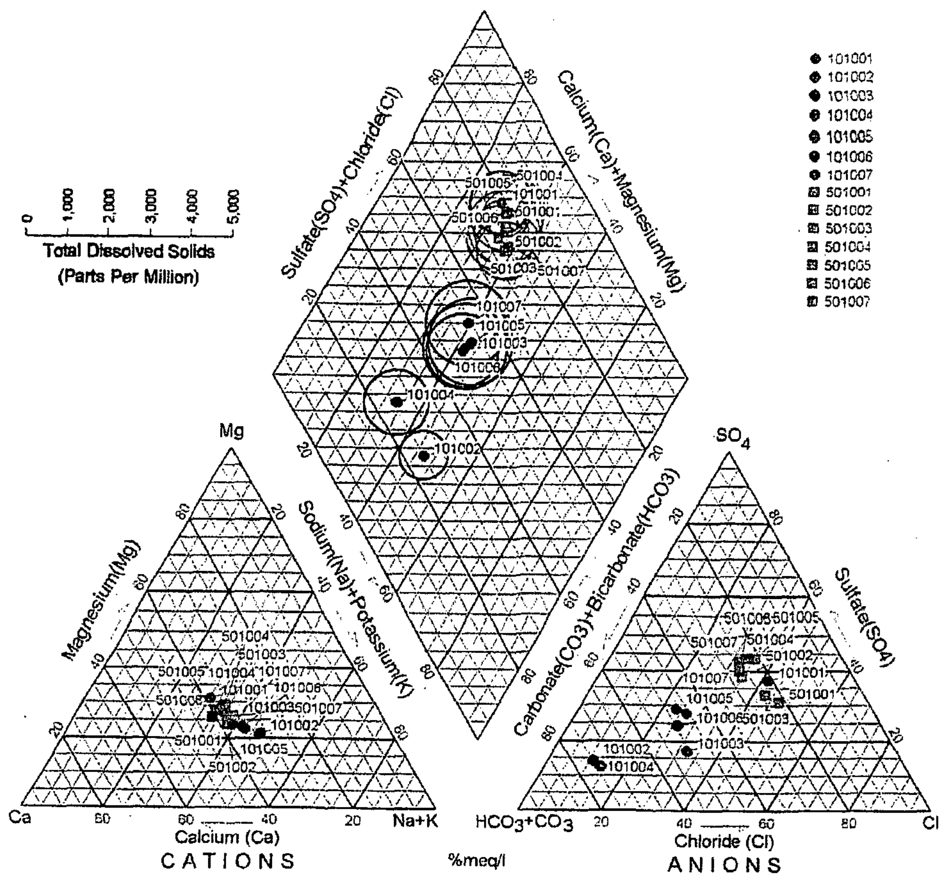
SWDIV NAVFACENGCOM SAN DIEGO, CALIFORNIA	LAW Crandall LAWGIBB Group Member A Division of Law Engineering and Environmental Services, Inc.	PIPER DIAGRAM WATERSHED STATIONS SANTA MARGARITA RIVER WATERSHED PROJECT: 70300-7-0193 Figure: 11



SWDIV NAVFACENGCOM SAN DIEGO, CALIFORNIA	LAW Crandall LAWGIBB Group Member A Division of Law Engineering and Environmental Services, Inc.	MONITORING LOCATIONS SANTA MARGARITA RIVER WATERSHED PROJECT: 70300-7-0193 FIGURE: 4

Santa Margarita River Near Fallbrook & MW-1 (Sta. 501 &101)

1997 through 1999



Prepared By: SKR
Checked By: KRW

SWDIV
NAVFACENGCOM
SAN DIEGO, CALIFORNIA

LAW Crandall
LAWGIBB Group Member
A Division of Law Engineering and Environmental Services, Inc.

PIPER DIAGRAM
STATIONS 501 & 101
SANTA MARGARITA
RIVER WATERSHED

PROJECT: 70300-7-0193

Figure: 12

A WATER QUALITY INVENTORY SERIES
BIOLOGICAL AND PHYSICAL/ HABITAT ASSESSMENT OF
CALIFORNIA WATER BODIES

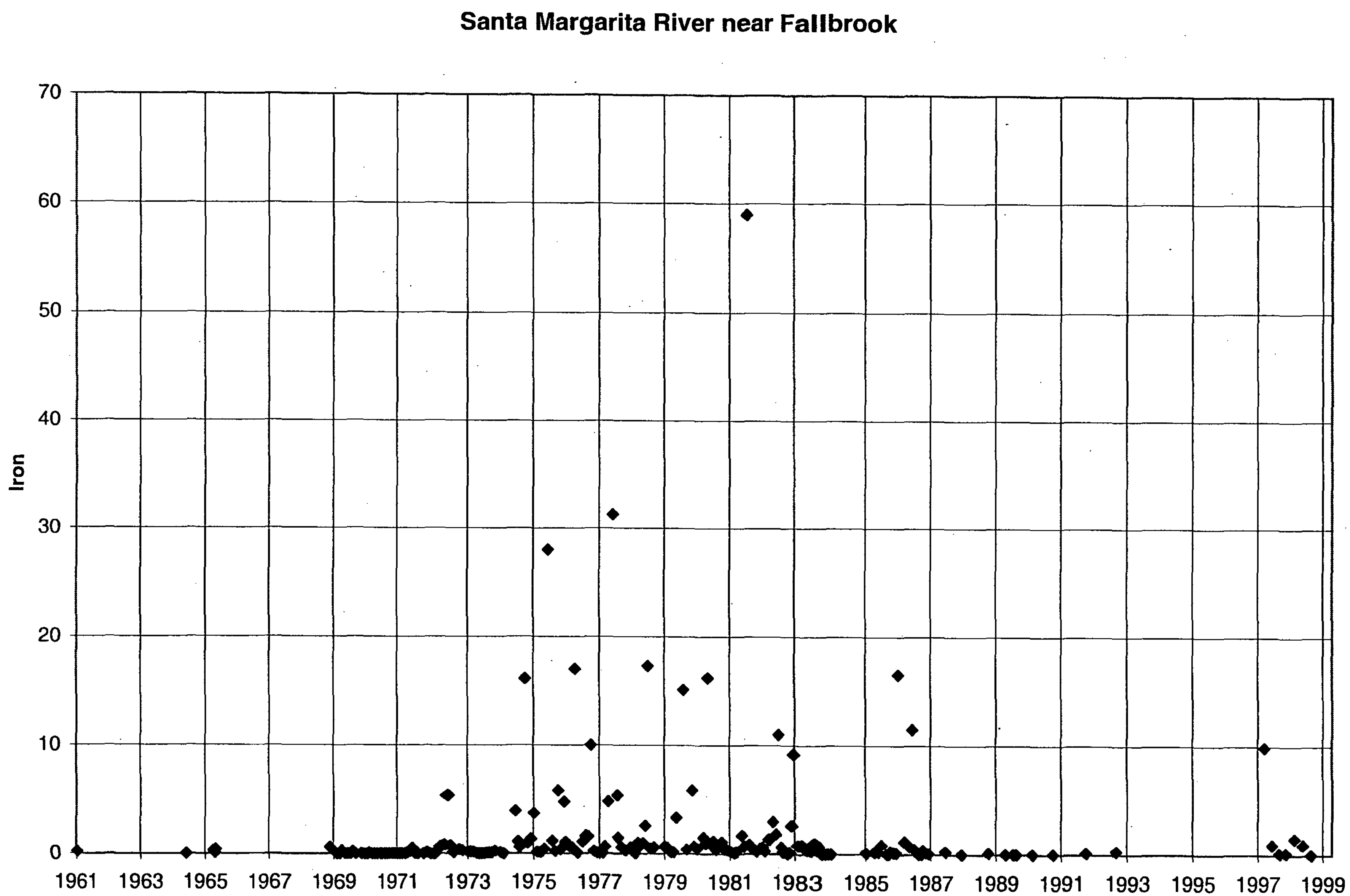
San Diego Regional Water Quality Control Board: 1999 Biological Assessment Annual Report

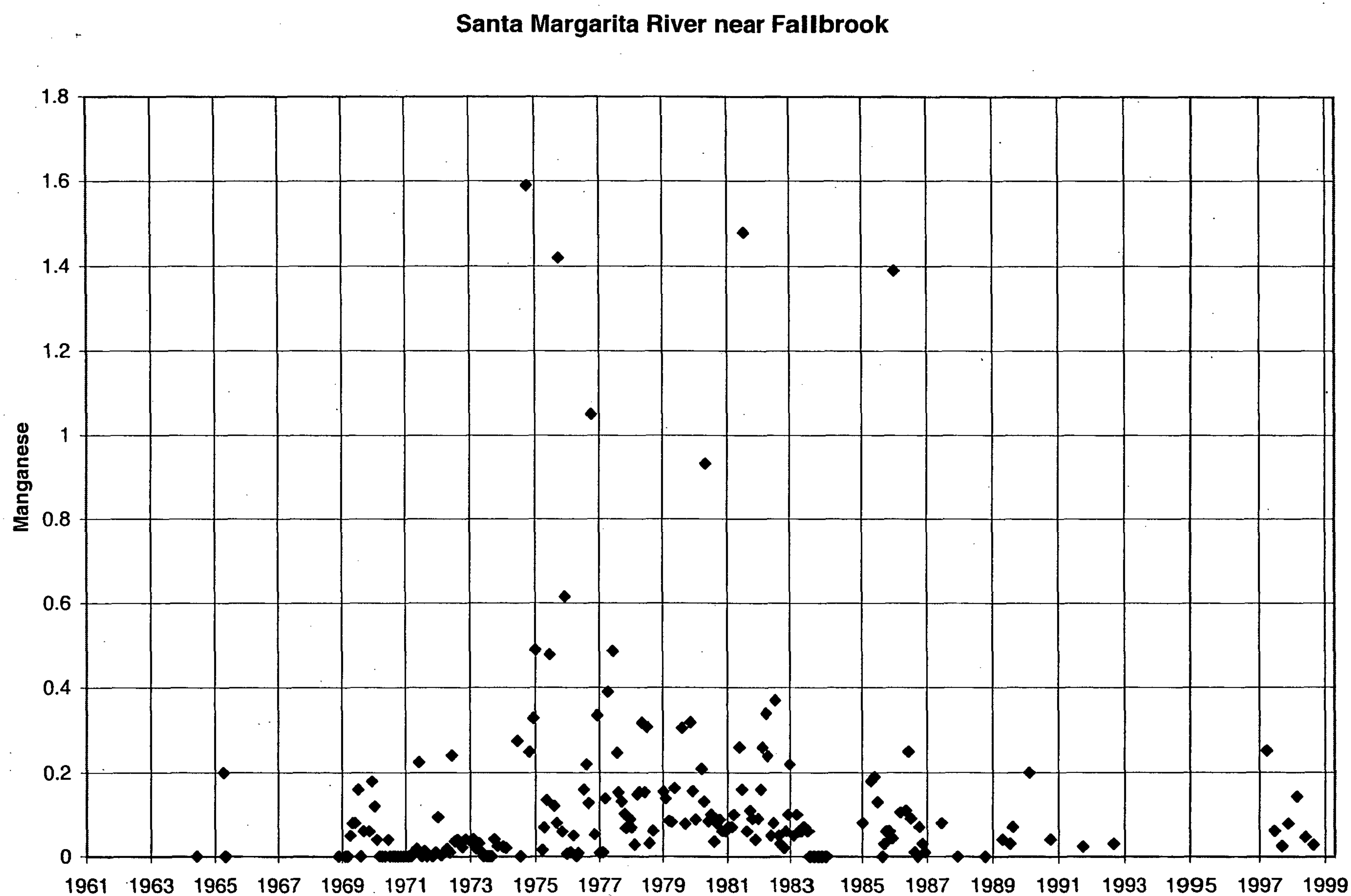
California Department of Fish and Game
Office of Spill Prevention and Response
Water Pollution Control Laboratory
2005 Nimbus Road
Rancho Cordova, CA. 95670
(916) 358-2858; jharring@ospr.dfg.ca.gov

PROGRAM MANAGER
James M. Harrington

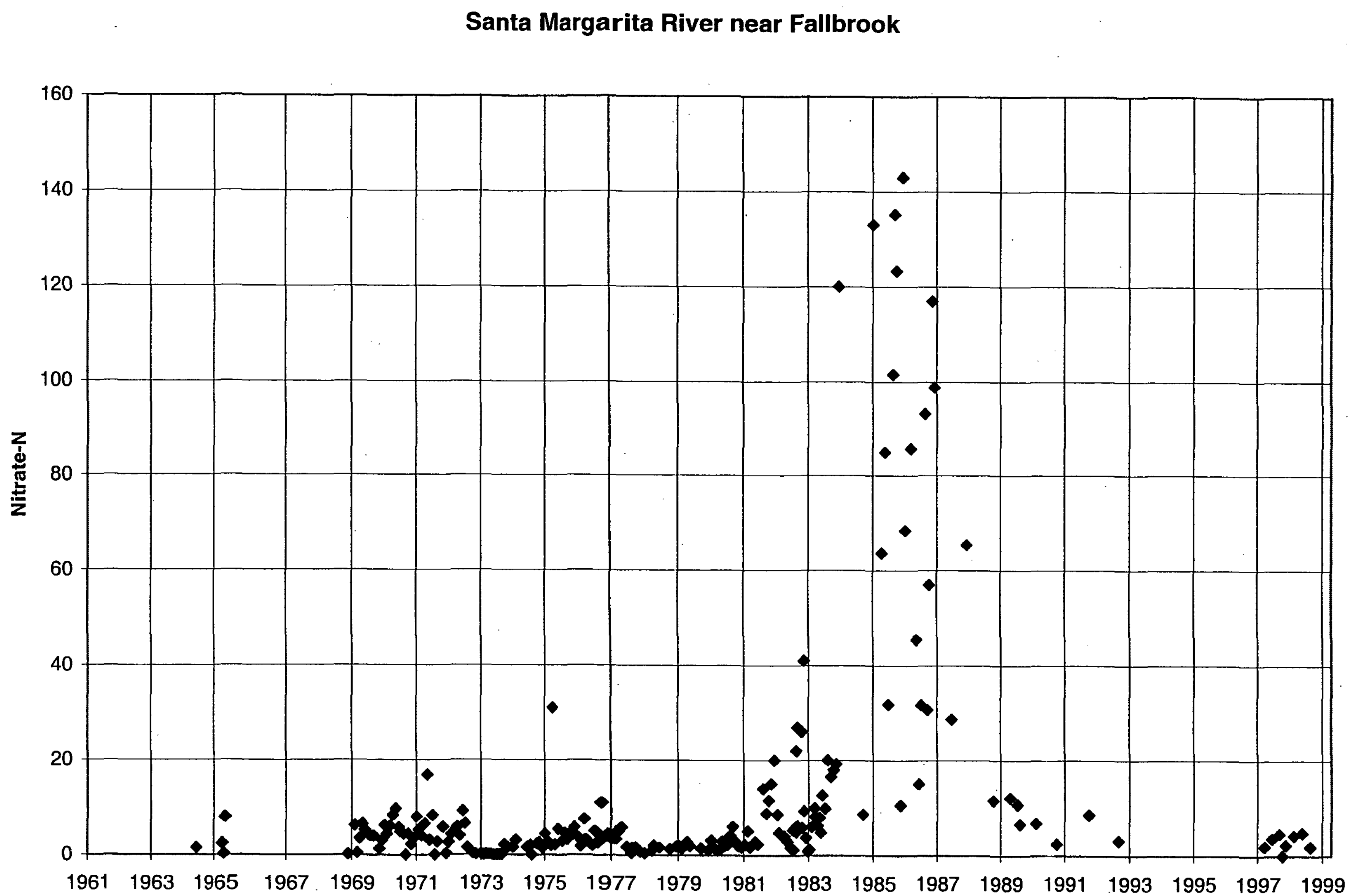
PROJECT LEADERS
Peter Ode, Angie Montalvo

LABORATORY AND FIELD TECHNICIANS
Doug Post, Christopher Sheehy, Mike Dawson

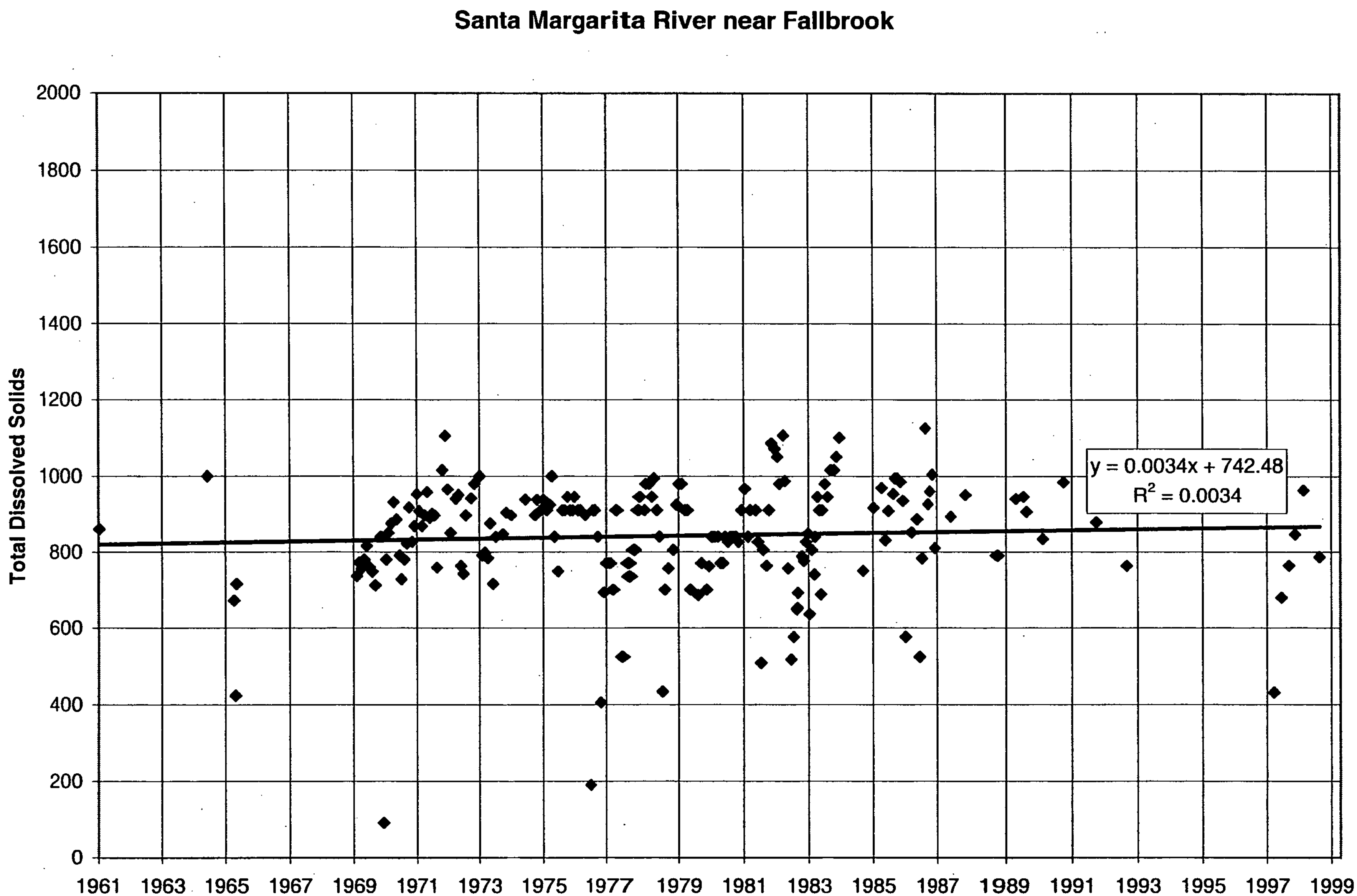

Santa Margarita River near Fallbrook
Iron
70
60
50
40
30
20
10
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999



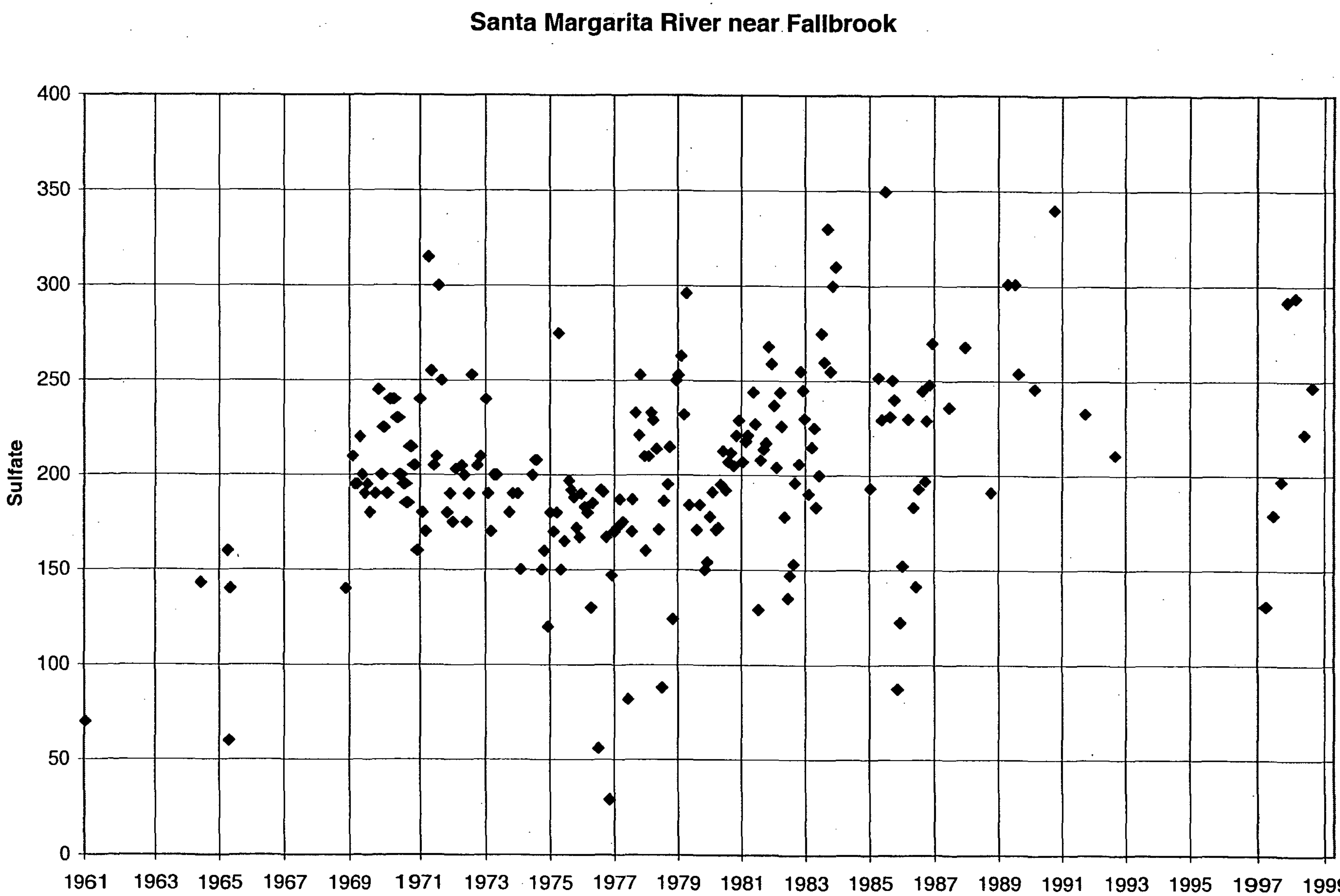
Santa Margarita River near Fallbrook
Manganese
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999

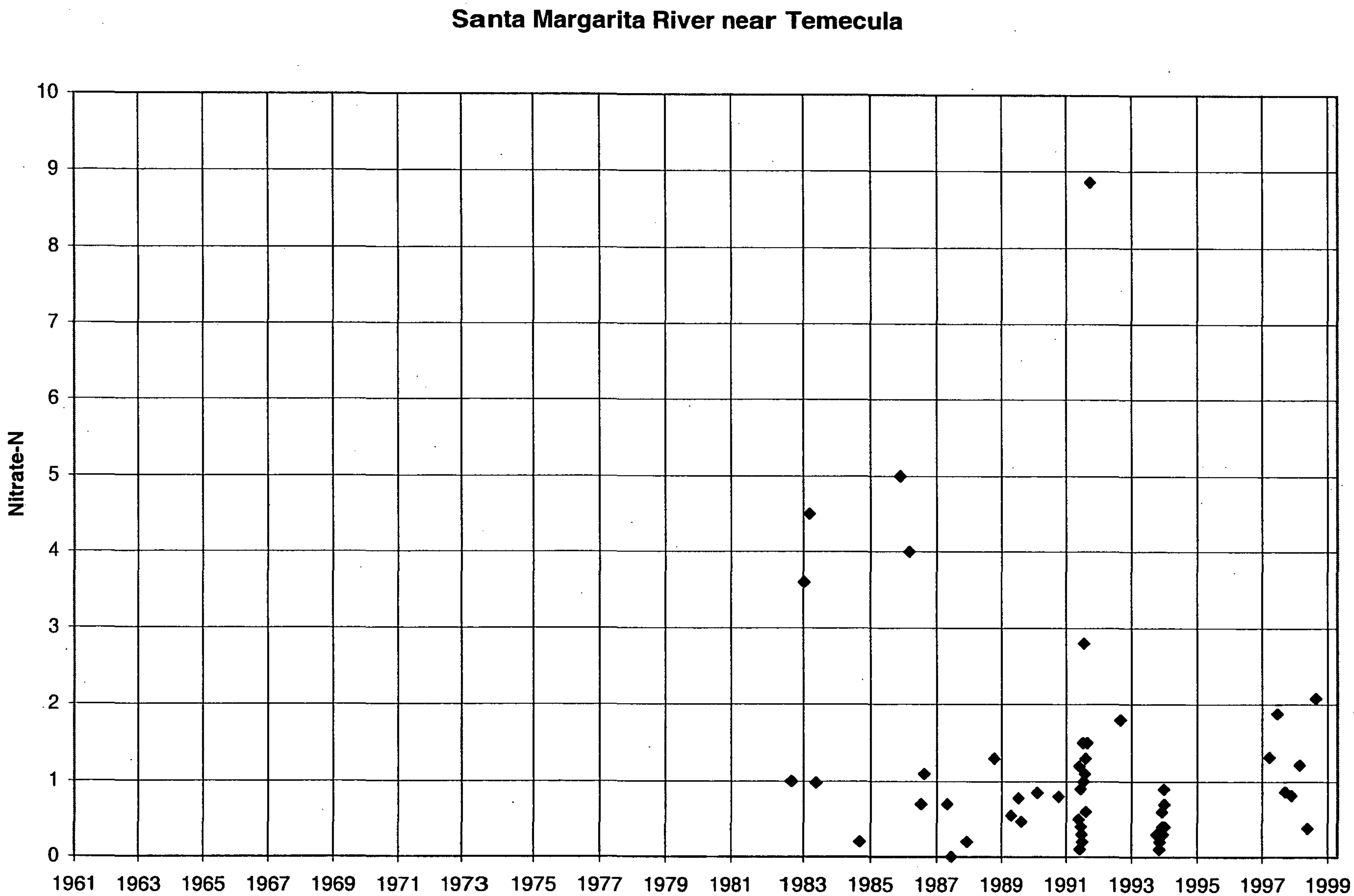


Santa Margarita River near Fallbrook
Nitrate-N
160
140
120
100
80
60
40
20
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999



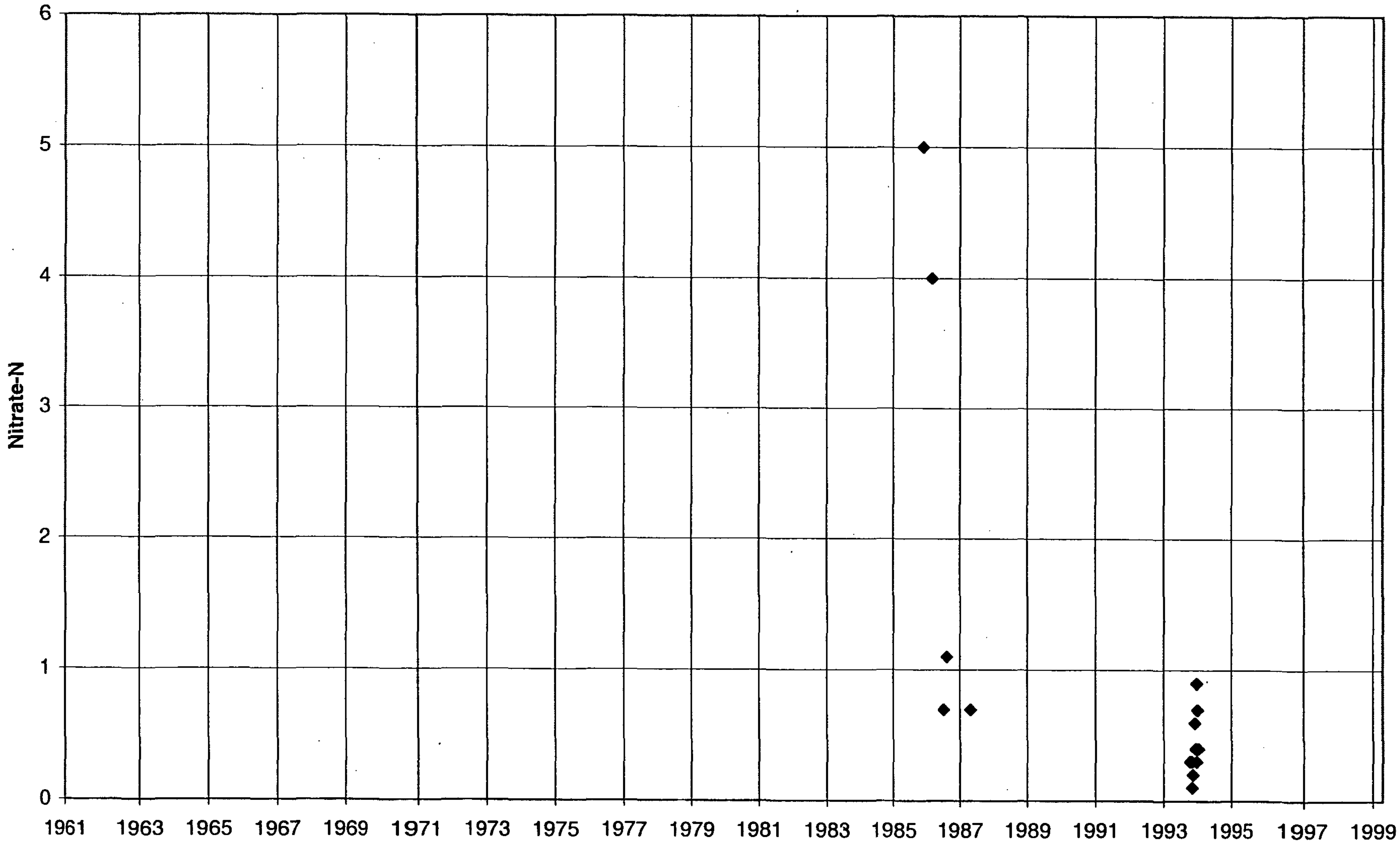
Santa Margarita River near Fallbrook
Total Dissolved Solids
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
y = 0.0034x + 742.48
R^2 = 0.0034

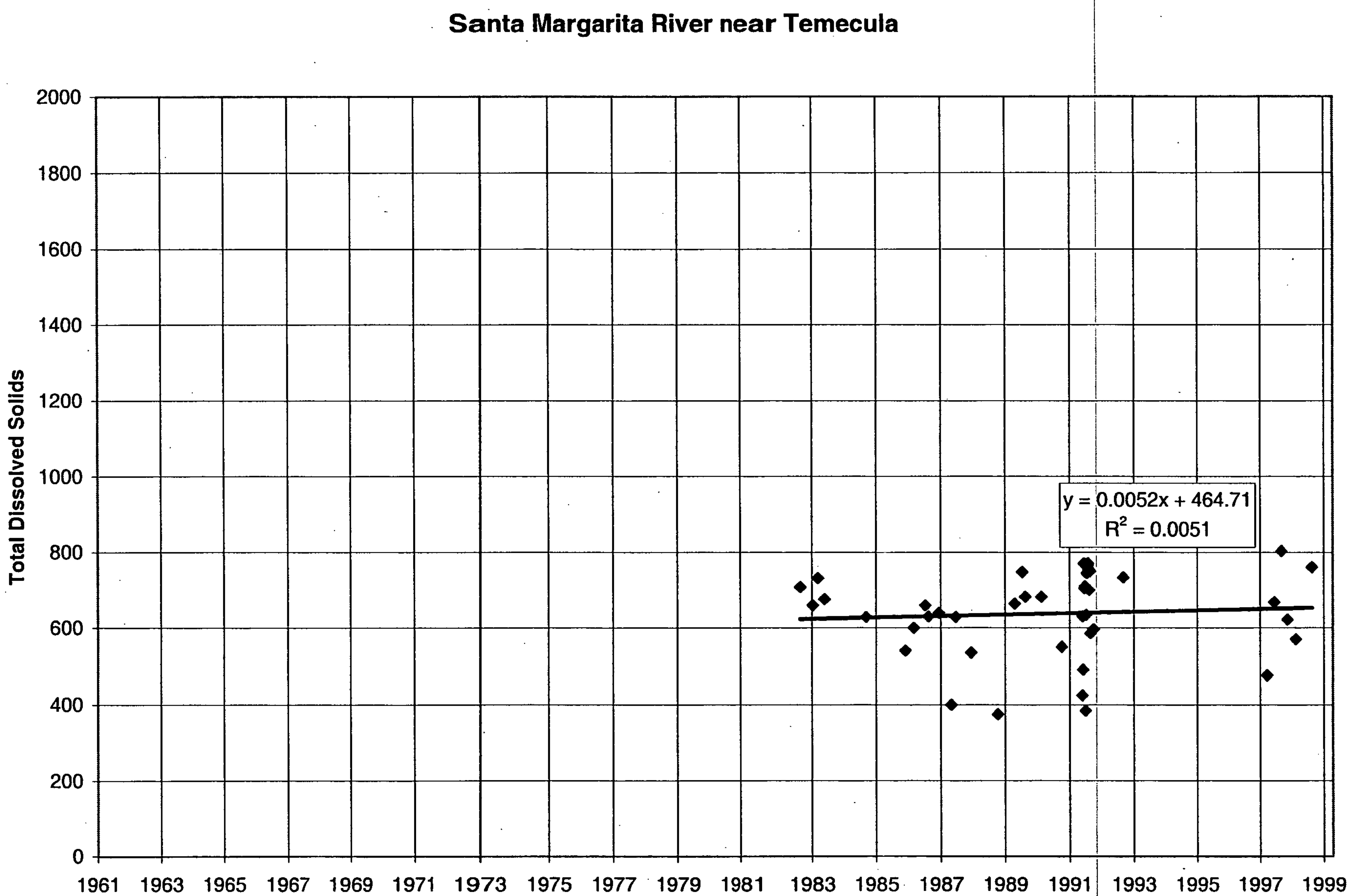

Santa Margarita River near Fallbrook
Sulfate
400
350
300
250
200
150
100
50
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999



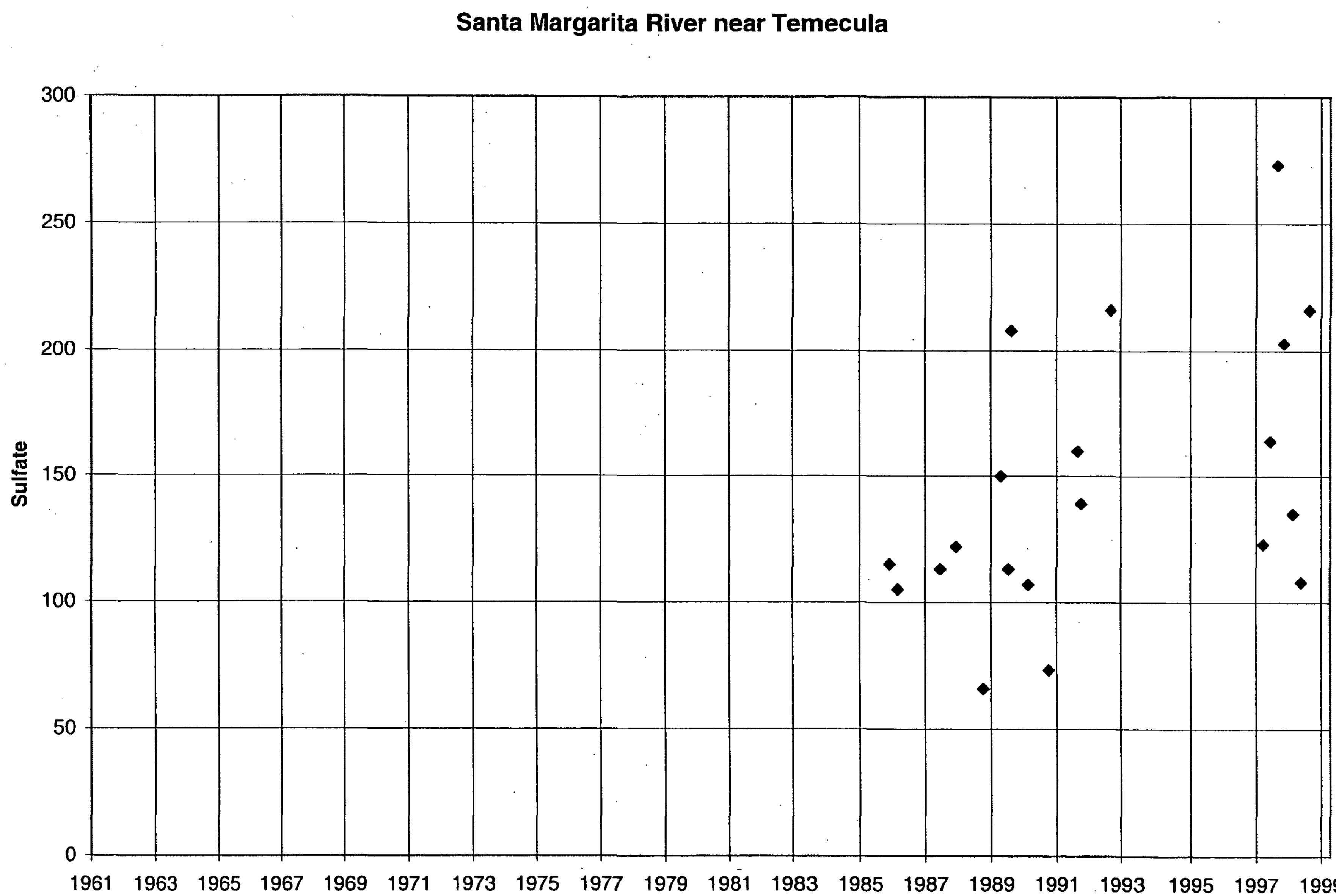
Santa Margarita River near Temecula
Nitrate-N
10
9
8
7
6
5
4
3
2
1
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999

Santa Margarita River at Temecula

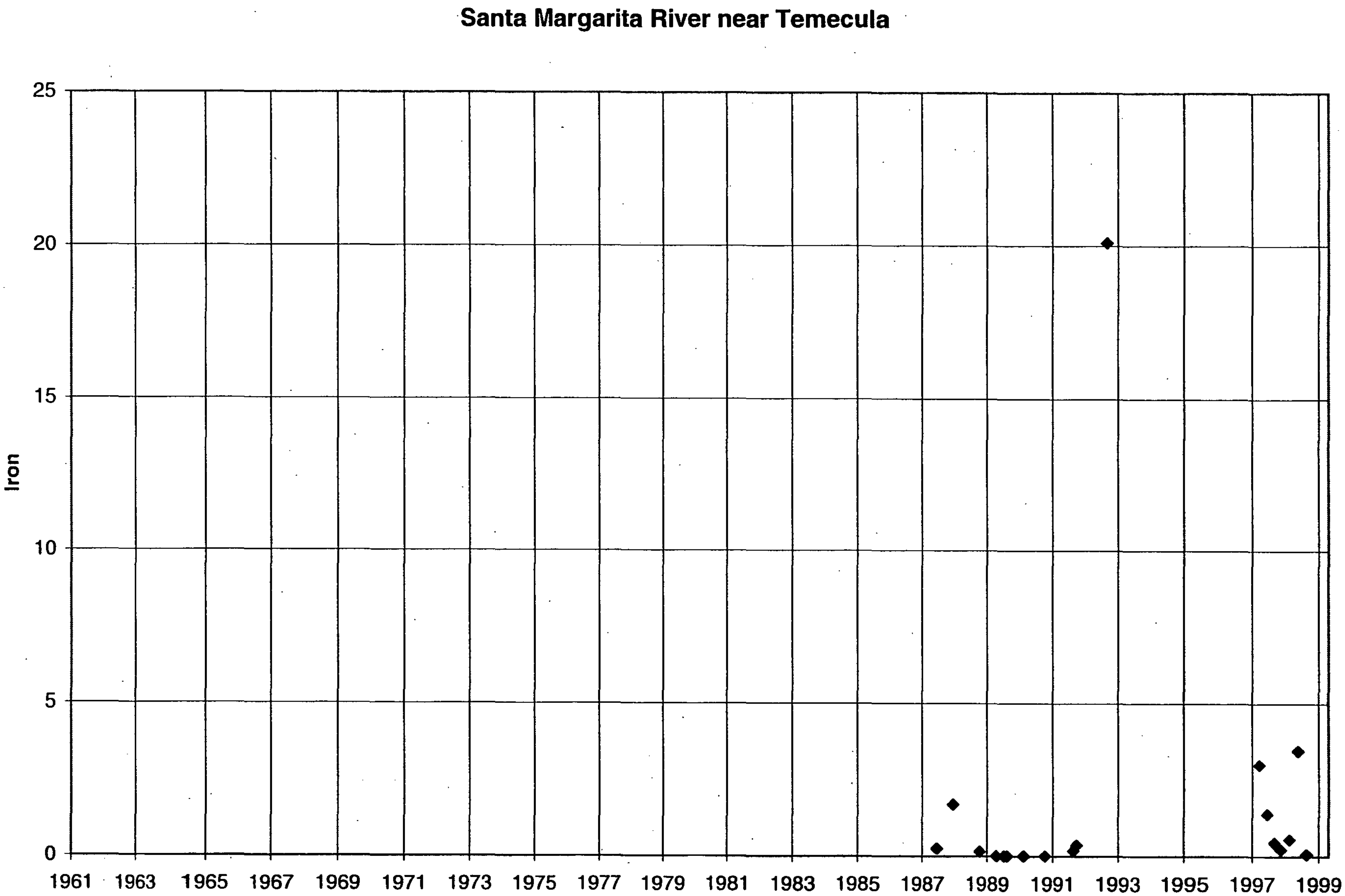




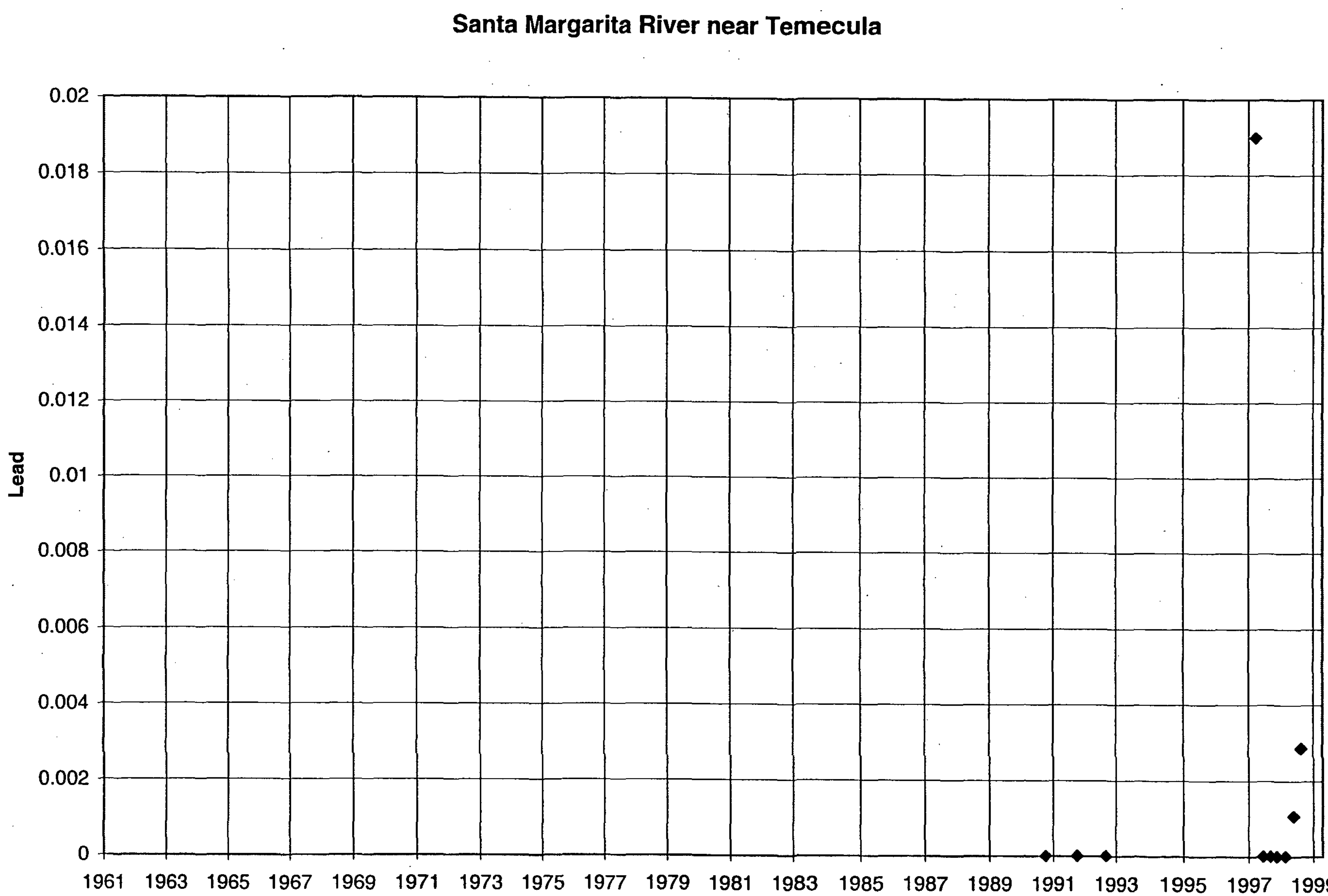
Santa Margarita River near Temecula
Total Dissolved Solids
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
y = 0.0052x + 464.71
R2 = 0.0051

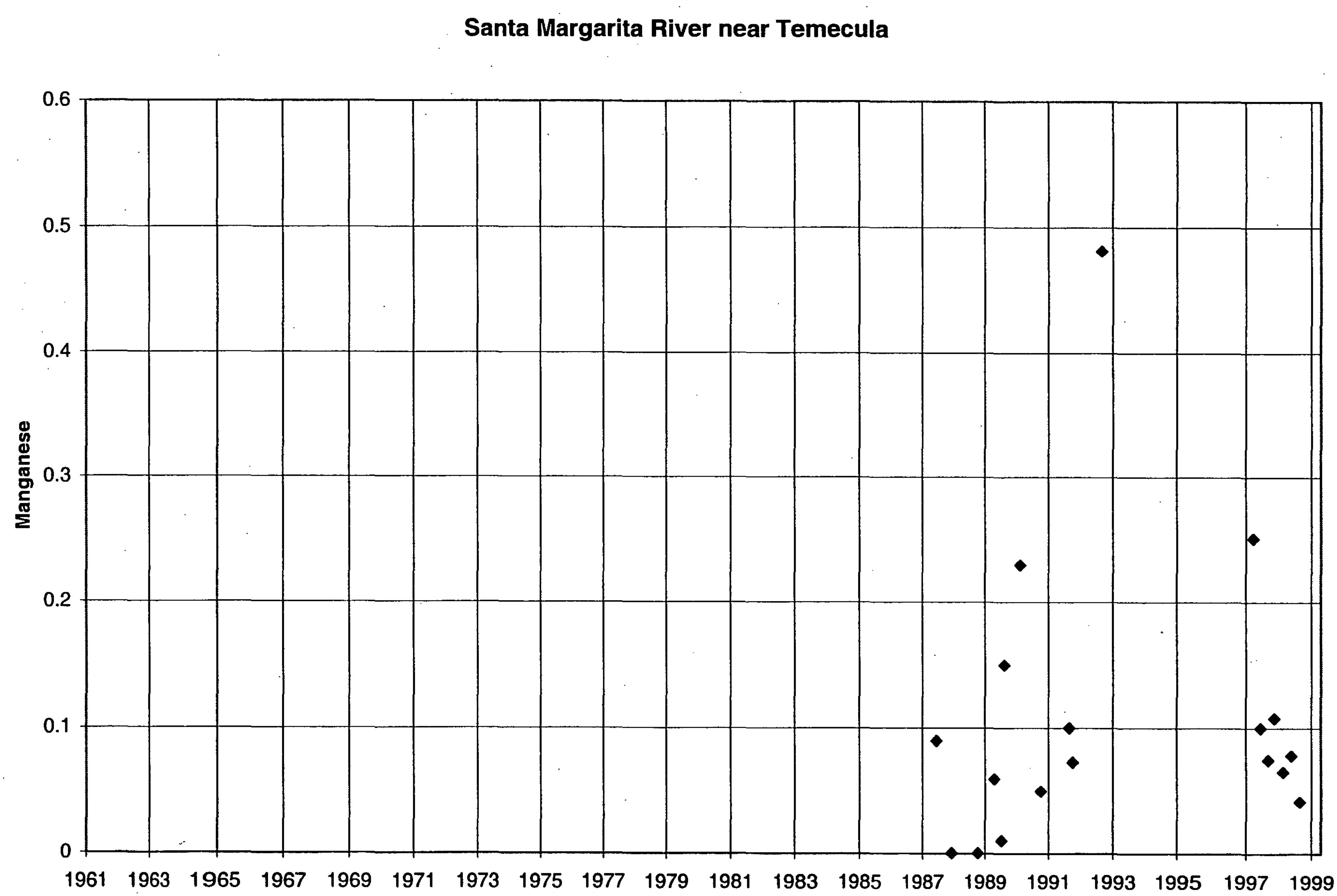


Santa Margarita River near Temecula
Sulfate
300
250
200
150
100
50
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999



Santa Margarita River near Temecula
Iron
25
20
15
10
5
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999


Santa Margarita River near Temecula
Lead
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999


Santa Margarita River near Temecula
Manganese
0.6
0.5
0.4
0.3
0.2
0.1
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999

fldRound	fldWell	fldMatrix	fldNewName	fldWell8	fldUnits	fldDL	fldSampleDate	fldSampleMont
10	08	surface water	Zinc	0.016J	mg/L	0.01	3/13/00	3
06	08	surface water	Zinc	NS	mg/L	0.01	2/10/99	2
04	08	surface water	Zinc	ND	mg/L	0.01	8/4/98	8
07	08	surface water	Zinc	ND	mg/L	0.02	5/11/99	5
01	08	surface water	Zinc	0.022	mg/L	0.0100	12/9/97	12
09	08	surface water	Zinc	NS	mg/L	0.03	12/6/99	12
08	08	surface water	Zinc	NS	mg/L	0.03	9/28/99	9
05	08	surface water	Zinc	ND	mg/L	0.01	11/9/98	11
11	08	surface water	Zinc	ND	mg/L	0.01	6/1/00	6
03	08	surface water	Zinc	ND	mg/L	0.01	5/26/98	5
02	08	surface water	Zinc	ND	mg/L	0.03	3/3/98	3
06	08	surface water	Total Organic Carbon	1.94	mg/L	1	2/10/99	2
04	08	surface water	Total Organic Carbon	5.09	mg/L	1	8/4/98	8
05	08	surface water	Total Organic Carbon	2.31	mg/L	1	11/9/98	11
07	08	surface water	Total Organic Carbon	13.7	mg/L	1	5/11/99	5
11	08	surface water	Total Organic Carbon	5.2	mg/L	0.5	6/1/00	6
08	08	surface water	Total Organic Carbon	NS	mg/L	0.5	9/28/99	9
03	08	surface water	Total Organic Carbon	2.89	mg/L	1	5/26/98	5
09	08	surface water	Total Organic Carbon	NS	mg/L	0.5	12/6/99	12
02	08	surface water	Total Organic Carbon	5.64	mg/L	1	3/3/98	3
01	08	surface water	Total Organic Carbon	7.5	mg/L	1.00	12/9/97	12
10	08	surface water	Total Organic Carbon	10	mg/L	0.1	3/13/00	3
11	08	surface water	Total Dissolved Solids	776	mg/L	5	6/1/00	6
01	08	surface water	Total Dissolved Solids	660	mg/L	10.0	12/9/97	12
10	08	surface water	Total Dissolved Solids	701	mg/L	5	3/13/00	3
02	08	surface water	Total Dissolved Solids	522	mg/L	10	3/3/98	3
04	08	surface water	Total Dissolved Solids	748	mg/L	10	8/4/98	8
06	08	surface water	Total Dissolved Solids	717	mg/L	10	2/10/99	2
07	08	surface water	Total Dissolved Solids	786	mg/L	10	5/11/99	5
05	08	surface water	Total Dissolved Solids	785	mg/L	10	11/9/98	11
03	08	surface water	Total Dissolved Solids	642	mg/L	10	5/26/98	5
09	08	surface water	Total Dissolved Solids	NS	mg/L	10	12/6/99	12
08	08	surface water	Total Dissolved Solids	NS	mg/L	10	9/28/99	9
02	08	surface water	Total Coliform	1600	mpn/100ml	2	3/3/98	3
05	08	surface water	Total Coliform	900	mpn/100ml	2	11/9/98	11
07	08	surface water	Total Coliform	23	mpn/100ml	2	5/11/99	5
01	08	surface water	Total Coliform	>1600	mpn/100ml	2	12/9/97	12
06	08	surface water	Total Coliform	500	mpn/100ml	2	2/10/99	2

fldRound	fldWell	fldMatrix	fldNewName	fldWell8	fldUnits	fldDL	fldSampleDate	fldSampleMont
11	08	surface water	Total Coliform	30	MPN/100 m	2	6/1/00	6
10	08	surface water	Total Coliform	500	MPN/100 m	3.0	3/13/00	3
08	08	surface water	Total Coliform	NS	mpn/100ml	2	9/28/99	9
03	08	surface water	Total Coliform	220	mpn/100ml	2	5/26/98	5
04	08	surface water	Total Coliform	900	mpn/100ml	2	8/4/98	8
09	08	surface water	Total Coliform	NS	mpn/100ml	2	12/6/99	12
07	08	surface water	Surfactants (MBAS)	ND	mg/L	0.1	5/11/99	5
05	08	surface water	Surfactants (MBAS)	ND	mg/L	0.1	11/9/98	11
11	08	surface water	Surfactants (MBAS)	ND	mg/L	0.03	6/1/00	6
04	08	surface water	Surfactants (MBAS)	ND	mg/L	0.1	8/4/98	8
09	08	surface water	Surfactants (MBAS)	NS	mg/L	0.05	12/6/99	12
08	08	surface water	Surfactants (MBAS)	NS	mg/L	0.05	9/28/99	9
03	08	surface water	Surfactants (MBAS)	ND	mg/L	0.1	5/26/98	5
02	08	surface water	Surfactants (MBAS)	ND	mg/L	0.1	3/3/98	3
10	08	surface water	Surfactants (MBAS)	0.06	mg/L	0.03	3/13/00	3
01	08	surface water	Surfactants (MBAS)	ND	mg/L	0.100	12/9/97	12
06	08	surface water	Surfactants (MBAS)	NS	mg/L	0.1	2/10/99	2
04	08	surface water	Sulfate	224	mg/L	50	8/4/98	8
02	08	surface water	Sulfate	132	mg/L	4	3/3/98	3
03	08	surface water	Sulfate	171	mg/L	10	5/26/98	5
08	08	surface water	Sulfate	NS	mg/L	10	9/28/99	9
07	08	surface water	Sulfate	193	mg/L	50	5/11/99	5
10	08	surface water	Sulfate	185	mg/L	5	3/13/00	3
09	08	surface water	Sulfate	NS	mg/L	10	12/6/99	12
05	08	surface water	Sulfate	278	mg/L	5	11/9/98	11
06	08	surface water	Sulfate	193	mg/L	5	2/10/99	2
01	08	surface water	Sulfate	157	mg/L	10.0	12/9/97	12
11	08	surface water	Sulfate	205	mg/L	5	6/1/00	6
03	08	surface water	Sodium	78.9	mg/L	0.3	5/26/98	5
04	08	surface water	Sodium	101	mg/L	0.3	8/4/98	8
07	08	surface water	Sodium	134	mg/L	0.3	5/11/99	5
02	08	surface water	Sodium	80	mg/L	4	3/3/98	3
10	08	surface water	Sodium	87.9	mg/L	0.25	3/13/00	3
11	08	surface water	Sodium	95.3	mg/L	0.25	6/1/00	6
01	08	surface water	Sodium	78.8	mg/L	0.300	12/9/97	12
05	08	surface water	Sodium	94.5	mg/L	0.3	11/9/98	11
06	08	surface water	Sodium	90.8	mg/L	0.3	2/10/99	2
09	08	surface water	Sodium	NS	mg/L	0.5	12/6/99	12

fldRound	fldWell	fldMatrix	fldNewName	fldWell8	fldUnits	fldDL	fldSampleDate	fldSampleMont
08	08	surface water	Sodium	NS	mg/L	0.5	9/28/99	9
06	08	surface water	Potassium	2.9	mg/L	1	2/10/99	2
08	08	surface water	Potassium	NS	mg/L	1.0	9/28/99	9
05	08	surface water	Potassium	3.75	mg/L	0.3	11/9/98	11
11	08	surface water	Potassium	3.6	mg/L	0.5	6/1/00	6
10	08	surface water	Potassium	3.8	mg/L	0.5	3/13/00	3
07	08	surface water	Potassium	3.06	mg/L	1	5/11/99	5
02	08	surface water	Potassium	3	mg/L	2	3/3/98	3
09	08	surface water	Potassium	NS	mg/L	1.0	12/6/99	12
01	08	surface water	Potassium	5.4	mg/L	0.300	12/9/97	12
03	08	surface water	Potassium	2.47	mg/L	0.3	5/26/98	5
04	08	surface water	Potassium	3.93	mg/L	0.3	8/4/98	8
03	08	surface water	Phosphorus	0.095	mg/L	0.01	5/26/98	5
01	08	surface water	Phosphorus	0.208	mg/L	0.01	12/9/97	12
02	08	surface water	Phosphorus	0.378	mg/L	0.01	3/3/98	3
04	08	surface water	Phosphorus	0.13	mg/L	0.01	8/4/98	8
06	08	surface water	Phosphorus	0.033	mg/L	0.01	2/10/99	2
05	08	surface water	Phosphorus	0.036	mg/L	0.01	11/9/98	11
07	08	surface water	Phosphorus	0.118	mg/L	0.01	5/11/99	5
04	08	surface water	Phosphate	NS	mg/L	0.3	8/4/98	8
05	08	surface water	Phosphate	NS	mg/L	0.3	11/9/98	11
01	08	surface water	Phosphate	NS	mg/L	0.3	12/9/97	12
06	08	surface water	Phosphate	NS	mg/L	0.3	2/10/99	2
09	08	surface water	Phosphate	NS	mg/L	0.3	12/6/99	12
02	08	surface water	Phosphate	NS	mg/L	0.3	3/3/98	3
11	08	surface water	Phosphate	ND	mg/L	0.30	6/1/00	6
07	08	surface water	Phosphate	NS	mg/L	0.3	5/11/99	5
03	08	surface water	Phosphate	NS	mg/L	0.3	5/26/98	5
10	08	surface water	Phosphate	0.8	mg/L	0.30	3/13/00	3
08	08	surface water	Phosphate	NS	mg/L	0.3	9/28/99	9
02	08	surface water	pH	8.11	pH units	2.0-12.5	3/3/98	3
03	08	surface water	pH	8.13	pH units	2.5-12.0	5/26/98	5
08	08	surface water	pH	NS	pH units	1.00	9/28/99	9
04	08	surface water	pH	8.42	pH units	2.5-12.0	8/4/98	8
10	08	surface water	pH	7.90	mg/L	0.01	3/13/00	3
11	08	surface water	pH	7.24	mg/L	0.01	6/1/00	6
07	08	surface water	pH	7.55	pH units	2.5-12.0	5/11/99	5
06	08	surface water	pH	8.24	pH units		2/10/99	2

fldRound	fldWell	fldMatrix	fldNewName	fldWell8	fldUnits	fldDL	fldSampleDate	fldSampleMont
11	08	surface water	pH	7.24	mg/L	0.01	6/1/00	6
08	08	surface water	pH	NS	pH units	1.00	9/28/99	9
10	08	surface water	pH	7.90	mg/L	0.01	3/13/00	3
09	08	surface water	pH	NS	pH units	1.00	12/6/99	12
01	08	surface water	pH	8.06	pH units	2.0-12.5	12/9/97	12
09	08	surface water	pH	NS	pH units	1.00	12/6/99	12
11	08	surface water	Oil and Grease	ND	mg/L	0.5	6/1/00	6
07	08	surface water	Oil and Grease	ND	mg/L	1	5/11/99	5
03	08	surface water	Oil and Grease	ND	mg/L	0.952	5/26/98	5
02	08	surface water	Oil and Grease	ND	mg/L	1.39	3/3/98	3
04	08	surface water	Oil and Grease	ND	mg/L	1.18	8/4/98	8
05	08	surface water	Oil and Grease	ND	mg/L	1	11/9/98	11
10	08	surface water	Oil and Grease	ND	mg/L	0.5	3/13/00	3
09	08	surface water	Oil and Grease	NS	mg/L	1.0	12/6/99	12
08	08	surface water	Oil and Grease	NS	mg/L	1.0	9/28/99	9
11	08	surface water	Oil and Grease	ND	mg/L	0.5	6/1/00	6
06	08	surface water	Oil and Grease	NS	mg/L	1	2/10/99	2
09	08	surface water	Oil and Grease	NS	mg/L	1.0	12/6/99	12
01	08	surface water	Oil and Grease	ND	mg/L	1.16	12/9/97	12
10	08	surface water	Oil and Grease	ND	mg/L	0.5	3/13/00	3
08	08	surface water	Oil and Grease	NS	mg/L	1.0	9/28/99	9
02	08	surface water	Nitrogen	NS	mg/L	0.1	3/3/98	3
10	08	surface water	Nitrogen	0.2	mg/L	0.05	3/13/00	3
01	08	surface water	Nitrogen	0.2	mg/L	0.100	12/9/97	12
06	08	surface water	Nitrogen	NS	mg/L	0.1	2/10/99	2
03	08	surface water	Nitrogen	0.7	mg/Kg	0.5	5/26/98	5
07	08	surface water	Nitrogen	0.404	mg/L	0.4	5/11/99	5
02	08	surface water	Nitrogen	NS	mg/L	0.1	3/3/98	3
02	08	surface water	Nitrogen	NS	mg/L	0.1	3/3/98	3
09	08	surface water	Nitrogen	NS	mg/L	0.1	12/6/99	12
04	08	surface water	Nitrogen	NS	mg/L	0.1	8/4/98	8
08	08	surface water	Nitrogen	NS	mg/L	0.1	9/28/99	9
05	08	surface water	Nitrogen	0.453	mg/L	0.1	11/9/98	11
09	08	surface water	Nitrite	NS	mg/L	0.02	12/6/99	12
08	08	surface water	Nitrite	NS	mg/L	0.02	9/28/99	9
03	08	surface water	Nitrate-N	2.19	mg/L	0.5	5/26/98	5
02	08	surface water	Nitrate-N	3.59	mg/L	2	3/3/98	3
09	08	surface water	Nitrate-N	NS	mg/L	0.1	12/6/99	12

fldRound	fldWell	fldMatrix	fldNewName	fldWell8	fldUnits	fldDL	fldSampleDate	fldSampleMont
08	08	surface water	Nitrate-N	NS	mg/L	0.1	9/28/99	9
11	08	surface water	Nitrate-N	ND	mg/L	0.05	6/1/00	6
10	08	surface water	Nitrate-N	5.3	mg/L	0.05	3/13/00	3
07	08	surface water	Nitrate-N	0.1	mg/L	0.05	5/11/99	5
04	08	surface water	Nitrate-N	0.24	mg/L	0.05	8/4/98	8
06	08	surface water	Nitrate-N	1.19	mg/L	0.05	2/10/99	2
01	08	surface water	Nitrate-N	1.4	mg/L	0.100	12/9/97	12
05	08	surface water	Nitrate-N	0.393	mg/L	0.05	11/9/98	11
09	08	surface water	Mercury	NS	mg/L	0.0002	12/6/99	12
01	08	surface water	Mercury	ND	mg/L	0.000200	12/9/97	12
07	08	surface water	Mercury	ND	mg/L	0.0002	5/11/99	5
05	08	surface water	Mercury	ND	mg/L	0.0002	11/9/98	11
08	08	surface water	Mercury	NS	mg/L	0.0002	9/28/99	9
03	08	surface water	Mercury	ND	mg/L	0.0002	5/26/98	5
02	08	surface water	Mercury	NS	mg/L	0.0002	3/3/98	3
06	08	surface water	Mercury	NS	mg/L	0.0002	2/10/99	2
11	08	surface water	Mercury	NS	mg/L	0.0002	6/1/00	6
10	08	surface water	Mercury	ND	mg/L	0.0002	3/13/00	3
04	08	surface water	Mercury	NS	mg/L	0.0002	8/4/98	8
02	08	surface water	Manganese	0.07	mg/L	0.01	3/3/98	3
09	08	surface water	Manganese	NS	mg/L	0.01	12/6/99	12
04	08	surface water	Manganese	0.0287	mg/L	0.01	8/4/98	8
05	08	surface water	Manganese	0.0154	mg/L	0.01	11/9/98	11
07	08	surface water	Manganese	0.237	mg/L	0.01	5/11/99	5
08	08	surface water	Manganese	NS	mg/L	0.01	9/28/99	9
10	08	surface water	Manganese	0.014	mg/L	0.005	3/13/00	3
03	08	surface water	Manganese	0.037	mg/L	0.01	5/26/98	5
06	08	surface water	Manganese	NS	mg/L	0.01	2/10/99	2
01	08	surface water	Manganese	0.14	mg/L	0.0100	12/9/97	12
11	08	surface water	Manganese	ND	mg/L	0.005	6/1/00	6
04	08	surface water	Magnesium	39.8	mg/L	0.2	8/4/98	8
11	08	surface water	Magnesium	37.6	mg/L	0.2	6/1/00	6
01	08	surface water	Magnesium	34.3	mg/L	0.200	12/9/97	12
10	08	surface water	Magnesium	35.7	mg/L	0.20	3/13/00	3
02	08	surface water	Magnesium	30	mg/L	0.1	3/3/98	3
07	08	surface water	Magnesium	34.9	mg/L	0.2	5/11/99	5
05	08	surface water	Magnesium	41	mg/L	0.2	11/9/98	11
09	08	surface water	Magnesium	NS	mg/L	0.5	12/6/99	12

fldRound	fldWell	fldMatrix	fldNewName	fldWell8	fldUnits	fldDL	fldSampleDate	fldSampleMont
06	08	surface water	Magnesium	38	mg/L	0.2	2/10/99	2
03	08	surface water	Magnesium	33.8	mg/L	0.2	5/26/98	5
08	08	surface water	Magnesium	NS	mg/L	0.5	9/28/99	9
04	08	surface water	Lead	ND	mg/L	0.001	8/4/98	8
09	08	surface water	Lead	NS	mg/L	0.05	12/6/99	12
07	08	surface water	Lead	ND	mg/L	0.001	5/11/99	5
01	08	surface water	Lead	ND	mg/L	0.0200	12/9/97	12
10	08	surface water	Lead	ND	mg/L	0.005	3/13/00	3
06	08	surface water	Lead	0.00373	mg/L	0.001	2/10/99	2
05	08	surface water	Lead	ND	mg/L	0.001	11/9/98	11
02	08	surface water	Lead	ND	mg/L	0.015	3/3/98	3
03	08	surface water	Lead	0.00104	mg/L	0.001	5/26/98	5
08	08	surface water	Lead	NS	mg/L	0.05	9/28/99	9
11	08	surface water	Lead	ND	mg/L	0.005	6/1/00	6
09	08	surface water	Iron	NS	mg/L	0.05	12/6/99	12
08	08	surface water	Iron	NS	mg/L	0.05	9/28/99	9
04	08	surface water	Iron	0.283	mg/L	0.05	8/4/98	8
11	08	surface water	Iron	ND	mg/L	0.03	6/1/00	6
03	08	surface water	Iron	1.14	mg/L	0.05	5/26/98	5
06	08	surface water	Iron	0.136	mg/L	0.05	2/10/99	2
10	08	surface water	Iron	0.041J	mg/L	0.03	3/13/00	3
01	08	surface water	Iron	2.47	mg/L	0.0500	12/9/97	12
05	08	surface water	Iron	0.1	mg/L	0.05	11/9/98	11
02	08	surface water	Iron	3	mg/L	0.1	3/3/98	3
07	08	surface water	Iron	0.5	mg/L	0.05	5/11/99	5
05	08	surface water	Hydroxide	ND	mg/L	0.5	11/9/98	11
10	08	surface water	Hydroxide	ND	mg/L	0.5	3/13/00	3
07	08	surface water	Hydroxide	ND	mg/L	0.5	5/11/99	5
03	08	surface water	Hydroxide	ND	mg/L	0.5	5/26/98	5
04	08	surface water	Hydroxide	ND	mg/L	0.5	8/4/98	8
09	08	surface water	Hydroxide	NS	mg/L	2	12/6/99	12
11	08	surface water	Hydroxide	ND	mg/L	0.5	6/1/00	6
08	08	surface water	Hydroxide	NS	mg/L	2	9/28/99	9
06	08	surface water	Hydroxide	NS	mg/L	0.5	2/10/99	2
01	08	surface water	Hydroxide	ND	mg/L	1.00	12/9/97	12
02	08	surface water	Hydroxide	ND	mg/L	0.5	3/3/98	3
07	08	surface water	Hardness (CaCO3)	363	mg/L	2	5/11/99	5
10	08	surface water	Hardness (CaCO3)	368	mg/L	1	3/13/00	3

fldRound	fldWell	fldMatrix	fldNewName	fldWell8	fldUnits	fldDL	fldSampleDate	fldSampleMont
02	08	surface water	Hardness (CaCO3)	290	mg/L	10	3/3/98	3
04	08	surface water	Hardness (CaCO3)	431	mg/L	5	8/4/98	8
03	08	surface water	Hardness (CaCO3)	331	mg/L	5	5/26/98	5
06	08	surface water	Hardness (CaCO3)	432	mg/L	1	2/10/99	2
09	08	surface water	Hardness (CaCO3)	NS	mg/L	2	12/6/99	12
11	08	surface water	Hardness (CaCO3)	408	mg/L	1	6/1/00	6
08	08	surface water	Hardness (CaCO3)	NS	mg/L	2	9/28/99	9
05	08	surface water	Hardness (CaCO3)	426	mg/L	1	11/9/98	11
01	08	surface water	Hardness (CaCO3)	350	mg/L	10.0	12/9/97	12
02	08	surface water	Fluoride	0.239	mg/L	0.2	3/3/98	3
04	08	surface water	Fluoride	0.367	mg/L	0.1	8/4/98	8
11	08	surface water	Fluoride	0.5	mg/L	0.1	6/1/00	6
10	08	surface water	Fluoride	0.4	mg/L	0.1	3/13/00	3
01	08	surface water	Fluoride	ND	mg/L	0.200	12/9/97	12
09	08	surface water	Fluoride	NS	mg/L	0.2	12/6/99	12
08	08	surface water	Fluoride	NS	mg/L	0.2	9/28/99	9
03	08	surface water	Fluoride	0.331	mg/L	0.2	5/26/98	5
06	08	surface water	Fluoride	0.326	mg/L	0.1	2/10/99	2
07	08	surface water	Fluoride	0.382	mg/L	0.1	5/11/99	5
05	08	surface water	Fluoride	0.354	mg/L	0.1	11/9/98	11
03	08	surface water	Fecal Coliform	30	mpn/100ml	2	5/26/98	5
01	08	surface water	Fecal Coliform	1600	mpn/100ml	2	12/9/97	12
04	08	surface water	Fecal Coliform	280	mpn/100ml	2	8/4/98	8
11	08	surface water	Fecal Coliform	13	MPN/mL	2	6/1/00	6
10	08	surface water	Fecal Coliform	70	MPN/100 m	2	3/13/00	3
06	08	surface water	Fecal Coliform	17	mpn/100ml	2	2/10/99	2
09	08	surface water	Fecal Coliform	NS	mpn/100ml	2	12/6/99	12
05	08	surface water	Fecal Coliform	70	mpn/100ml	2	11/9/98	11
07	08	surface water	Fecal Coliform	6.9	mpn/100ml	2	5/11/99	5
08	08	surface water	Fecal Coliform	NS	mpn/100ml	2	9/28/99	9
02	08	surface water	Fecal Coliform	110	mpn/100ml	2	3/3/98	3
09	08	surface water	Cyanide (Total)	NS	mg/L	0.005	12/6/99	12
10	08	surface water	Cyanide (Total)	ND	mg/L	0.01	3/13/00	3
11	08	surface water	Cyanide (Total)	NS	mg/L	0.01	6/1/00	6
02	08	surface water	Cyanide (Total)	NS	mg/L	0.005	3/3/98	3
08	08	surface water	Cyanide (Total)	NS	mg/L	.01	9/28/99	9
04	08	surface water	Cyanide (Total)	NS	mg/L	0.005	8/4/98	8
01	08	surface water	Cyanide (Total)	ND	mg/L	0.00500	12/9/97	12

fldRound	fldWell	fldMatrix	fldNewName	fldWell8	fldUnits	fldDL	fldSampleDate	fldSampleMont
05	08	surface water	Cyanide (Total)	ND	mg/L	0.005	11/9/98	11
06	08	surface water	Cyanide (Total)	NS	mg/L	0.005	2/10/99	2
04	08	surface water	Cyanide (Total)	NS	mg/L	0.005	8/4/98	8
07	08	surface water	Cyanide (Total)	ND	mg/L	0.005	5/11/99	5
06	08	surface water	Cyanide (Total)	NS	mg/L	0.005	2/10/99	2
02	08	surface water	Cyanide (Total)	NS	mg/L	0.005	3/3/98	3
03	08	surface water	Cyanide (Total)	ND	mg/L	0.005	5/26/98	5
09	08	surface water	Cyanide (Total)	NS	mg/L	0.005	12/6/99	12
02	08	surface water	Copper	ND	mg/L	0.02	3/3/98	3
01	08	surface water	Copper	0.01	mg/L	0.00500	12/9/97	12
08	08	surface water	Copper	NS	mg/L	0.02	9/28/99	9
10	08	surface water	Copper	0.009	mg/L	0.005	3/13/00	3
09	08	surface water	Copper	NS	mg/L	0.02	12/6/99	12
07	08	surface water	Copper	ND	mg/L	0.005	5/11/99	5
11	08	surface water	Copper	ND	mg/L	0.005	6/1/00	6
04	08	surface water	Copper	ND	mg/L	0.005	8/4/98	8
03	08	surface water	Copper	ND	mg/L	0.005	5/26/98	5
05	08	surface water	Copper	ND	mg/L	0.005	11/9/98	11
06	08	surface water	Copper	NS	mg/L	0.005	2/10/99	2
03	08	surface water	Conductivity	902	umhos/cm	1	5/26/98	5
11	08	surface water	Conductivity	1,230	mg/L	5	6/1/00	6
08	08	surface water	Conductivity	NS	umhos/cm	10	9/28/99	9
06	08	surface water	Conductivity	1130	umhos/cm	1	2/10/99	2
10	08	surface water	Conductivity	1,090	mg/L	5	3/13/00	3
07	08	surface water	Conductivity	1350	umhos/cm	1	5/11/99	5
09	08	surface water	Conductivity	NS	umhos/cm	10	12/6/99	12
05	08	surface water	Conductivity	1150	umhos/cm	1	11/9/98	11
02	08	surface water	Conductivity	814	umhos/cm	1	3/3/98	3
01	08	surface water	Conductivity	1070	umhos/cm	1.00	12/9/97	12
04	08	surface water	Conductivity	1140	umhos/cm	1	8/4/98	8
11	08	surface water	Chloride	170	mg/L	0.5	6/1/00	6
11	08	surface water	Chloride	170	mg/L	0.5	6/1/00	6
07	08	surface water	Chloride	172	mg/L	1	5/11/99	5
10	08	surface water	Chloride	143	mg/L	0.5	3/13/00	3
10	08	surface water	Chloride	143	mg/L	0.5	3/13/00	3
09	08	surface water	Chloride	NS	mg/L	1	12/6/99	12
08	08	surface water	Chloride	NS	mg/L	1	9/28/99	9
09	08	surface water	Chloride	NS	mg/L	1	12/6/99	12

fldRound	fldWell	fldMatrix	fldNewName	fldWell8	fldUnits	fldDL	fldSampleDate	fldSampleMont
08	08	surface water	Chloride	NS	mg/L	1	9/28/99	9
03	08	surface water	Chloride	164	mg/L	50	5/26/98	5
04	08	surface water	Chloride	159	mg/L	1	8/4/98	8
06	08	surface water	Chloride	139	mg/L	1	2/10/99	2
01	08	surface water	Chloride	183	mg/L	20.0	12/9/97	12
02	08	surface water	Chloride	105	mg/L	20	3/3/98	3
05	08	surface water	Chloride	160	mg/L	1	11/9/98	11
11	08	surface water	Carbonate	20	mg/L	0.5	6/1/00	6
09	08	surface water	Carbonate	NS	mg/L	2	12/6/99	12
08	08	surface water	Carbonate	NS	mg/L	2	9/28/99	9
10	08	surface water	Carbonate	ND	mg/L	0.5	3/13/00	3
05	08	surface water	Carbonate	3.91	mg/L	0.5	11/9/98	11
07	08	surface water	Carbonate	1.73	mg/L	0.5	5/11/99	5
06	08	surface water	Carbonate	3.61	mg/L	0.5	2/10/99	2
03	08	surface water	Carbonate	2.08	mg/L	0.5	5/26/98	5
01	08	surface water	Carbonate	2.18	mg/L	1.00	12/9/97	12
02	08	surface water	Carbonate	1.5	mg/L	0.5	3/3/98	3
04	08	surface water	Carbonate	4.6	mg/L	0.5	8/4/98	8
11	08	surface water	Calcium	91.3	mg/L	0.1	6/1/00	6
09	08	surface water	Calcium	NS	mg/L	0.5	12/6/99	12
01	08	surface water	Calcium	85.7	mg/L	0.100	12/9/97	12
05	08	surface water	Calcium	88.3	mg/L	0.1	11/9/98	11
04	08	surface water	Calcium	91.6	mg/L	0.1	8/4/98	8
10	08	surface water	Calcium	84.4	mg/L	0.10	3/13/00	3
07	08	surface water	Calcium	94.7	mg/L	0.1	5/11/99	5
02	08	surface water	Calcium	77	mg/L	0.2	3/3/98	3
03	08	surface water	Calcium	72	mg/L	0.1	5/26/98	5
08	08	surface water	Calcium	NS	mg/L	0.5	9/28/99	9
06	08	surface water	Calcium	84.7	mg/L	0.1	2/10/99	2
03	08	surface water	Boron	ND	mg/L	0.5	5/26/98	5
11	08	surface water	Boron	0.2	mg/L	0.1	6/1/00	6
08	08	surface water	Boron	NS	mg/L	0.2	9/28/99	9
09	08	surface water	Boron	NS	mg/L	0.2	12/6/99	12
10	08	surface water	Boron	0.1	mg/L	0.1	3/13/00	3
06	08	surface water	Boron	0.169	mg/L	0.1	2/10/99	2
04	08	surface water	Boron	0.203	mg/L	0.1	8/4/98	8
07	08	surface water	Boron	0.219	mg/L	0.1	5/11/99	5
02	08	surface water	Boron	ND	mg/L	0.5	3/3/98	3

fldRound	fldWell	fldMatrix	fldNewName	fldWell8	fldUnits	fldDL	fldSampleDate	fldSampleMont
05	08	surface water	Boron	0.202	mg/L	0.1	11/9/98	11
01	08	surface water	Boron	ND	mg/L	0.5	12/9/97	12
06	08	surface water	Biochemical Oxygen Dem	NS	mg/L	2	2/10/99	2
10	08	surface water	Biochemical Oxygen Dem	ND	mg/L	2	3/13/00	3
11	08	surface water	Biochemical Oxygen Dem	NS	mg/L	2	6/1/00	6
05	08	surface water	Biochemical Oxygen Dem	ND	mg/L	2	11/9/98	11
07	08	surface water	Biochemical Oxygen Dem	3.06	mg/L	2	5/11/99	5
09	08	surface water	Biochemical Oxygen Dem	NS	mg/L	2	12/6/99	12
08	08	surface water	Biochemical Oxygen Dem	NS	mg/L	0	9/28/99	9
02	08	surface water	Biochemical Oxygen Dem	NS	mg/L	2	3/3/98	3
01	08	surface water	Biochemical Oxygen Dem	ND	mg/L	2.00	12/9/97	12
03	08	surface water	Biochemical Oxygen Dem	ND	mg/L	2	5/26/98	5
04	08	surface water	Biochemical Oxygen Dem	NS	mg/L	2	8/4/98	8
03	08	surface water	Bicarbonate	164	mg/L	1	5/26/98	5
10	08	surface water	Bicarbonate	156	mg/L	1	3/13/00	3
02	08	surface water	Bicarbonate	126	mg/L	1	3/3/98	3
04	08	surface water	Bicarbonate	186	mg/L	1	8/4/98	8
05	08	surface water	Bicarbonate	158	mg/L	1	11/9/98	11
06	08	surface water	Bicarbonate	188	mg/L	1	2/10/99	2
07	08	surface water	Bicarbonate	231	mg/L	1	5/11/99	5
09	08	surface water	Bicarbonate	NS	mg/L	2	12/6/99	12
01	08	surface water	Bicarbonate	143	mg/L	1.00	12/9/97	12
08	08	surface water	Bicarbonate	NS	mg/L	2	9/28/99	9
11	08	surface water	Bicarbonate	164	mg/L	1	6/1/00	6
06	08	surface water	Arsenic	NS	mg/L	0.025	2/10/99	2
09	08	surface water	Arsenic	NS	mg/L	0.005	12/6/99	12
04	08	surface water	Arsenic	ND	mg/L	0.025	8/4/98	8
10	08	surface water	Arsenic	ND	mg/L	0.025	3/13/00	3
02	08	surface water	Arsenic	ND	mg/L	0.01	3/3/98	3
08	08	surface water	Arsenic	NS	mg/L	0.005	9/28/99	9
05	08	surface water	Arsenic	ND	mg/L	0.025	11/9/98	11
07	08	surface water	Arsenic	ND	mg/L	0.025	5/11/99	5
01	08	surface water	Arsenic	ND	mg/L	0.0250	12/9/97	12
03	08	surface water	Arsenic	ND	mg/L	0.025	5/26/98	5
11	08	surface water	Arsenic	ND	mg/L	0.025	6/1/00	6
09	08	surface water	Aluminum	NS	mg/L	0.1	12/6/99	12
08	08	surface water	Aluminum	NS	mg/L	0.1	9/28/99	9
04	08	surface water	Alkalinity (CaCO3)	191	mg/L	1	8/4/98	8

fldRound	fldWell	fldMatrix	fldNewName	fldWell8	fldUnits	fldDL	fldSampleDate	fldSampleMont
10	08	surface water	Alkalinity (CaCO3)	156	mg/L	1	3/13/00	3
07	08	surface water	Alkalinity (CaCO3)	233	mg/L	1	5/11/99	5
05	08	surface water	Alkalinity (CaCO3)	162	mg/L	1	11/9/98	11
06	08	surface water	Alkalinity (CaCO3)	192	mg/L	1	2/10/99	2
09	08	surface water	Alkalinity (CaCO3)	NS	mg/L	2	12/6/99	12
03	08	surface water	Alkalinity (CaCO3)	166	mg/L	1	5/26/98	5
02	08	surface water	Alkalinity (CaCO3)	128	mg/L	1	3/3/98	3
08	08	surface water	Alkalinity (CaCO3)	NS	mg/L	2	9/28/99	9
11	08	surface water	Alkalinity (CaCO3)	184	mg/L	1	6/1/00	6
01	08	surface water	Alkalinity (CaCO3)	145	mg/L	1.00	12/9/97	12

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
02	04	surface water	Zinc	ND	mg/L	0.03	3/3/98	3
09	04	surface water	Zinc	ND	mg/L	0.03	12/6/99	12
08	04	surface water	Zinc	ND	mg/L	0.03	9/28/99	9
05	04	surface water	Zinc	0.0144	mg/L	0.01	11/9/98	11
06	04	surface water	Zinc	0.0205	mg/L	0.01	2/10/99	2
01	04	surface water	Zinc	0.021	mg/L	0.0100	12/9/97	12
10	04	surface water	Zinc	0.010J	mg/L	0.01	3/7/00	3
03	04	surface water	Zinc	ND	mg/L	0.01	5/26/98	5
11	04	surface water	Zinc	ND	mg/L	0.01	6/1/00	6
04	04	surface water	Zinc	ND	mg/L	0.01	8/4/98	8
07	04	surface water	Zinc	ND	mg/L	0.02	5/11/99	5
10	04	surface water	Total Organic Carbon	13	mg/L	0.1	3/7/00	3
11	04	surface water	Total Organic Carbon	4.6	mg/L	0.5	6/1/00	6
06	04	surface water	Total Organic Carbon	6.59	mg/L	1	2/10/99	2
01	04	surface water	Total Organic Carbon	8.77	mg/L	1.00	12/9/97	12
09	04	surface water	Total Organic Carbon	14.2	mg/L	0.5	12/6/99	12
07	04	surface water	Total Organic Carbon	3.2	mg/L	1	5/11/99	5
05	04	surface water	Total Organic Carbon	15.6	mg/L	1	11/9/98	11
02	04	surface water	Total Organic Carbon	6.09	mg/L	1	3/3/98	3
03	04	surface water	Total Organic Carbon	8.53	mg/L	1	5/26/98	5
04	04	surface water	Total Organic Carbon	2.05	mg/L	1	8/4/98	8
08	04	surface water	Total Organic Carbon	4.1	mg/L	0.5	9/28/99	9
06	04	surface water	Total Dissolved Solids	499	mg/L	10	2/10/99	2
09	04	surface water	Total Dissolved Solids	756	mg/L	10	12/6/99	12
02	04	surface water	Total Dissolved Solids	668	mg/L	10	3/3/98	3
03	04	surface water	Total Dissolved Solids	803	mg/L	10	5/26/98	5
01	04	surface water	Total Dissolved Solids	476	mg/L	10.0	12/9/97	12
07	04	surface water	Total Dissolved Solids	761	mg/L	10	5/11/99	5
05	04	surface water	Total Dissolved Solids	570	mg/L	10	11/9/98	11
08	04	surface water	Total Dissolved Solids	519	mg/L	10	9/28/99	9
10	04	surface water	Total Dissolved Solids	480	mg/L	5	3/7/00	3
11	04	surface water	Total Dissolved Solids	537	mg/L	5	6/1/00	6
04	04	surface water	Total Dissolved Solids	622	mg/L	10	8/4/98	8
06	04	surface water	Total Coliform	>1600	mpn/100ml	2	2/10/99	2
09	04	surface water	Total Coliform	240	mpn/100ml	2	12/6/99	12
05	04	surface water	Total Coliform	>1600	mpn/100ml	2	11/9/98	11
04	04	surface water	Total Coliform	500	mpn/100ml	2	8/4/98	8
02	04	surface water	Total Coliform	>1600	mpn/100ml	2	3/3/98	3

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
08	04	surface water	Total Coliform	<2	mpn/100ml	2	9/28/99	9
07	04	surface water	Total Coliform	>23	mpn/100ml	2	5/11/99	5
03	04	surface water	Total Coliform	>1600	mpn/100ml	2	5/26/98	5
01	04	surface water	Total Coliform	>1600	mpn/100ml	2	12/9/97	12
11	04	surface water	Total Coliform	1,600	MPN/100 m	2	6/1/00	6
10	04	surface water	Total Coliform	>1,600	MPN/100 m	3.0	3/7/00	3
06	04	surface water	Surfactants (MBAS)	NS	mg/L	0.1	2/10/99	2
07	04	surface water	Surfactants (MBAS)	ND	mg/L	0.1	5/11/99	5
02	04	surface water	Surfactants (MBAS)	0.108	mg/L	0.1	3/3/98	3
04	04	surface water	Surfactants (MBAS)	ND	mg/L	0.1	8/4/98	8
03	04	surface water	Surfactants (MBAS)	ND	mg/L	0.1	5/26/98	5
01	04	surface water	Surfactants (MBAS)	ND	mg/L	0.100	12/9/97	12
05	04	surface water	Surfactants (MBAS)	0.358	mg/L	0.1	11/9/98	11
09	04	surface water	Surfactants (MBAS)	ND	mg/L	0.05	12/6/99	12
10	04	surface water	Surfactants (MBAS)	0.11	mg/L	0.03	3/7/00	3
11	04	surface water	Surfactants (MBAS)	ND	mg/L	0.03	6/1/00	6
08	04	surface water	Surfactants (MBAS)	ND	mg/L	0.05	9/28/99	9
02	04	surface water	Sulfate	164	mg/L	4	3/3/98	3
06	04	surface water	Sulfate	108	mg/L	5	2/10/99	2
03	04	surface water	Sulfate	273	mg/L	10	5/26/98	5
11	04	surface water	Sulfate	107	mg/L	5	6/1/00	6
08	04	surface water	Sulfate	113	mg/L	10	9/28/99	9
04	04	surface water	Sulfate	203	mg/L	50	8/4/98	8
01	04	surface water	Sulfate	123	mg/L	10.0	12/9/97	12
10	04	surface water	Sulfate	69	mg/L	5	3/7/00	3
05	04	surface water	Sulfate	135	mg/L	5	11/9/98	11
07	04	surface water	Sulfate	216	mg/L	50	5/11/99	5
09	04	surface water	Sulfate	133	mg/L	10	12/6/99	12
02	04	surface water	Sodium	110	mg/L	4	3/3/98	3
03	04	surface water	Sodium	122	mg/L	0.3	5/26/98	5
05	04	surface water	Sodium	99.7	mg/L	0.3	11/9/98	11
04	04	surface water	Sodium	100	mg/L	0.3	8/4/98	8
11	04	surface water	Sodium	83.1	mg/L	0.25	6/1/00	6
10	04	surface water	Sodium	71.6	mg/L	0.25	3/7/00	3
06	04	surface water	Sodium	89.5	mg/L	0.3	2/10/99	2
08	04	surface water	Sodium	79.2	mg/L	0.5	9/28/99	9
07	04	surface water	Sodium	94.7	mg/L	0.3	5/11/99	5
09	04	surface water	Sodium	110	mg/L	0.5	12/6/99	12

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
01	04	surface water	Sodium	78.4	mg/L	0.300	12/9/97	12
08	04	surface water	Potassium	3.0	mg/L	1.0	9/28/99	9
05	04	surface water	Potassium	9.73	mg/L	0.3	11/9/98	11
02	04	surface water	Potassium	5	mg/L	2	3/3/98	3
09	04	surface water	Potassium	2.5	mg/L	1.0	12/6/99	12
06	04	surface water	Potassium	5.96	mg/L	1	2/10/99	2
11	04	surface water	Potassium	2.8	mg/L	0.5	6/1/00	6
03	04	surface water	Potassium	6.11	mg/L	0.3	5/26/98	5
10	04	surface water	Potassium	3.9	mg/L	0.5	3/7/00	3
07	04	surface water	Potassium	1.53	mg/L	1	5/11/99	5
01	04	surface water	Potassium	4.25	mg/L	0.300	12/9/97	12
04	04	surface water	Potassium	3.32	mg/L	0.3	8/4/98	8
03	04	surface water	Phosphorus	0.101	mg/L	0.01	5/26/98	5
02	04	surface water	Phosphorus	0.511	mg/L	0.01	3/3/98	3
04	04	surface water	Phosphorus	0.07	mg/L	0.01	8/4/98	8
07	04	surface water	Phosphorus	0.085	mg/L	0.01	5/11/99	5
05	04	surface water	Phosphorus	0.25	mg/L	0.01	11/9/98	11
06	04	surface water	Phosphorus	0.256	mg/L	0.01	2/10/99	2
01	04	surface water	Phosphorus	0.254	mg/L	0.01	12/9/97	12
03	04	surface water	Phosphate	NS	mg/L	0.3	5/26/98	5
11	04	surface water	Phosphate	ND	mg/L	0.30	6/1/00	6
02	04	surface water	Phosphate	NS	mg/L	0.3	3/3/98	3
05	04	surface water	Phosphate	NS	mg/L	0.3	11/9/98	11
01	04	surface water	Phosphate	NS	mg/L	0.3	12/9/97	12
09	04	surface water	Phosphate	0.4	mg/L	0.3	12/6/99	12
07	04	surface water	Phosphate	NS	mg/L	0.3	5/11/99	5
06	04	surface water	Phosphate	NS	mg/L	0.3	2/10/99	2
04	04	surface water	Phosphate	NS	mg/L	0.3	8/4/98	8
08	04	surface water	Phosphate	0.4	mg/L	0.3	9/28/99	9
10	04	surface water	Phosphate	1.2	mg/L	0.30	3/7/00	3
01	04	surface water	pH	7.7	pH units	2.0-12.5	12/9/97	12
04	04	surface water	pH	7.95	pH units	2.5-12.0	8/4/98	8
02	04	surface water	pH	8.27	pH units	2.0-12.5	3/3/98	3
09	04	surface water	pH	7.59	pH units	1.00	12/6/99	12
03	04	surface water	pH	7.64	pH units	2.5-12.0	5/26/98	5
08	04	surface water	pH	7.88	pH units	1.00	9/28/99	9
06	04	surface water	pH	7.78	pH units		2/10/99	2
10	04	surface water	pH	7.99	mg/L	0.01	3/7/00	3

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
09	04	surface water	pH	7.59	pH units	1.00	12/6/99	12
11	04	surface water	pH	7.52	mg/L	0.01	6/1/00	6
11	04	surface water	pH	7.52	mg/L	0.01	6/1/00	6
10	04	surface water	pH	7.99	mg/L	0.01	3/7/00	3
08	04	surface water	pH	7.88	pH units	1.00	9/28/99	9
07	04	surface water	pH	7.89	pH units	2.5-12.0	5/11/99	5
06	04	surface water	Oil and Grease	NS	mg/L	1	2/10/99	2
11	04	surface water	Oil and Grease	ND	mg/L	0.5	6/1/00	6
10	04	surface water	Oil and Grease	ND	mg/L	0.5	3/7/00	3
02	04	surface water	Oil and Grease	ND	mg/L	0.962	3/3/98	3
10	04	surface water	Oil and Grease	ND	mg/L	0.5	3/7/00	3
09	04	surface water	Oil and Grease	ND	mg/L	1.0	12/6/99	12
05	04	surface water	Oil and Grease	ND	mg/L	1	11/9/98	11
07	04	surface water	Oil and Grease	ND	mg/L	0.971	5/11/99	5
08	04	surface water	Oil and Grease	ND	mg/L	1.0	9/28/99	9
08	04	surface water	Oil and Grease	ND	mg/L	1.0	9/28/99	9
03	04	surface water	Oil and Grease	ND	mg/L	0.971	5/26/98	5
04	04	surface water	Oil and Grease	ND	mg/L	1.1	8/4/98	8
09	04	surface water	Oil and Grease	ND	mg/L	1.0	12/6/99	12
01	04	surface water	Oil and Grease	ND	mg/L	1.21	12/9/97	12
11	04	surface water	Oil and Grease	ND	mg/L	0.5	6/1/00	6
10	04	surface water	Nitrogen	ND	mg/L	0.05	3/7/00	3
05	04	surface water	Nitrogen	1.57	mg/L	0.1	11/9/98	11
08	04	surface water	Nitrogen	0.4	mg/L	0.1	9/28/99	9
09	04	surface water	Nitrogen	NS	mg/L	0.1	12/6/99	12
02	04	surface water	Nitrogen	NS	mg/L	0.1	3/3/98	3
06	04	surface water	Nitrogen	NS	mg/L	0.1	2/10/99	2
03	04	surface water	Nitrogen	0.8	mg/Kg	0.5	5/26/98	5
02	04	surface water	Nitrogen	NS	mg/L	0.1	3/3/98	3
06	04	surface water	Nitrogen	NS	mg/L	0.1	2/10/99	2
04	04	surface water	Nitrogen	NS	mg/L	0.1	8/4/98	8
07	04	surface water	Nitrogen	ND	mg/L	0.4	5/11/99	5
04	04	surface water	Nitrogen	NS	mg/L	0.1	8/4/98	8
09	04	surface water	Nitrogen	NS	mg/L	0.1	12/6/99	12
06	04	surface water	Nitrogen	NS	mg/L	0.1	2/10/99	2
01	04	surface water	Nitrogen	0.434	mg/L	0.100	12/9/97	12
02	04	surface water	Nitrogen	NS	mg/L	0.1	3/3/98	3
04	04	surface water	Nitrogen	NS	mg/L	0.1	8/4/98	8

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
09	04	surface water	Nitrite	ND	mg/L	0.02	12/6/99	12
08	04	surface water	Nitrite	0.03	mg/L	0.02	9/28/99	9
07	04	surface water	Nitrate-N	2.08	mg/L	0.1	5/11/99	5
06	04	surface water	Nitrate-N	0.381	mg/L	0.05	2/10/99	2
10	04	surface water	Nitrate-N	2.7	mg/L	0.05	3/7/00	3
08	04	surface water	Nitrate-N	2.0	mg/L	0.1	9/28/99	9
03	04	surface water	Nitrate-N	0.868	mg/L	0.1	5/26/98	5
09	04	surface water	Nitrate-N	ND	mg/L	0.1	12/6/99	12
02	04	surface water	Nitrate-N	1.88	mg/L	0.1	3/3/98	3
11	04	surface water	Nitrate-N	1.2	mg/L	0.05	6/1/00	6
01	04	surface water	Nitrate-N	1.32	mg/L	0.100	12/9/97	12
04	04	surface water	Nitrate-N	0.82	mg/L	0.05	8/4/98	8
05	04	surface water	Nitrate-N	1.22	mg/L	0.05	11/9/98	11
06	04	surface water	Mercury	NS	mg/L	0.0002	2/10/99	2
01	04	surface water	Mercury	ND	mg/L	0.000200	12/9/97	12
11	04	surface water	Mercury	NS	mg/L	0.0002	6/1/00	6
10	04	surface water	Mercury	ND	mg/L	0.0002	3/7/00	3
07	04	surface water	Mercury	ND	mg/L	0.0002	5/11/99	5
08	04	surface water	Mercury	ND	mg/L	0.0002	9/28/99	9
04	04	surface water	Mercury	NS	mg/L	0.0002	8/4/98	8
09	04	surface water	Mercury	NS	mg/L	0.0002	12/6/99	12
05	04	surface water	Mercury	ND	mg/L	0.0002	11/9/98	11
03	04	surface water	Mercury	ND	mg/L	0.0002	5/26/98	5
02	04	surface water	Mercury	NS	mg/L	0.0002	3/3/98	3
09	04	surface water	Manganese	0.12	mg/L	0.01	12/6/99	12
08	04	surface water	Manganese	0.03	mg/L	0.01	9/28/99	9
07	04	surface water	Manganese	0.0417	mg/L	0.01	5/11/99	5
03	04	surface water	Manganese	0.075	mg/L	0.01	5/26/98	5
10	04	surface water	Manganese	0.02	mg/L	0.005	3/7/00	3
01	04	surface water	Manganese	0.251	mg/L	0.0100	12/9/97	12
05	04	surface water	Manganese	0.0656	mg/L	0.01	11/9/98	11
02	04	surface water	Manganese	0.1	mg/L	0.01	3/3/98	3
11	04	surface water	Manganese	0.02	mg/L	0.005	6/1/00	6
06	04	surface water	Manganese	0.0786	mg/L	0.01	2/10/99	2
04	04	surface water	Manganese	0.108	mg/L	0.01	8/4/98	8
06	04	surface water	Magnesium	14.7	mg/L	0.2	2/10/99	2
09	04	surface water	Magnesium	27.4	mg/L	0.5	12/6/99	12
07	04	surface water	Magnesium	22.4	mg/L	0.2	5/11/99	5

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
08	04	surface water	Magnesium	17.5	mg/L	0.5	9/28/99	9
10	04	surface water	Magnesium	13.2	mg/L	0.20	3/7/00	3
02	04	surface water	Magnesium	28	mg/L	0.1	3/3/98	3
03	04	surface water	Magnesium	32.2	mg/L	0.2	5/26/98	5
01	04	surface water	Magnesium	18.7	mg/L	0.200	12/9/97	12
05	04	surface water	Magnesium	16.7	mg/L	0.2	11/9/98	11
04	04	surface water	Magnesium	24.2	mg/L	0.2	8/4/98	8
11	04	surface water	Magnesium	17.7	mg/L	0.2	6/1/00	6
11	04	surface water	Lead	ND	mg/L	0.005	6/1/00	6
06	04	surface water	Lead	0.00107	mg/L	0.001	2/10/99	2
07	04	surface water	Lead	0.00286	mg/L	0.001	5/11/99	5
01	04	surface water	Lead	0.019	mg/L	0.0200	12/9/97	12
03	04	surface water	Lead	ND	mg/L	0.001	5/26/98	5
02	04	surface water	Lead	ND	mg/L	0.015	3/3/98	3
10	04	surface water	Lead	0.025	mg/L	0.005	3/7/00	3
08	04	surface water	Lead	ND	mg/L	0.1	9/28/99	9
05	04	surface water	Lead	ND	mg/L	0.001	11/9/98	11
09	04	surface water	Lead	ND	mg/L	0.05	12/6/99	12
04	04	surface water	Lead	ND	mg/L	0.001	8/4/98	8
04	04	surface water	Iron	0.221	mg/L	0.05	8/4/98	8
06	04	surface water	Iron	3.46	mg/L	0.05	2/10/99	2
11	04	surface water	Iron	ND	mg/L	0.03	6/1/00	6
05	04	surface water	Iron	0.564	mg/L	0.05	11/9/98	11
07	04	surface water	Iron	0.0668	mg/L	0.05	5/11/99	5
10	04	surface water	Iron	0.035J	mg/L	0.03	3/7/00	3
02	04	surface water	Iron	1.4	mg/L	0.1	3/3/98	3
03	04	surface water	Iron	0.447	mg/L	0.05	5/26/98	5
08	04	surface water	Iron	ND	mg/L	0.05	9/28/99	9
01	04	surface water	Iron	3	mg/L	0.0500	12/9/97	12
09	04	surface water	Iron	0.11	mg/L	0.05	12/6/99	12
07	04	surface water	Hydroxide	ND	mg/L	0.5	5/11/99	5
01	04	surface water	Hydroxide	ND	mg/L	0.500	12/9/97	12
09	04	surface water	Hydroxide	ND	mg/L	2	12/6/99	12
03	04	surface water	Hydroxide	ND	mg/L	0.5	5/26/98	5
04	04	surface water	Hydroxide	ND	mg/L	0.5	8/4/98	8
08	04	surface water	Hydroxide	ND	mg/L	0.5	9/28/99	9
10	04	surface water	Hydroxide	ND	mg/L	0.5	3/7/00	3
06	04	surface water	Hydroxide	NS	mg/L	0.5	2/10/99	2

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
02	04	surface water	Hydroxide	ND	mg/L	0.5	3/3/98	3
05	04	surface water	Hydroxide	ND	mg/L	0.5	11/9/98	11
11	04	surface water	Hydroxide	ND	mg/L	0.5	6/1/00	6
06	04	surface water	Hardness (CaCO3)	192	mg/L	1	2/10/99	2
07	04	surface water	Hardness (CaCO3)	353	mg/L	2	5/11/99	5
05	04	surface water	Hardness (CaCO3)	230	mg/L	1	11/9/98	11
04	04	surface water	Hardness (CaCO3)	295	mg/L	2	8/4/98	8
01	04	surface water	Hardness (CaCO3)	247	mg/L	10.0	12/9/97	12
02	04	surface water	Hardness (CaCO3)	320	mg/L	10	3/3/98	3
11	04	surface water	Hardness (CaCO3)	242	mg/L	1	6/1/00	6
08	04	surface water	Hardness (CaCO3)	236	mg/L	2	9/28/99	9
09	04	surface water	Hardness (CaCO3)	400	mg/L	2	12/6/99	12
03	04	surface water	Hardness (CaCO3)	310	mg/L	5	5/26/98	5
10	04	surface water	Hardness (CaCO3)	186	mg/L	1	3/7/00	3
09	04	surface water	Fluoride	0.4	mg/L	0.2	12/6/99	12
10	04	surface water	Fluoride	0.5	mg/L	0.1	3/7/00	3
02	04	surface water	Fluoride	0.32	mg/L	0.2	3/3/98	3
04	04	surface water	Fluoride	0.353	mg/L	0.1	8/4/98	8
11	04	surface water	Fluoride	0.5	mg/L	0.1	6/1/00	6
08	04	surface water	Fluoride	0.5	mg/L	0.1	9/28/99	9
03	04	surface water	Fluoride	1.12	mg/L	1	5/26/98	5
05	04	surface water	Fluoride	0.352	mg/L	0.1	11/9/98	11
07	04	surface water	Fluoride	0.281	mg/L	0.1	5/11/99	5
01	04	surface water	Fluoride	ND	mg/L	0.200	12/9/97	12
06	04	surface water	Fluoride	0.292	mg/L	0.1	2/10/99	2
08	04	surface water	Fecal Coliform	<2	mpn/100ml	2	9/28/99	9
05	04	surface water	Fecal Coliform	>1600	mpn/100ml	2	11/9/98	11
07	04	surface water	Fecal Coliform	>23	mpn/100ml	2	5/11/99	5
01	04	surface water	Fecal Coliform	>1600	mpn/100ml		12/9/97	12
03	04	surface water	Fecal Coliform	1600	mpn/100ml	2	5/26/98	5
09	04	surface water	Fecal Coliform	80	mpn/100ml	2	12/6/99	12
02	04	surface water	Fecal Coliform	300	mpn/100ml	2	3/3/98	3
04	04	surface water	Fecal Coliform	17	mpn/100ml	2	8/4/98	8
11	04	surface water	Fecal Coliform	13	MPN/mL	2	6/1/00	6
10	04	surface water	Fecal Coliform	>1,600	MPN/100 m	2	3/7/00	3
06	04	surface water	Fecal Coliform	1600	mpn/100ml	2	2/10/99	2
02	04	surface water	Cyanide (Total)	NS	mg/L	0.005	3/3/98	3
10	04	surface water	Cyanide (Total)	ND	mg/L	0.01	3/7/00	3

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
06	04	surface water	Cyanide (Total)	NS	mg/L	0.005	2/10/99	2
09	04	surface water	Cyanide (Total)	NS	mg/L	0.005	12/6/99	12
04	04	surface water	Cyanide (Total)	NS	mg/L	0.005	8/4/98	8
02	04	surface water	Cyanide (Total)	NS	mg/L	0.005	3/3/98	3
01	04	surface water	Cyanide (Total)	ND	mg/L	0.00500	12/9/97	12
04	04	surface water	Cyanide (Total)	NS	mg/L	0.005	8/4/98	8
06	04	surface water	Cyanide (Total)	NS	mg/L	0.005	2/10/99	2
03	04	surface water	Cyanide (Total)	ND	mg/L	0.005	5/26/98	5
07	04	surface water	Cyanide (Total)	ND	mg/L	0.005	5/11/99	5
05	04	surface water	Cyanide (Total)	ND	mg/L	0.005	11/9/98	11
08	04	surface water	Cyanide (Total)	ND	mg/L	0.01	9/28/99	9
09	04	surface water	Cyanide (Total)	NS	mg/L	0.005	12/6/99	12
11	04	surface water	Cyanide (Total)	NS	mg/L	0.01	6/1/00	6
09	04	surface water	Copper	0.03	mg/L	0.02	12/6/99	12
08	04	surface water	Copper	ND	mg/L	0.02	9/28/99	9
05	04	surface water	Copper	ND	mg/L	0.005	11/9/98	11
02	04	surface water	Copper	ND	mg/L	0.02	3/3/98	3
04	04	surface water	Copper	ND	mg/L	0.005	8/4/98	8
06	04	surface water	Copper	0.005	mg/L	0.005	2/10/99	2
01	04	surface water	Copper	ND	mg/L	0.00500	12/9/97	12
11	04	surface water	Copper	ND	mg/L	0.005	6/1/00	6
07	04	surface water	Copper	ND	mg/L	0.005	5/11/99	5
10	04	surface water	Copper	ND	mg/L	0.005	3/7/00	3
03	04	surface water	Copper	ND	mg/L	0.005	5/26/98	5
08	04	surface water	Conductivity	821	umhos/cm	10	9/28/99	9
06	04	surface water	Conductivity	776	umhos/cm	1	2/10/99	2
07	04	surface water	Conductivity	1140	umhos/cm	1	5/11/99	5
05	04	surface water	Conductivity	860	umhos/cm	1	11/9/98	11
10	04	surface water	Conductivity	728	mg/L	5	3/7/00	3
11	04	surface water	Conductivity	873	mg/L	5	6/1/00	6
09	04	surface water	Conductivity	1250	umhos/cm	10	12/6/99	12
03	04	surface water	Conductivity	1120	umhos/cm	1	5/26/98	5
01	04	surface water	Conductivity	934	umhos/cm	1.00	12/9/97	12
02	04	surface water	Conductivity	983	umhos/cm	1	3/3/98	3
04	04	surface water	Conductivity	977	umhos/cm	1	8/4/98	8
10	04	surface water	Chloride	99	mg/L	0.5	3/7/00	3
07	04	surface water	Chloride	95.1	mg/L	1	5/11/99	5
02	04	surface water	Chloride	115	mg/L	20	3/3/98	3

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
06	04	surface water	Chloride	96.6	mg/L	1	2/10/99	2
08	04	surface water	Chloride	81	mg/L	1	9/28/99	9
09	04	surface water	Chloride	147	mg/L	1	12/6/99	12
03	04	surface water	Chloride	197	mg/L	50	5/26/98	5
10	04	surface water	Chloride	99	mg/L	0.5	3/7/00	3
11	04	surface water	Chloride	99	mg/L	0.5	6/1/00	6
09	04	surface water	Chloride	147	mg/L	1	12/6/99	12
11	04	surface water	Chloride	99	mg/L	0.5	6/1/00	6
04	04	surface water	Chloride	98.3	mg/L	1	8/4/98	8
05	04	surface water	Chloride	109	mg/L	1	11/9/98	11
08	04	surface water	Chloride	81	mg/L	1	9/28/99	9
01	04	surface water	Chloride	148	mg/L	20.0	12/9/97	12
02	04	surface water	Carbonate	2.48	mg/L	0.5	3/3/98	3
03	04	surface water	Carbonate	0.862	mg/L	0.5	5/26/98	5
04	04	surface water	Carbonate	1.7	mg/L	0.5	8/4/98	8
05	04	surface water	Carbonate	ND	mg/L	0.5	11/9/98	11
06	04	surface water	Carbonate	1.09	mg/L	0.5	2/10/99	2
09	04	surface water	Carbonate	ND	mg/L	2	12/6/99	12
10	04	surface water	Carbonate	ND	mg/L	0.5	3/7/00	3
08	04	surface water	Carbonate	ND	mg/L	0.5	9/28/99	9
11	04	surface water	Carbonate	8	mg/L	0.5	6/1/00	6
01	04	surface water	Carbonate	1.08	mg/L	1.00	12/9/97	12
07	04	surface water	Carbonate	2.11	mg/L	0.5	5/11/99	5
09	04	surface water	Calcium	112	mg/L	0.5	12/6/99	12
08	04	surface water	Calcium	63.4	mg/L	0.5	9/28/99	9
11	04	surface water	Calcium	66.0	mg/L	0.1	6/1/00	6
01	04	surface water	Calcium	85.3	mg/L	0.100	12/9/97	12
07	04	surface water	Calcium	105	mg/L	0.1	5/11/99	5
03	04	surface water	Calcium	97.9	mg/L	0.1	5/26/98	5
02	04	surface water	Calcium	85	mg/L	0.2	3/3/98	3
06	04	surface water	Calcium	47.9	mg/L	0.1	2/10/99	2
04	04	surface water	Calcium	83.4	mg/L	0.1	8/4/98	8
05	04	surface water	Calcium	61.3	mg/L	0.1	11/9/98	11
10	04	surface water	Calcium	47.7	mg/L	0.10	3/7/00	3
07	04	surface water	Boron	0.197	mg/L	0.1	5/11/99	5
10	04	surface water	Boron	0.3	mg/L	0.1	3/7/00	3
06	04	surface water	Boron	0.345	mg/L	0.1	2/10/99	2
03	04	surface water	Boron	ND	mg/L	0.5	5/26/98	5

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
11	04	surface water	Boron	0.2	mg/L	0.1	6/1/00	6
05	04	surface water	Boron	0.377	mg/L	0.1	11/9/98	11
08	04	surface water	Boron	0.2	mg/L	0.2	9/28/99	9
09	04	surface water	Boron	ND	mg/L	0.2	12/6/99	12
01	04	surface water	Boron	ND	mg/L	0.5	12/9/97	12
02	04	surface water	Boron	ND	mg/L	0.5	3/3/98	3
04	04	surface water	Boron	0.228	mg/L	0.1	8/4/98	8
01	04	surface water	Biochemical Oxygen Dem	2.38	mg/L	2.00	12/9/97	12
10	04	surface water	Biochemical Oxygen Dem	ND	mg/L	2	3/7/00	3
04	04	surface water	Biochemical Oxygen Dem	NS	mg/L	2	8/4/98	8
11	04	surface water	Biochemical Oxygen Dem	NS	mg/L	2	6/1/00	6
05	04	surface water	Biochemical Oxygen Dem	6.72	mg/L	2	11/9/98	11
02	04	surface water	Biochemical Oxygen Dem	NS	mg/L	2	3/3/98	3
08	04	surface water	Biochemical Oxygen Dem	ND	mg/L	2	9/28/99	9
03	04	surface water	Biochemical Oxygen Dem	ND	mg/L	2	5/26/98	5
09	04	surface water	Biochemical Oxygen Dem	NS	mg/L	2	12/6/99	12
06	04	surface water	Biochemical Oxygen Dem	NS	mg/L	2	2/10/99	2
07	04	surface water	Biochemical Oxygen Dem	ND	mg/L	2	5/11/99	5
04	04	surface water	Bicarbonate	203	mg/L	1	8/4/98	8
05	04	surface water	Bicarbonate	158	mg/L	1	11/9/98	11
02	04	surface water	Bicarbonate	170	mg/L	1	3/3/98	3
08	04	surface water	Bicarbonate	164	mg/L	1	9/28/99	9
01	04	surface water	Bicarbonate	163	mg/L	1.00	12/9/97	12
06	04	surface water	Bicarbonate	153	mg/L	1	2/10/99	2
03	04	surface water	Bicarbonate	195	mg/L	1	5/26/98	5
11	04	surface water	Bicarbonate	180	mg/L	1	6/1/00	6
10	04	surface water	Bicarbonate	134	mg/L	1	3/7/00	3
09	04	surface water	Bicarbonate	288	mg/L	2	12/6/99	12
07	04	surface water	Bicarbonate	235	mg/L	1	5/11/99	5
01	04	surface water	Arsenic	ND	mg/L	0.0250	12/9/97	12
05	04	surface water	Arsenic	ND	mg/L	0.025	11/9/98	11
10	04	surface water	Arsenic	ND	mg/L	0.025	3/7/00	3
07	04	surface water	Arsenic	ND	mg/L	0.025	5/11/99	5
06	04	surface water	Arsenic	NS	mg/L	0.025	2/10/99	2
09	04	surface water	Arsenic	ND	mg/L	0.005	12/6/99	12
08	04	surface water	Arsenic	ND	mg/L	0.005	9/28/99	9
03	04	surface water	Arsenic	ND	mg/L	0.025	5/26/98	5
02	04	surface water	Arsenic	ND	mg/L	0.01	3/3/98	3

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
11	04	surface water	Arsenic	ND	mg/L	0.025	6/1/00	6
04	04	surface water	Arsenic	ND	mg/L	0.025	8/4/98	8
09	04	surface water	Aluminum	0.2	mg/L	0.1	12/6/99	12
01	04	surface water	Alkalinity (CaCO3)	164	mg/L	1.00	12/9/97	12
02	04	surface water	Alkalinity (CaCO3)	173	mg/L	1	3/3/98	3
04	04	surface water	Alkalinity (CaCO3)	205	mg/L	1	8/4/98	8
03	04	surface water	Alkalinity (CaCO3)	211	mg/L	1	5/26/98	5
10	04	surface water	Alkalinity (CaCO3)	134	mg/L	1	3/7/00	3
06	04	surface water	Alkalinity (CaCO3)	154	mg/L	1	2/10/99	2
05	04	surface water	Alkalinity (CaCO3)	159	mg/L	1	11/9/98	11
07	04	surface water	Alkalinity (CaCO3)	237	mg/L	1	5/11/99	5
09	04	surface water	Alkalinity (CaCO3)	288	mg/L	2	12/6/99	12
08	04	surface water	Alkalinity (CaCO3)	164	mg/L	1	9/28/99	9
11	04	surface water	Alkalinity (CaCO3)	188	mg/L	1	6/1/00	6

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
02	04	surface water	Zinc	ND	mg/L	0.03	3/3/98	3
09	04	surface water	Zinc	ND	mg/L	0.03	12/6/99	12
08	04	surface water	Zinc	ND	mg/L	0.03	9/28/99	9
05	04	surface water	Zinc	0.0144	mg/L	0.01	11/9/98	11
06	04	surface water	Zinc	0.0205	mg/L	0.01	2/10/99	2
01	04	surface water	Zinc	0.021	mg/L	0.0100	12/9/97	12
10	04	surface water	Zinc	0.010J	mg/L	0.01	3/7/00	3
03	04	surface water	Zinc	ND	mg/L	0.01	5/26/98	5
11	04	surface water	Zinc	ND	mg/L	0.01	6/1/00	6
04	04	surface water	Zinc	ND	mg/L	0.01	8/4/98	8
07	04	surface water	Zinc	ND	mg/L	0.02	5/11/99	5
10	04	surface water	Total Organic Carbon	13	mg/L	0.1	3/7/00	3
11	04	surface water	Total Organic Carbon	4.6	mg/L	0.5	6/1/00	6
06	04	surface water	Total Organic Carbon	6.59	mg/L	1	2/10/99	2
01	04	surface water	Total Organic Carbon	8.77	mg/L	1.00	12/9/97	12
09	04	surface water	Total Organic Carbon	14.2	mg/L	0.5	12/6/99	12
07	04	surface water	Total Organic Carbon	3.2	mg/L	1	5/11/99	5
05	04	surface water	Total Organic Carbon	15.6	mg/L	1	11/9/98	11
02	04	surface water	Total Organic Carbon	6.09	mg/L	1	3/3/98	3
03	04	surface water	Total Organic Carbon	8.53	mg/L	1	5/26/98	5
04	04	surface water	Total Organic Carbon	2.05	mg/L	1	8/4/98	8
08	04	surface water	Total Organic Carbon	4.1	mg/L	0.5	9/28/99	9
06	04	surface water	Total Dissolved Solids	499	mg/L	10	2/10/99	2
09	04	surface water	Total Dissolved Solids	756	mg/L	10	12/6/99	12
02	04	surface water	Total Dissolved Solids	668	mg/L	10	3/3/98	3
03	04	surface water	Total Dissolved Solids	803	mg/L	10	5/26/98	5
01	04	surface water	Total Dissolved Solids	476	mg/L	10.0	12/9/97	12
07	04	surface water	Total Dissolved Solids	761	mg/L	10	5/11/99	5
05	04	surface water	Total Dissolved Solids	570	mg/L	10	11/9/98	11
08	04	surface water	Total Dissolved Solids	519	mg/L	10	9/28/99	9
10	04	surface water	Total Dissolved Solids	480	mg/L	5	3/7/00	3
11	04	surface water	Total Dissolved Solids	537	mg/L	5	6/1/00	6
04	04	surface water	Total Dissolved Solids	622	mg/L	10	8/4/98	8
06	04	surface water	Total Coliform	>1600	mpn/100ml	2	2/10/99	2
09	04	surface water	Total Coliform	240	mpn/100ml	2	12/6/99	12
05	04	surface water	Total Coliform	>1600	mpn/100ml	2	11/9/98	11
04	04	surface water	Total Coliform	500	mpn/100ml	2	8/4/98	8
02	04	surface water	Total Coliform	>1600	mpn/100ml	2	3/3/98	3

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
08	04	surface water	Total Coliform	<2	mpn/100ml	2	9/28/99	9
07	04	surface water	Total Coliform	>23	mpn/100ml	2	5/11/99	5
03	04	surface water	Total Coliform	>1600	mpn/100ml	2	5/26/98	5
01	04	surface water	Total Coliform	>1600	mpn/100ml	2	12/9/97	12
11	04	surface water	Total Coliform	1,600	MPN/100 m	2	6/1/00	6
10	04	surface water	Total Coliform	>1,600	MPN/100 m	3.0	3/7/00	3
06	04	surface water	Surfactants (MBAS)	NS	mg/L	0.1	2/10/99	2
07	04	surface water	Surfactants (MBAS)	ND	mg/L	0.1	5/11/99	5
02	04	surface water	Surfactants (MBAS)	0.108	mg/L	0.1	3/3/98	3
04	04	surface water	Surfactants (MBAS)	ND	mg/L	0.1	8/4/98	8
03	04	surface water	Surfactants (MBAS)	ND	mg/L	0.1	5/26/98	5
01	04	surface water	Surfactants (MBAS)	ND	mg/L	0.100	12/9/97	12
05	04	surface water	Surfactants (MBAS)	0.358	mg/L	0.1	11/9/98	11
09	04	surface water	Surfactants (MBAS)	ND	mg/L	0.05	12/6/99	12
10	04	surface water	Surfactants (MBAS)	0.11	mg/L	0.03	3/7/00	3
11	04	surface water	Surfactants (MBAS)	ND	mg/L	0.03	6/1/00	6
08	04	surface water	Surfactants (MBAS)	ND	mg/L	0.05	9/28/99	9
02	04	surface water	Sulfate	164	mg/L	4	3/3/98	3
06	04	surface water	Sulfate	108	mg/L	5	2/10/99	2
03	04	surface water	Sulfate	273	mg/L	10	5/26/98	5
11	04	surface water	Sulfate	107	mg/L	5	6/1/00	6
08	04	surface water	Sulfate	113	mg/L	10	9/28/99	9
04	04	surface water	Sulfate	203	mg/L	50	8/4/98	8
01	04	surface water	Sulfate	123	mg/L	10.0	12/9/97	12
10	04	surface water	Sulfate	69	mg/L	5	3/7/00	3
05	04	surface water	Sulfate	135	mg/L	5	11/9/98	11
07	04	surface water	Sulfate	216	mg/L	50	5/11/99	5
09	04	surface water	Sulfate	133	mg/L	10	12/6/99	12
02	04	surface water	Sodium	110	mg/L	4	3/3/98	3
03	04	surface water	Sodium	122	mg/L	0.3	5/26/98	5
05	04	surface water	Sodium	99.7	mg/L	0.3	11/9/98	11
04	04	surface water	Sodium	100	mg/L	0.3	8/4/98	8
11	04	surface water	Sodium	83.1	mg/L	0.25	6/1/00	6
10	04	surface water	Sodium	71.6	mg/L	0.25	3/7/00	3
06	04	surface water	Sodium	89.5	mg/L	0.3	2/10/99	2
08	04	surface water	Sodium	79.2	mg/L	0.5	9/28/99	9
07	04	surface water	Sodium	94.7	mg/L	0.3	5/11/99	5
09	04	surface water	Sodium	110	mg/L	0.5	12/6/99	12

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
01	04	surface water	Sodium	78.4	mg/L	0.300	12/9/97	12
08	04	surface water	Potassium	3.0	mg/L	1.0	9/28/99	9
05	04	surface water	Potassium	9.73	mg/L	0.3	11/9/98	11
02	04	surface water	Potassium	5	mg/L	2	3/3/98	3
09	04	surface water	Potassium	2.5	mg/L	1.0	12/6/99	12
06	04	surface water	Potassium	5.96	mg/L	1	2/10/99	2
11	04	surface water	Potassium	2.8	mg/L	0.5	6/1/00	6
03	04	surface water	Potassium	6.11	mg/L	0.3	5/26/98	5
10	04	surface water	Potassium	3.9	mg/L	0.5	3/7/00	3
07	04	surface water	Potassium	1.53	mg/L	1	5/11/99	5
01	04	surface water	Potassium	4.25	mg/L	0.300	12/9/97	12
04	04	surface water	Potassium	3.32	mg/L	0.3	8/4/98	8
03	04	surface water	Phosphorus	0.101	mg/L	0.01	5/26/98	5
02	04	surface water	Phosphorus	0.511	mg/L	0.01	3/3/98	3
04	04	surface water	Phosphorus	0.07	mg/L	0.01	8/4/98	8
07	04	surface water	Phosphorus	0.085	mg/L	0.01	5/11/99	5
05	04	surface water	Phosphorus	0.25	mg/L	0.01	11/9/98	11
06	04	surface water	Phosphorus	0.256	mg/L	0.01	2/10/99	2
01	04	surface water	Phosphorus	0.254	mg/L	0.01	12/9/97	12
03	04	surface water	Phosphate	NS	mg/L	0.3	5/26/98	5
11	04	surface water	Phosphate	ND	mg/L	0.30	6/1/00	6
02	04	surface water	Phosphate	NS	mg/L	0.3	3/3/98	3
05	04	surface water	Phosphate	NS	mg/L	0.3	11/9/98	11
01	04	surface water	Phosphate	NS	mg/L	0.3	12/9/97	12
09	04	surface water	Phosphate	0.4	mg/L	0.3	12/6/99	12
07	04	surface water	Phosphate	NS	mg/L	0.3	5/11/99	5
06	04	surface water	Phosphate	NS	mg/L	0.3	2/10/99	2
04	04	surface water	Phosphate	NS	mg/L	0.3	8/4/98	8
08	04	surface water	Phosphate	0.4	mg/L	0.3	9/28/99	9
10	04	surface water	Phosphate	1.2	mg/L	0.30	3/7/00	3
01	04	surface water	pH	7.7	pH units	2.0-12.5	12/9/97	12
04	04	surface water	pH	7.95	pH units	2.5-12.0	8/4/98	8
02	04	surface water	pH	8.27	pH units	2.0-12.5	3/3/98	3
09	04	surface water	pH	7.59	pH units	1.00	12/6/99	12
03	04	surface water	pH	7.64	pH units	2.5-12.0	5/26/98	5
08	04	surface water	pH	7.88	pH units	1.00	9/28/99	9
06	04	surface water	pH	7.78	pH units		2/10/99	2
10	04	surface water	pH	7.99	mg/L	0.01	3/7/00	3

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
09	04	surface water	pH	7.59	pH units	1.00	12/6/99	12
11	04	surface water	pH	7.52	mg/L	0.01	6/1/00	6
11	04	surface water	pH	7.52	mg/L	0.01	6/1/00	6
10	04	surface water	pH	7.99	mg/L	0.01	3/7/00	3
08	04	surface water	pH	7.88	pH units	1.00	9/28/99	9
07	04	surface water	pH	7.89	pH units	2.5-12.0	5/11/99	5
06	04	surface water	Oil and Grease	NS	mg/L	1	2/10/99	2
11	04	surface water	Oil and Grease	ND	mg/L	0.5	6/1/00	6
10	04	surface water	Oil and Grease	ND	mg/L	0.5	3/7/00	3
02	04	surface water	Oil and Grease	ND	mg/L	0.962	3/3/98	3
10	04	surface water	Oil and Grease	ND	mg/L	0.5	3/7/00	3
09	04	surface water	Oil and Grease	ND	mg/L	1.0	12/6/99	12
05	04	surface water	Oil and Grease	ND	mg/L	1	11/9/98	11
07	04	surface water	Oil and Grease	ND	mg/L	0.971	5/11/99	5
08	04	surface water	Oil and Grease	ND	mg/L	1.0	9/28/99	9
08	04	surface water	Oil and Grease	ND	mg/L	1.0	9/28/99	9
03	04	surface water	Oil and Grease	ND	mg/L	0.971	5/26/98	5
04	04	surface water	Oil and Grease	ND	mg/L	1.1	8/4/98	8
09	04	surface water	Oil and Grease	ND	mg/L	1.0	12/6/99	12
01	04	surface water	Oil and Grease	ND	mg/L	1.21	12/9/97	12
11	04	surface water	Oil and Grease	ND	mg/L	0.5	6/1/00	6
10	04	surface water	Nitrogen	ND	mg/L	0.05	3/7/00	3
05	04	surface water	Nitrogen	1.57	mg/L	0.1	11/9/98	11
08	04	surface water	Nitrogen	0.4	mg/L	0.1	9/28/99	9
09	04	surface water	Nitrogen	NS	mg/L	0.1	12/6/99	12
02	04	surface water	Nitrogen	NS	mg/L	0.1	3/3/98	3
06	04	surface water	Nitrogen	NS	mg/L	0.1	2/10/99	2
03	04	surface water	Nitrogen	0.8	mg/Kg	0.5	5/26/98	5
02	04	surface water	Nitrogen	NS	mg/L	0.1	3/3/98	3
06	04	surface water	Nitrogen	NS	mg/L	0.1	2/10/99	2
04	04	surface water	Nitrogen	NS	mg/L	0.1	8/4/98	8
07	04	surface water	Nitrogen	ND	mg/L	0.4	5/11/99	5
04	04	surface water	Nitrogen	NS	mg/L	0.1	8/4/98	8
09	04	surface water	Nitrogen	NS	mg/L	0.1	12/6/99	12
06	04	surface water	Nitrogen	NS	mg/L	0.1	2/10/99	2
01	04	surface water	Nitrogen	0.434	mg/L	0.100	12/9/97	12
02	04	surface water	Nitrogen	NS	mg/L	0.1	3/3/98	3
04	04	surface water	Nitrogen	NS	mg/L	0.1	8/4/98	8

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
09	04	surface water	Nitrite	ND	mg/L	0.02	12/6/99	12
08	04	surface water	Nitrite	0.03	mg/L	0.02	9/28/99	9
07	04	surface water	Nitrate-N	2.08	mg/L	0.1	5/11/99	5
06	04	surface water	Nitrate-N	0.381	mg/L	0.05	2/10/99	2
10	04	surface water	Nitrate-N	2.7	mg/L	0.05	3/7/00	3
08	04	surface water	Nitrate-N	2.0	mg/L	0.1	9/28/99	9
03	04	surface water	Nitrate-N	0.868	mg/L	0.1	5/26/98	5
09	04	surface water	Nitrate-N	ND	mg/L	0.1	12/6/99	12
02	04	surface water	Nitrate-N	1.88	mg/L	0.1	3/3/98	3
11	04	surface water	Nitrate-N	1.2	mg/L	0.05	6/1/00	6
01	04	surface water	Nitrate-N	1.32	mg/L	0.100	12/9/97	12
04	04	surface water	Nitrate-N	0.82	mg/L	0.05	8/4/98	8
05	04	surface water	Nitrate-N	1.22	mg/L	0.05	11/9/98	11
06	04	surface water	Mercury	NS	mg/L	0.0002	2/10/99	2
01	04	surface water	Mercury	ND	mg/L	0.000200	12/9/97	12
11	04	surface water	Mercury	NS	mg/L	0.0002	6/1/00	6
10	04	surface water	Mercury	ND	mg/L	0.0002	3/7/00	3
07	04	surface water	Mercury	ND	mg/L	0.0002	5/11/99	5
08	04	surface water	Mercury	ND	mg/L	0.0002	9/28/99	9
04	04	surface water	Mercury	NS	mg/L	0.0002	8/4/98	8
09	04	surface water	Mercury	NS	mg/L	0.0002	12/6/99	12
05	04	surface water	Mercury	ND	mg/L	0.0002	11/9/98	11
03	04	surface water	Mercury	ND	mg/L	0.0002	5/26/98	5
02	04	surface water	Mercury	NS	mg/L	0.0002	3/3/98	3
09	04	surface water	Manganese	0.12	mg/L	0.01	12/6/99	12
08	04	surface water	Manganese	0.03	mg/L	0.01	9/28/99	9
07	04	surface water	Manganese	0.0417	mg/L	0.01	5/11/99	5
03	04	surface water	Manganese	0.075	mg/L	0.01	5/26/98	5
10	04	surface water	Manganese	0.02	mg/L	0.005	3/7/00	3
01	04	surface water	Manganese	0.251	mg/L	0.0100	12/9/97	12
05	04	surface water	Manganese	0.0656	mg/L	0.01	11/9/98	11
02	04	surface water	Manganese	0.1	mg/L	0.01	3/3/98	3
11	04	surface water	Manganese	0.02	mg/L	0.005	6/1/00	6
06	04	surface water	Manganese	0.0786	mg/L	0.01	2/10/99	2
04	04	surface water	Manganese	0.108	mg/L	0.01	8/4/98	8
06	04	surface water	Magnesium	14.7	mg/L	0.2	2/10/99	2
09	04	surface water	Magnesium	27.4	mg/L	0.5	12/6/99	12
07	04	surface water	Magnesium	22.4	mg/L	0.2	5/11/99	5

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
08	04	surface water	Magnesium	17.5	mg/L	0.5	9/28/99	9
10	04	surface water	Magnesium	13.2	mg/L	0.20	3/7/00	3
02	04	surface water	Magnesium	28	mg/L	0.1	3/3/98	3
03	04	surface water	Magnesium	32.2	mg/L	0.2	5/26/98	5
01	04	surface water	Magnesium	18.7	mg/L	0.200	12/9/97	12
05	04	surface water	Magnesium	16.7	mg/L	0.2	11/9/98	11
04	04	surface water	Magnesium	24.2	mg/L	0.2	8/4/98	8
11	04	surface water	Magnesium	17.7	mg/L	0.2	6/1/00	6
11	04	surface water	Lead	ND	mg/L	0.005	6/1/00	6
06	04	surface water	Lead	0.00107	mg/L	0.001	2/10/99	2
07	04	surface water	Lead	0.00286	mg/L	0.001	5/11/99	5
01	04	surface water	Lead	0.019	mg/L	0.0200	12/9/97	12
03	04	surface water	Lead	ND	mg/L	0.001	5/26/98	5
02	04	surface water	Lead	ND	mg/L	0.015	3/3/98	3
10	04	surface water	Lead	0.025	mg/L	0.005	3/7/00	3
08	04	surface water	Lead	ND	mg/L	0.1	9/28/99	9
05	04	surface water	Lead	ND	mg/L	0.001	11/9/98	11
09	04	surface water	Lead	ND	mg/L	0.05	12/6/99	12
04	04	surface water	Lead	ND	mg/L	0.001	8/4/98	8
04	04	surface water	Iron	0.221	mg/L	0.05	8/4/98	8
06	04	surface water	Iron	3.46	mg/L	0.05	2/10/99	2
11	04	surface water	Iron	ND	mg/L	0.03	6/1/00	6
05	04	surface water	Iron	0.564	mg/L	0.05	11/9/98	11
07	04	surface water	Iron	0.0668	mg/L	0.05	5/11/99	5
10	04	surface water	Iron	0.035J	mg/L	0.03	3/7/00	3
02	04	surface water	Iron	1.4	mg/L	0.1	3/3/98	3
03	04	surface water	Iron	0.447	mg/L	0.05	5/26/98	5
08	04	surface water	Iron	ND	mg/L	0.05	9/28/99	9
01	04	surface water	Iron	3	mg/L	0.0500	12/9/97	12
09	04	surface water	Iron	0.11	mg/L	0.05	12/6/99	12
07	04	surface water	Hydroxide	ND	mg/L	0.5	5/11/99	5
01	04	surface water	Hydroxide	ND	mg/L	0.500	12/9/97	12
09	04	surface water	Hydroxide	ND	mg/L	2	12/6/99	12
03	04	surface water	Hydroxide	ND	mg/L	0.5	5/26/98	5
04	04	surface water	Hydroxide	ND	mg/L	0.5	8/4/98	8
08	04	surface water	Hydroxide	ND	mg/L	0.5	9/28/99	9
10	04	surface water	Hydroxide	ND	mg/L	0.5	3/7/00	3
06	04	surface water	Hydroxide	NS	mg/L	0.5	2/10/99	2

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
02	04	surface water	Hydroxide	ND	mg/L	0.5	3/3/98	3
05	04	surface water	Hydroxide	ND	mg/L	0.5	11/9/98	11
11	04	surface water	Hydroxide	ND	mg/L	0.5	6/1/00	6
06	04	surface water	Hardness (CaCO3)	192	mg/L	1	2/10/99	2
07	04	surface water	Hardness (CaCO3)	353	mg/L	2	5/11/99	5
05	04	surface water	Hardness (CaCO3)	230	mg/L	1	11/9/98	11
04	04	surface water	Hardness (CaCO3)	295	mg/L	2	8/4/98	8
01	04	surface water	Hardness (CaCO3)	247	mg/L	10.0	12/9/97	12
02	04	surface water	Hardness (CaCO3)	320	mg/L	10	3/3/98	3
11	04	surface water	Hardness (CaCO3)	242	mg/L	1	6/1/00	6
08	04	surface water	Hardness (CaCO3)	236	mg/L	2	9/28/99	9
09	04	surface water	Hardness (CaCO3)	400	mg/L	2	12/6/99	12
03	04	surface water	Hardness (CaCO3)	310	mg/L	5	5/26/98	5
10	04	surface water	Hardness (CaCO3)	186	mg/L	1	3/7/00	3
09	04	surface water	Fluoride	0.4	mg/L	0.2	12/6/99	12
10	04	surface water	Fluoride	0.5	mg/L	0.1	3/7/00	3
02	04	surface water	Fluoride	0.32	mg/L	0.2	3/3/98	3
04	04	surface water	Fluoride	0.353	mg/L	0.1	8/4/98	8
11	04	surface water	Fluoride	0.5	mg/L	0.1	6/1/00	6
08	04	surface water	Fluoride	0.5	mg/L	0.1	9/28/99	9
03	04	surface water	Fluoride	1.12	mg/L	1	5/26/98	5
05	04	surface water	Fluoride	0.352	mg/L	0.1	11/9/98	11
07	04	surface water	Fluoride	0.281	mg/L	0.1	5/11/99	5
01	04	surface water	Fluoride	ND	mg/L	0.200	12/9/97	12
06	04	surface water	Fluoride	0.292	mg/L	0.1	2/10/99	2
08	04	surface water	Fecal Coliform	<2	mpn/100ml	2	9/28/99	9
05	04	surface water	Fecal Coliform	>1600	mpn/100ml	2	11/9/98	11
07	04	surface water	Fecal Coliform	>23	mpn/100ml	2	5/11/99	5
01	04	surface water	Fecal Coliform	>1600	mpn/100ml		12/9/97	12
03	04	surface water	Fecal Coliform	1600	mpn/100ml	2	5/26/98	5
09	04	surface water	Fecal Coliform	80	mpn/100ml	2	12/6/99	12
02	04	surface water	Fecal Coliform	300	mpn/100ml	2	3/3/98	3
04	04	surface water	Fecal Coliform	17	mpn/100ml	2	8/4/98	8
11	04	surface water	Fecal Coliform	13	MPN/mL	2	6/1/00	6
10	04	surface water	Fecal Coliform	>1,600	MPN/100 m	2	3/7/00	3
06	04	surface water	Fecal Coliform	1600	mpn/100ml	2	2/10/99	2
02	04	surface water	Cyanide (Total)	NS	mg/L	0.005	3/3/98	3
10	04	surface water	Cyanide (Total)	ND	mg/L	0.01	3/7/00	3

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
06	04	surface water	Cyanide (Total)	NS	mg/L	0.005	2/10/99	2
09	04	surface water	Cyanide (Total)	NS	mg/L	0.005	12/6/99	12
04	04	surface water	Cyanide (Total)	NS	mg/L	0.005	8/4/98	8
02	04	surface water	Cyanide (Total)	NS	mg/L	0.005	3/3/98	3
01	04	surface water	Cyanide (Total)	ND	mg/L	0.00500	12/9/97	12
04	04	surface water	Cyanide (Total)	NS	mg/L	0.005	8/4/98	8
06	04	surface water	Cyanide (Total)	NS	mg/L	0.005	2/10/99	2
03	04	surface water	Cyanide (Total)	ND	mg/L	0.005	5/26/98	5
07	04	surface water	Cyanide (Total)	ND	mg/L	0.005	5/11/99	5
05	04	surface water	Cyanide (Total)	ND	mg/L	0.005	11/9/98	11
08	04	surface water	Cyanide (Total)	ND	mg/L	0.01	9/28/99	9
09	04	surface water	Cyanide (Total)	NS	mg/L	0.005	12/6/99	12
11	04	surface water	Cyanide (Total)	NS	mg/L	0.01	6/1/00	6
09	04	surface water	Copper	0.03	mg/L	0.02	12/6/99	12
08	04	surface water	Copper	ND	mg/L	0.02	9/28/99	9
05	04	surface water	Copper	ND	mg/L	0.005	11/9/98	11
02	04	surface water	Copper	ND	mg/L	0.02	3/3/98	3
04	04	surface water	Copper	ND	mg/L	0.005	8/4/98	8
06	04	surface water	Copper	0.005	mg/L	0.005	2/10/99	2
01	04	surface water	Copper	ND	mg/L	0.00500	12/9/97	12
11	04	surface water	Copper	ND	mg/L	0.005	6/1/00	6
07	04	surface water	Copper	ND	mg/L	0.005	5/11/99	5
10	04	surface water	Copper	ND	mg/L	0.005	3/7/00	3
03	04	surface water	Copper	ND	mg/L	0.005	5/26/98	5
08	04	surface water	Conductivity	821	umhos/cm	10	9/28/99	9
06	04	surface water	Conductivity	776	umhos/cm	1	2/10/99	2
07	04	surface water	Conductivity	1140	umhos/cm	1	5/11/99	5
05	04	surface water	Conductivity	860	umhos/cm	1	11/9/98	11
10	04	surface water	Conductivity	728	mg/L	5	3/7/00	3
11	04	surface water	Conductivity	873	mg/L	5	6/1/00	6
09	04	surface water	Conductivity	1250	umhos/cm	10	12/6/99	12
03	04	surface water	Conductivity	1120	umhos/cm	1	5/26/98	5
01	04	surface water	Conductivity	934	umhos/cm	1.00	12/9/97	12
02	04	surface water	Conductivity	983	umhos/cm	1	3/3/98	3
04	04	surface water	Conductivity	977	umhos/cm	1	8/4/98	8
10	04	surface water	Chloride	99	mg/L	0.5	3/7/00	3
07	04	surface water	Chloride	95.1	mg/L	1	5/11/99	5
02	04	surface water	Chloride	115	mg/L	20	3/3/98	3

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
06	04	surface water	Chloride	96.6	mg/L	1	2/10/99	2
08	04	surface water	Chloride	81	mg/L	1	9/28/99	9
09	04	surface water	Chloride	147	mg/L	1	12/6/99	12
03	04	surface water	Chloride	197	mg/L	50	5/26/98	5
10	04	surface water	Chloride	99	mg/L	0.5	3/7/00	3
11	04	surface water	Chloride	99	mg/L	0.5	6/1/00	6
09	04	surface water	Chloride	147	mg/L	1	12/6/99	12
11	04	surface water	Chloride	99	mg/L	0.5	6/1/00	6
04	04	surface water	Chloride	98.3	mg/L	1	8/4/98	8
05	04	surface water	Chloride	109	mg/L	1	11/9/98	11
08	04	surface water	Chloride	81	mg/L	1	9/28/99	9
01	04	surface water	Chloride	148	mg/L	20.0	12/9/97	12
02	04	surface water	Carbonate	2.48	mg/L	0.5	3/3/98	3
03	04	surface water	Carbonate	0.862	mg/L	0.5	5/26/98	5
04	04	surface water	Carbonate	1.7	mg/L	0.5	8/4/98	8
05	04	surface water	Carbonate	ND	mg/L	0.5	11/9/98	11
06	04	surface water	Carbonate	1.09	mg/L	0.5	2/10/99	2
09	04	surface water	Carbonate	ND	mg/L	2	12/6/99	12
10	04	surface water	Carbonate	ND	mg/L	0.5	3/7/00	3
08	04	surface water	Carbonate	ND	mg/L	0.5	9/28/99	9
11	04	surface water	Carbonate	8	mg/L	0.5	6/1/00	6
01	04	surface water	Carbonate	1.08	mg/L	1.00	12/9/97	12
07	04	surface water	Carbonate	2.11	mg/L	0.5	5/11/99	5
09	04	surface water	Calcium	112	mg/L	0.5	12/6/99	12
08	04	surface water	Calcium	63.4	mg/L	0.5	9/28/99	9
11	04	surface water	Calcium	66.0	mg/L	0.1	6/1/00	6
01	04	surface water	Calcium	85.3	mg/L	0.100	12/9/97	12
07	04	surface water	Calcium	105	mg/L	0.1	5/11/99	5
03	04	surface water	Calcium	97.9	mg/L	0.1	5/26/98	5
02	04	surface water	Calcium	85	mg/L	0.2	3/3/98	3
06	04	surface water	Calcium	47.9	mg/L	0.1	2/10/99	2
04	04	surface water	Calcium	83.4	mg/L	0.1	8/4/98	8
05	04	surface water	Calcium	61.3	mg/L	0.1	11/9/98	11
10	04	surface water	Calcium	47.7	mg/L	0.10	3/7/00	3
07	04	surface water	Boron	0.197	mg/L	0.1	5/11/99	5
10	04	surface water	Boron	0.3	mg/L	0.1	3/7/00	3
06	04	surface water	Boron	0.345	mg/L	0.1	2/10/99	2
03	04	surface water	Boron	ND	mg/L	0.5	5/26/98	5

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
11	04	surface water	Boron	0.2	mg/L	0.1	6/1/00	6
05	04	surface water	Boron	0.377	mg/L	0.1	11/9/98	11
08	04	surface water	Boron	0.2	mg/L	0.2	9/28/99	9
09	04	surface water	Boron	ND	mg/L	0.2	12/6/99	12
01	04	surface water	Boron	ND	mg/L	0.5	12/9/97	12
02	04	surface water	Boron	ND	mg/L	0.5	3/3/98	3
04	04	surface water	Boron	0.228	mg/L	0.1	8/4/98	8
01	04	surface water	Biochemical Oxygen Dem	2.38	mg/L	2.00	12/9/97	12
10	04	surface water	Biochemical Oxygen Dem	ND	mg/L	2	3/7/00	3
04	04	surface water	Biochemical Oxygen Dem	NS	mg/L	2	8/4/98	8
11	04	surface water	Biochemical Oxygen Dem	NS	mg/L	2	6/1/00	6
05	04	surface water	Biochemical Oxygen Dem	6.72	mg/L	2	11/9/98	11
02	04	surface water	Biochemical Oxygen Dem	NS	mg/L	2	3/3/98	3
08	04	surface water	Biochemical Oxygen Dem	ND	mg/L	2	9/28/99	9
03	04	surface water	Biochemical Oxygen Dem	ND	mg/L	2	5/26/98	5
09	04	surface water	Biochemical Oxygen Dem	NS	mg/L	2	12/6/99	12
06	04	surface water	Biochemical Oxygen Dem	NS	mg/L	2	2/10/99	2
07	04	surface water	Biochemical Oxygen Dem	ND	mg/L	2	5/11/99	5
04	04	surface water	Bicarbonate	203	mg/L	1	8/4/98	8
05	04	surface water	Bicarbonate	158	mg/L	1	11/9/98	11
02	04	surface water	Bicarbonate	170	mg/L	1	3/3/98	3
08	04	surface water	Bicarbonate	164	mg/L	1	9/28/99	9
01	04	surface water	Bicarbonate	163	mg/L	1.00	12/9/97	12
06	04	surface water	Bicarbonate	153	mg/L	1	2/10/99	2
03	04	surface water	Bicarbonate	195	mg/L	1	5/26/98	5
11	04	surface water	Bicarbonate	180	mg/L	1	6/1/00	6
10	04	surface water	Bicarbonate	134	mg/L	1	3/7/00	3
09	04	surface water	Bicarbonate	288	mg/L	2	12/6/99	12
07	04	surface water	Bicarbonate	235	mg/L	1	5/11/99	5
01	04	surface water	Arsenic	ND	mg/L	0.0250	12/9/97	12
05	04	surface water	Arsenic	ND	mg/L	0.025	11/9/98	11
10	04	surface water	Arsenic	ND	mg/L	0.025	3/7/00	3
07	04	surface water	Arsenic	ND	mg/L	0.025	5/11/99	5
06	04	surface water	Arsenic	NS	mg/L	0.025	2/10/99	2
09	04	surface water	Arsenic	ND	mg/L	0.005	12/6/99	12
08	04	surface water	Arsenic	ND	mg/L	0.005	9/28/99	9
03	04	surface water	Arsenic	ND	mg/L	0.025	5/26/98	5
02	04	surface water	Arsenic	ND	mg/L	0.01	3/3/98	3

fldRound	fldWell	fldMatrix	fldNewName	fldWell4	fldUnits	fldDL	fldSampleDate	fldSampleMont
11	04	surface water	Arsenic	ND	mg/L	0.025	6/1/00	6
04	04	surface water	Arsenic	ND	mg/L	0.025	8/4/98	8
09	04	surface water	Aluminum	0.2	mg/L	0.1	12/6/99	12
01	04	surface water	Alkalinity (CaCO3)	164	mg/L	1.00	12/9/97	12
02	04	surface water	Alkalinity (CaCO3)	173	mg/L	1	3/3/98	3
04	04	surface water	Alkalinity (CaCO3)	205	mg/L	1	8/4/98	8
03	04	surface water	Alkalinity (CaCO3)	211	mg/L	1	5/26/98	5
10	04	surface water	Alkalinity (CaCO3)	134	mg/L	1	3/7/00	3
06	04	surface water	Alkalinity (CaCO3)	154	mg/L	1	2/10/99	2
05	04	surface water	Alkalinity (CaCO3)	159	mg/L	1	11/9/98	11
07	04	surface water	Alkalinity (CaCO3)	237	mg/L	1	5/11/99	5
09	04	surface water	Alkalinity (CaCO3)	288	mg/L	2	12/6/99	12
08	04	surface water	Alkalinity (CaCO3)	164	mg/L	1	9/28/99	9
11	04	surface water	Alkalinity (CaCO3)	188	mg/L	1	6/1/00	6

fldRound	fldWell	fldMatrix	fldNewName	fldMethod	fldWell1	fldUnits	fldDL	fldSampleDate	fldSampleMont
03	01	surface water	Zinc	EPA 200.7	ND	mg/L	0.01	5/26/98	5
09	01	surface water	Zinc	GEN.MINERAL.	ND	mg/L	0.03	12/6/99	12
08	01	surface water	Zinc	GEN.MINERAL	ND	mg/L	0.03	9/28/99	9
01	01	surface water	Zinc	EPA 200.7	0.037	mg/L	0.0100	12/9/97	12
06	01	surface water	Zinc	EPA 200.7	NS	mg/L	0.01	2/10/99	2
10	01	surface water	Zinc	GEN.-MINERALS	ND	mg/L	0.01	3/7/00	3
11	01	surface water	Zinc	GEN.-MINERALS	ND	mg/L	0.01	6/1/00	6
02	01	surface water	Zinc	EPA 200.7	ND	mg/L	0.03	3/3/98	3
07	01	surface water	Zinc	EPA 200.7	ND	mg/L	0.02	5/11/99	5
05	01	surface water	Zinc	EPA 200.7	ND	mg/L	0.01	11/9/98	11
04	01	surface water	Zinc	EPA 200.7	ND	mg/L	0.01	8/4/98	8
10	01	surface water	Total Organic Carbon	415.1	7.7	mg/L	0.1	3/7/00	3
11	01	surface water	Total Organic Carbon	415.1	5.8	mg/L	0.5	6/1/00	6
05	01	surface water	Total Organic Carbon	SW415.1	5.85	mg/L	1	11/9/98	11
01	01	surface water	Total Organic Carbon	SW415.1	6.21	mg/L	1.00	12/9/97	12
09	01	surface water	Total Organic Carbon	415.1	0.9	mg/L	0.5	12/6/99	12
07	01	surface water	Total Organic Carbon	SW415.1	2.13	mg/L	1	5/11/99	5
06	01	surface water	Total Organic Carbon	SW415.1	6.37	mg/L	1	2/10/99	2
04	01	surface water	Total Organic Carbon	EPA 415.1	2.87	mg/L	1	8/4/98	8
02	01	surface water	Total Organic Carbon	EPA 415.1	5.87	mg/L	1	3/3/98	3
03	01	surface water	Total Organic Carbon	EPA 415.1	8.06	mg/L	1	5/26/98	5
08	01	surface water	Total Organic Carbon	415.1	20.3	mg/L	0.5	9/28/99	9
06	01	surface water	Total Dissolved Solids	EPA 160.1	771	mg/L	10	2/10/99	2
11	01	surface water	Total Dissolved Solids	GEN.-MINERALS	877	mg/L	5	6/1/00	6
03	01	surface water	Total Dissolved Solids	EPA 160.1	764	mg/L	10	5/26/98	5
02	01	surface water	Total Dissolved Solids	EPA 160.1	680	mg/L	10	3/3/98	3
01	01	surface water	Total Dissolved Solids	EPA 160.1	432	mg/L	10.0	12/9/97	12
05	01	surface water	Total Dissolved Solids	EPA 160.1	963	mg/L	10	11/9/98	11
07	01	surface water	Total Dissolved Solids	EPA 160.1	787	mg/L	10	5/11/99	5
09	01	surface water	Total Dissolved Solids	GEN.MINERAL.	1010	mg/L	10	12/6/99	12
08	01	surface water	Total Dissolved Solids	GEN.MINERAL	785	mg/L	10	9/28/99	9
10	01	surface water	Total Dissolved Solids	GEN.-MINERALS	538	mg/L	5	3/7/00	3
04	01	surface water	Total Dissolved Solids	EPA 160.1	846	mg/L	10	8/4/98	8
07	01	surface water	Total Coliform	9221	>23	mpn/100ml	2	5/11/99	5
06	01	surface water	Total Coliform	9221	>1600	mpn/100ml	2	2/10/99	2
08	01	surface water	Total Coliform	9221	900	mpn/100ml	2	9/28/99	9
01	01	surface water	Total Coliform	MTF	>1600	mpn/100ml	2	12/9/97	12
02	01	surface water	Total Coliform	MTF	>1600	mpn/100ml	2	3/3/98	3
04	01	surface water	Total Coliform	MTF	>1600	mpn/100ml	2	8/4/98	8

fldRound	fldWell	fldMatrix	fldNewName	fldMethod	fldWell1	fldUnits	fldDL	fldSampleDate	fldSampleMont
09	01	surface water	Total Coliform	9221	1600	mpn/100ml	2	12/6/99	12
05	01	surface water	Total Coliform	MTF	>1600	mpn/100ml	2	11/9/98	11
03	01	surface water	Total Coliform	MTF	>1600	mpn/100ml	2	5/26/98	5
10	01	surface water	Total Coliform	MPN(T)	>1,600	MPN/100 m	3.0	3/7/00	3
11	01	surface water	Total Coliform	MPN(T)	1,600	MPN/100 m	2	6/1/00	6
05	01	surface water	Surfactants (MBAS)	EPA 425.1	ND	mg/L	0.1	11/9/98	11
06	01	surface water	Surfactants (MBAS)	EPA 425.1	NS	mg/L	0.1	2/10/99	2
04	01	surface water	Surfactants (MBAS)	EPA 425.1	ND	mg/L	0.1	8/4/98	8
02	01	surface water	Surfactants (MBAS)	EPA 425.1	0.112	mg/L	0.1	3/3/98	3
03	01	surface water	Surfactants (MBAS)	EPA 425.1	ND	mg/L	0.1	5/26/98	5
01	01	surface water	Surfactants (MBAS)	EPA 425.1	ND	mg/L	0.100	12/9/97	12
07	01	surface water	Surfactants (MBAS)	EPA 425.1	0.116	mg/L	0.1	5/11/99	5
11	01	surface water	Surfactants (MBAS)	GEN.-MINERALS	ND	mg/L	0.03	6/1/00	6
10	01	surface water	Surfactants (MBAS)	GEN.-MINERALS	ND	mg/L	0.03	3/7/00	3
09	01	surface water	Surfactants (MBAS)	GEN.MINERAL.	ND	mg/L	0.05	12/6/99	12
08	01	surface water	Surfactants (MBAS)	GEN.MINERAL	ND	mg/L	0.05	9/28/99	9
02	01	surface water	Sulfate	EPA 300.0	179	mg/L	4	3/3/98	3
10	01	surface water	Sulfate	GEN.-MINERALS	117	mg/L	5	3/7/00	3
06	01	surface water	Sulfate	EPA 375.4	222	mg/L	5	2/10/99	2
05	01	surface water	Sulfate	EPA 375.4	294	mg/L	5	11/9/98	11
09	01	surface water	Sulfate	GEN.MINERAL.	285	mg/L	10	12/6/99	12
04	01	surface water	Sulfate	EPA 375.4	292	mg/L	50	8/4/98	8
01	01	surface water	Sulfate	EPA 300.0	131	mg/L	10.0	12/9/97	12
07	01	surface water	Sulfate	EPA 375.4	247	mg/L	50	5/11/99	5
03	01	surface water	Sulfate	EPA 300.0	197	mg/L	50	5/26/98	5
11	01	surface water	Sulfate	GEN.-MINERALS	231	mg/L	5	6/1/00	6
08	01	surface water	Sulfate	GEN.MINERAL	214	mg/L	10	9/28/99	9
06	01	surface water	Sodium	EPA 200.7	92.3	mg/L	0.3	2/10/99	2
03	01	surface water	Sodium	EPA 200.7	99.9	mg/L	0.3	5/26/98	5
11	01	surface water	Sodium	GEN.-MINERALS	109	mg/L	0.25	6/1/00	6
05	01	surface water	Sodium	EPA 200.7	111	mg/L	0.3	11/9/98	11
07	01	surface water	Sodium	EPA 200.7	106	mg/L	0.3	5/11/99	5
01	01	surface water	Sodium	EPA 200.7	62.4	mg/L	0.300	12/9/97	12
10	01	surface water	Sodium	GEN.-MINERALS	59.7	mg/L	0.25	3/7/00	3
09	01	surface water	Sodium	GEN.MINERAL.	101	mg/L	0.5	12/6/99	12
04	01	surface water	Sodium	EPA 200.7	108	mg/L	0.3	8/4/98	8
08	01	surface water	Sodium	GEN.MINERAL	94.2	mg/L	0.5	9/28/99	9
02	01	surface water	Sodium	EPA 200.7	100	mg/L	4	3/3/98	3
09	01	surface water	Potassium	GEN.MINERAL.	3.5	mg/L	1.0	12/6/99	12

fldRound	fldWell	fldMatrix	fldNewName	fldMethod	fldWell1	fldUnits	fldDL	fldSampleDate	fldSampleMont
07	01	surface water	Potassium	EPA 200.7	3.26	mg/L	1	5/11/99	5
01	01	surface water	Potassium	EPA 200.7	6.47	mg/L	0.300	12/9/97	12
08	01	surface water	Potassium	GEN.MINERAL	3.9	mg/L	1.0	9/28/99	9
02	01	surface water	Potassium	EPA 200.7	4	mg/L	2	3/3/98	3
03	01	surface water	Potassium	EPA 200.7	4.75	mg/L	0.3	5/26/98	5
06	01	surface water	Potassium	EPA 200.7	4.63	mg/L	1	2/10/99	2
11	01	surface water	Potassium	GEN.-MINERALS	3.7	mg/L	0.5	6/1/00	6
05	01	surface water	Potassium	EPA 200.7	7.14	mg/L	0.3	11/9/98	11
04	01	surface water	Potassium	EPA 200.7	4.47	mg/L	0.3	8/4/98	8
10	01	surface water	Potassium	GEN.-MINERALS	4.0	mg/L	0.5	3/7/00	3
02	01	surface water	Phosphorus	EPA 365.1	0.481	mg/L	0.01	3/3/98	3
03	01	surface water	Phosphorus	EPA 365.1	0.263	mg/L	0.01	5/26/98	5
04	01	surface water	Phosphorus	EPA 365.1	0.04	mg/L	0.01	8/4/98	8
06	01	surface water	Phosphorus	EPA 365.1	0.165	mg/L	0.01	2/10/99	2
05	01	surface water	Phosphorus	EPA 365.1	0.188	mg/L	0.01	11/9/98	11
07	01	surface water	Phosphorus	EPA 365.1	0.076	mg/L	0.01	5/11/99	5
01	01	surface water	Phosphorus	EPA 365.1	0.27	mg/L	0.01	12/9/97	12
06	01	surface water	Phosphate	365.2	NS	mg/L	0.3	2/10/99	2
09	01	surface water	Phosphate	365.2	ND	mg/L	0.3	12/6/99	12
08	01	surface water	Phosphate	365.2	ND	mg/L	0.3	9/28/99	9
07	01	surface water	Phosphate	EPA 365.2	NS	mg/L	0.3	5/11/99	5
10	01	surface water	Phosphate	365.2	1.2	mg/L	0.30	3/7/00	3
03	01	surface water	Phosphate	EPA 365.2	NS	mg/L	0.3	5/26/98	5
02	01	surface water	Phosphate	365.2	NS	mg/L	0.3	3/3/98	3
11	01	surface water	Phosphate	365.2	ND	mg/L	0.30	6/1/00	6
04	01	surface water	Phosphate	365.2	NS	mg/L	0.3	8/4/98	8
05	01	surface water	Phosphate	EPA 365.2	NS	mg/L	0.3	11/9/98	11
01	01	surface water	Phosphate	EPA 365.2	NS	mg/L	0.3	12/9/97	12
01	01	surface water	pH	EPA 150.1	7.85	pH units	2.0-12.5	12/9/97	12
03	01	surface water	pH	EPA 150.1	8.07	pH units	2.5-12.0	5/26/98	5
02	01	surface water	pH	EPA 150.1	8.19	pH units	2.0-12.5	3/3/98	3
10	01	surface water	pH	GEN.-MINERALS	8.02	mg/L	0.01	3/7/00	3
04	01	surface water	pH	EPA 150.1	8.29	pH units	2.5-12.0	8/4/98	8
09	01	surface water	pH	GEN.MINERAL.	7.83	pH units	1.00	12/6/99	12
06	01	surface water	pH	EPA 150.1	8.09	pH units		2/10/99	2
11	01	surface water	pH	GEN.-MINERALS	7.31	mg/L	0.01	6/1/00	6
10	01	surface water	pH	GEN.-MINERALS	8.02	mg/L	0.01	3/7/00	3
08	01	surface water	pH	GEN.MINERAL	8.05	pH units	1.00	9/28/99	9
08	01	surface water	pH	GEN.MINERAL	8.05	pH units	1.00	9/28/99	9

fldRound	fldWell	fldMatrix	fldNewName	fldMethod	fldWell1	fldUnits	fldDL	fldSampleDate	fldSampleMont
11	01	surface water	pH	GEN.-MINERALS	7.31	mg/L	0.01	6/1/00	6
09	01	surface water	pH	GEN.MINERAL.	7.83	pH units	1.00	12/6/99	12
07	01	surface water	pH	EPA 150.1	7.95	pH units	2.5-12.0	5/11/99	5
07	01	surface water	Oil and Grease	EPA 413.1	ND	mg/L	1.02	5/11/99	5
08	01	surface water	Oil and Grease	413.1	ND	mg/L	1.0	9/28/99	9
10	01	surface water	Oil and Grease	413.1	ND	mg/L	0.5	3/7/00	3
03	01	surface water	Oil and Grease	EPA 413.1	ND	mg/L	1	5/26/98	5
10	01	surface water	Oil and Grease	413.1	ND	mg/L	0.5	3/7/00	3
11	01	surface water	Oil and Grease	413.1	ND	mg/L	0.5	6/1/00	6
05	01	surface water	Oil and Grease	EPA 413.1	ND	mg/L	1	11/9/98	11
06	01	surface water	Oil and Grease	EPA 413.1	NS	mg/L	1	2/10/99	2
09	01	surface water	Oil and Grease	413.1	ND	mg/L	1.0	12/6/99	12
09	01	surface water	Oil and Grease	413.1	ND	mg/L	1.0	12/6/99	12
02	01	surface water	Oil and Grease	EPA 413.1	ND	mg/L	0.962	3/3/98	3
04	01	surface water	Oil and Grease	EPA 413.1	ND	mg/L	1.03	8/4/98	8
11	01	surface water	Oil and Grease	413.1	ND	mg/L	0.5	6/1/00	6
01	01	surface water	Oil and Grease	EPA 413.1	ND	mg/L	1.18	12/9/97	12
08	01	surface water	Oil and Grease	413.1	ND	mg/L	1.0	9/28/99	9
10	01	surface water	Nitrogen	351.3	0.09J	mg/L	0.05	3/7/00	3
07	01	surface water	Nitrogen	EPA 351.2	0.59	mg/L	0.4	5/11/99	5
05	01	surface water	Nitrogen	EPA 351.2	1.36	mg/L	0.1	11/9/98	11
06	01	surface water	Nitrogen	EPA 351.2	NS	mg/L	0.1	2/10/99	2
06	01	surface water	Nitrogen	EPA 351.2	NS	mg/L	0.1	2/10/99	2
09	01	surface water	Nitrogen	EPA 351.2	NS	mg/L	0.1	12/6/99	12
03	01	surface water	Nitrogen	EPA 351.2	0.7	mg/Kg	0.5	5/26/98	5
06	01	surface water	Nitrogen	EPA 351.2	NS	mg/L	0.1	2/10/99	2
02	01	surface water	Nitrogen	EPA 351.2	NS	mg/L	0.1	3/3/98	3
09	01	surface water	Nitrogen	EPA 351.2	NS	mg/L	0.1	12/6/99	12
08	01	surface water	Nitrogen	351.3	0.5	mg/L	0.1	9/28/99	9
02	01	surface water	Nitrogen	EPA 351.2	NS	mg/L	0.1	3/3/98	3
04	01	surface water	Nitrogen	EPA 351.2	NS	mg/L	0.1	8/4/98	8
04	01	surface water	Nitrogen	EPA 351.2	NS	mg/L	0.1	8/4/98	8
01	01	surface water	Nitrogen	EPA 351.2	0.379	mg/L	0.100	12/9/97	12
04	01	surface water	Nitrogen	EPA 351.2	NS	mg/L	0.1	8/4/98	8
02	01	surface water	Nitrogen	EPA 351.2	NS	mg/L	0.1	3/3/98	3
08	01	surface water	Nitrite	GEN.MINERAL	ND	mg/L	0.02	9/28/99	9
09	01	surface water	Nitrite	GEN.MINERAL.	ND	mg/L	0.02	12/6/99	12
10	01	surface water	Nitrate-N	352.1	15.5	mg/L	0.05	3/7/00	3
07	01	surface water	Nitrate-N	353.2-354.1	1.83	mg/L	0.05	5/11/99	5

fldRound	fldWell	fldMatrix	fldNewName	fldMethod	fldWell1	fldUnits	fldDL	fldSampleDate	fldSampleMont
06	01	surface water	Nitrate-N	353.2-354.1	4.76	mg/L	0.05	2/10/99	2
09	01	surface water	Nitrate-N	GEN.MINERAL.	3.2	mg/L	0.1	12/6/99	12
02	01	surface water	Nitrate-N	EPA 300.0	3.6	mg/L	2	3/3/98	3
08	01	surface water	Nitrate-N	GEN.MINERAL	1.7	mg/L	0.1	9/28/99	9
03	01	surface water	Nitrate-N	EPA 300.0	4.58	mg/L	0.5	5/26/98	5
11	01	surface water	Nitrate-N	GEN.-MINERALS	1.5	mg/L	0.05	6/1/00	6
01	01	surface water	Nitrate-N	EPA 300.0	1.94	mg/L	0.500	12/9/97	12
04	01	surface water	Nitrate-N	EPA 353.2	2.27	mg/L	0.1	8/4/98	8
05	01	surface water	Nitrate-N	353.2-354.1	4.2	mg/L	0.05	11/9/98	11
09	01	surface water	Mercury	EPA 245.1	NS	mg/L	0.0002	12/6/99	12
01	01	surface water	Mercury	SW7470	ND	mg/L	0.000200	12/9/97	12
10	01	surface water	Mercury	6010/7000	ND	mg/L	0.0002	3/7/00	3
11	01	surface water	Mercury	6010/7000	NS	mg/L	0.0002	6/1/00	6
05	01	surface water	Mercury	SW7470A	ND	mg/L	0.0002	11/9/98	11
08	01	surface water	Mercury	{6010/7000}	ND	mg/L	0.0002	9/28/99	9
03	01	surface water	Mercury	7470	ND	mg/L	0.0002	5/26/98	5
04	01	surface water	Mercury	EPA 245.1	NS	mg/L	0.0002	8/4/98	8
07	01	surface water	Mercury	EPA 245.1	ND	mg/L	0.0002	5/11/99	5
02	01	surface water	Mercury	EPA 245.1	NS	mg/L	0.0002	3/3/98	3
06	01	surface water	Mercury	EPA 245.1	NS	mg/L	0.0002	2/10/99	2
09	01	surface water	Manganese	GEN.MINERAL.	0.04	mg/L	0.01	12/6/99	12
08	01	surface water	Manganese	GEN.MINERAL	0.02	mg/L	0.01	9/28/99	9
01	01	surface water	Manganese	EPA 200.7	0.252	mg/L	0.0100	12/9/97	12
04	01	surface water	Manganese	EPA 200.7	0.0776	mg/L	0.01	8/4/98	8
07	01	surface water	Manganese	EPA 200.7	0.0274	mg/L	0.01	5/11/99	5
03	01	surface water	Manganese	EPA 200.7	0.024	mg/L	0.01	5/26/98	5
11	01	surface water	Manganese	GEN.-MINERALS	0.04	mg/L	0.005	6/1/00	6
05	01	surface water	Manganese	EPA 200.7	0.143	mg/L	0.01	11/9/98	11
06	01	surface water	Manganese	EPA 200.7	0.0454	mg/L	0.01	2/10/99	2
10	01	surface water	Manganese	GEN.-MINERALS	0.03	mg/L	0.005	3/7/00	3
02	01	surface water	Manganese	EPA 200.7	0.06	mg/L	0.01	3/3/98	3
04	01	surface water	Magnesium	EPA 200.7	49	mg/L	0.2	8/4/98	8
09	01	surface water	Magnesium	GEN.MINERAL.	56.9	mg/L	0.5	12/6/99	12
02	01	surface water	Magnesium	EPA 200.7	34	mg/L	0.1	3/3/98	3
08	01	surface water	Magnesium	GEN.MINERAL	37.5	mg/L	0.5	9/28/99	9
05	01	surface water	Magnesium	EPA 200.7	50.9	mg/L	0.2	11/9/98	11
03	01	surface water	Magnesium	EPA 200.7	40.8	mg/L	0.2	5/26/98	5
11	01	surface water	Magnesium	GEN.-MINERALS	44.1	mg/L	0.2	6/1/00	6
10	01	surface water	Magnesium	GEN.-MINERALS	25.2	mg/L	0.20	3/7/00	3

fldRound	fldWell	fldMatrix	fldNewName	fldMethod	fldWell1	fldUnits	fldDL	fldSampleDate	fldSampleMont
07	01	surface water	Magnesium	EPA 200.7	38.9	mg/L	0.2	5/11/99	5
06	01	surface water	Magnesium	EPA 200.7	40.7	mg/L	0.2	2/10/99	2
01	01	surface water	Magnesium	EPA 200.7	27.3	mg/L	0.200	12/9/97	12
06	01	surface water	Lead	EPA 239.2	NS	mg/L	0.001	2/10/99	2
05	01	surface water	Lead	EPA 239.2	ND	mg/L	0.001	11/9/98	11
10	01	surface water	Lead	6010/7000	ND	mg/L	0.005	3/7/00	3
01	01	surface water	Lead	EPA 200.7	ND	mg/L	0.0200	12/9/97	12
04	01	surface water	Lead	EPA 239.2	ND	mg/L	0.001	8/4/98	8
03	01	surface water	Lead	EPA 239.2	ND	mg/L	0.001	5/26/98	5
07	01	surface water	Lead	EPA 239.2	ND	mg/L	0.001	5/11/99	5
09	01	surface water	Lead	{6010/7000}	ND	mg/L	0.05	12/6/99	12
11	01	surface water	Lead	6010BSCAN	ND	mg/L	0.005	6/1/00	6
08	01	surface water	Lead	{6010/7000}	ND	mg/L	0.1	9/28/99	9
02	01	surface water	Lead	EPA 239.2	ND	mg/L	0.015	3/3/98	3
10	01	surface water	Iron	GEN.-MINERALS	ND	mg/L	0.03	3/7/00	3
11	01	surface water	Iron	GEN.-MINERALS	ND	mg/L	0.03	6/1/00	6
03	01	surface water	Iron	EPA 200.7	0.134	mg/L	0.05	5/26/98	5
06	01	surface water	Iron	EPA 200.7	0.932	mg/L	0.05	2/10/99	2
05	01	surface water	Iron	EPA 200.7	1.48	mg/L	0.05	11/9/98	11
04	01	surface water	Iron	EPA 200.7	0.149	mg/L	0.05	8/4/98	8
01	01	surface water	Iron	EPA 200.7	9.89	mg/L	0.0500	12/9/97	12
07	01	surface water	Iron	EPA 200.7	ND	mg/L	0.05	5/11/99	5
08	01	surface water	Iron	GEN.MINERAL	ND	mg/L	0.05	9/28/99	9
02	01	surface water	Iron	EPA 200.7	0.9	mg/L	0.1	3/3/98	3
09	01	surface water	Iron	GEN.MINERAL.	0.06	mg/L	0.05	12/6/99	12
05	01	surface water	Hydroxide	SM406	ND	mg/L	0.5	11/9/98	11
01	01	surface water	Hydroxide	SM406	ND	mg/L	1.00	12/9/97	12
09	01	surface water	Hydroxide	GEN.MINERAL.	ND	mg/L	2	12/6/99	12
02	01	surface water	Hydroxide	SM406	ND	mg/L	0.5	3/3/98	3
04	01	surface water	Hydroxide	HYDROXID	ND	mg/L	0.5	8/4/98	8
11	01	surface water	Hydroxide	GEN.-MINERALS	ND	mg/L	0.5	6/1/00	6
08	01	surface water	Hydroxide	GEN.MINERAL	ND	mg/L	0.5	9/28/99	9
07	01	surface water	Hydroxide	SM406C	ND	mg/L	0.5	5/11/99	5
03	01	surface water	Hydroxide	HYDROXID	ND	mg/L	0.5	5/26/98	5
06	01	surface water	Hydroxide	SM406C	NS	mg/L	0.5	2/10/99	2
10	01	surface water	Hydroxide	GEN.-MINERALS	ND	mg/L	0.5	3/7/00	3
06	01	surface water	Hardness (CaCO3)	EPA 130.2	460	mg/L	1	2/10/99	2
07	01	surface water	Hardness (CaCO3)	EPA 130.2	376	mg/L	2	5/11/99	5
05	01	surface water	Hardness (CaCO3)	EPA 130.2	570	mg/L	1	11/9/98	11

fldRound	fldWell	fldMatrix	fldNewName	fldMethod	fldWell1	fldUnits	fldDL	fldSampleDate	fldSampleMont
04	01	surface water	Hardness (CaCO3)	EPA 130.2	483	mg/L	5	8/4/98	8
01	01	surface water	Hardness (CaCO3)	EPA 130.2	259	mg/L	10.0	12/9/97	12
02	01	surface water	Hardness (CaCO3)	EPA 130.2	348	mg/L	10	3/3/98	3
09	01	surface water	Hardness (CaCO3)	GEN.MINERAL.	564	mg/L	2	12/6/99	12
08	01	surface water	Hardness (CaCO3)	GEN.MINERAL	400	mg/L	2	9/28/99	9
11	01	surface water	Hardness (CaCO3)	GEN.-MINERALS	424	mg/L	1	6/1/00	6
03	01	surface water	Hardness (CaCO3)	EPA 130.2	344	mg/L	5	5/26/98	5
10	01	surface water	Hardness (CaCO3)	GEN.-MINERALS	278	mg/L	1	3/7/00	3
09	01	surface water	Fluoride	GEN.MINERAL.	0.4	mg/L	0.2	12/6/99	12
11	01	surface water	Fluoride	GEN.-MINERALS	0.6	mg/L	0.1	6/1/00	6
02	01	surface water	Fluoride	EPA 300.0	0.29	mg/L	0.2	3/3/98	3
04	01	surface water	Fluoride	EPA 340.2	0.319	mg/L	0.1	8/4/98	8
10	01	surface water	Fluoride	GEN.-MINERALS	0.4	mg/L	0.1	3/7/00	3
08	01	surface water	Fluoride	GEN.MINERAL	0.4	mg/L	0.1	9/28/99	9
05	01	surface water	Fluoride	EPA 340.2	0.336	mg/L	0.1	11/9/98	11
03	01	surface water	Fluoride	EPA 300.0	0.301	mg/L	0.2	5/26/98	5
06	01	surface water	Fluoride	EPA 340.2	0.297	mg/L	0.1	2/10/99	2
01	01	surface water	Fluoride	EPA 300.0	ND	mg/L	0.200	12/9/97	12
07	01	surface water	Fluoride	EPA 340.2	0.326	mg/L	0.1	5/11/99	5
08	01	surface water	Fecal Coliform	9221	130	mpn/100ml	2	9/28/99	9
05	01	surface water	Fecal Coliform	MTF	>1600	mpn/100ml	2	11/9/98	11
01	01	surface water	Fecal Coliform	MTF	>1600	mpn/100ml	2	12/9/97	12
07	01	surface water	Fecal Coliform	9221	>23	mpn/100ml	2	5/11/99	5
09	01	surface water	Fecal Coliform	9221	30	mpn/100ml	2	12/6/99	12
06	01	surface water	Fecal Coliform	9221	900	mpn/100ml	2	2/10/99	2
02	01	surface water	Fecal Coliform	MTF	140	mpn/100ml	2	3/3/98	3
04	01	surface water	Fecal Coliform	MTF	110	mpn/100ml	2	8/4/98	8
11	01	surface water	Fecal Coliform	MPN(F)	130	MPN/mL	2	6/1/00	6
10	01	surface water	Fecal Coliform	MPN(F)	240	MPN/100 m	2	3/7/00	3
03	01	surface water	Fecal Coliform	MTF	60	mpn/100ml	2	5/26/98	5
09	01	surface water	Cyanide (Total)	EPA 335.2	NS	mg/L	0.005	12/6/99	12
06	01	surface water	Cyanide (Total)	EPA 335.2	NS	mg/L	0.005	2/10/99	2
09	01	surface water	Cyanide (Total)	EPA 335.2	NS	mg/L	0.005	12/6/99	12
06	01	surface water	Cyanide (Total)	EPA 335.2	NS	mg/L	0.005	2/10/99	2
04	01	surface water	Cyanide (Total)	EPA 335.2	NS	mg/L	0.005	8/4/98	8
11	01	surface water	Cyanide (Total)	335.2	NS	mg/L	0.01	6/1/00	6
01	01	surface water	Cyanide (Total)	EPA 335.2	ND	mg/L	0.00500	12/9/97	12
04	01	surface water	Cyanide (Total)	EPA 335.2	NS	mg/L	0.005	8/4/98	8
02	01	surface water	Cyanide (Total)	EPA 335.2	NS	mg/L	0.005	3/3/98	3

fldRound	fldWell	fldMatrix	fldNewName	fldMethod	fldWell1	fldUnits	fldDL	fldSampleDate	fldSampleMont
03	01	surface water	Cyanide (Total)	EPA 335.2	ND	mg/L	0.005	5/26/98	5
05	01	surface water	Cyanide (Total)	EPA 335.2	ND	mg/L	0.005	11/9/98	11
07	01	surface water	Cyanide (Total)	EPA 335.2	ND	mg/L	0.005	5/11/99	5
08	01	surface water	Cyanide (Total)	335.2	ND	mg/L	0.01	9/28/99	9
10	01	surface water	Cyanide (Total)	335.2	ND	mg/L	0.01	3/7/00	3
02	01	surface water	Cyanide (Total)	EPA 335.2	NS	mg/L	0.005	3/3/98	3
09	01	surface water	Copper	GEN.MINERAL.	0.03	mg/L	0.02	12/6/99	12
08	01	surface water	Copper	GEN.MINERAL	ND	mg/L	0.02	9/28/99	9
05	01	surface water	Copper	EPA 200.7	ND	mg/L	0.005	11/9/98	11
01	01	surface water	Copper	EPA 200.7	0.007	mg/L	0.00500	12/9/97	12
10	01	surface water	Copper	GEN.-MINERALS	ND	mg/L	0.005	3/7/00	3
11	01	surface water	Copper	GEN.-MINERALS	ND	mg/L	0.005	6/1/00	6
03	01	surface water	Copper	EPA 200.7	ND	mg/L	0.005	5/26/98	5
07	01	surface water	Copper	EPA 200.7	ND	mg/L	0.005	5/11/99	5
04	01	surface water	Copper	EPA 200.7	ND	mg/L	0.005	8/4/98	8
02	01	surface water	Copper	EPA 200.7	ND	mg/L	0.02	3/3/98	3
06	01	surface water	Copper	EPA 200.7	NS	mg/L	0.005	2/10/99	2
08	01	surface water	Conductivity	GEN.MINERAL	1230	umhos/cm	10	9/28/99	9
06	01	surface water	Conductivity	EPA 120.1	1180	umhos/cm	1	2/10/99	2
07	01	surface water	Conductivity	EPA 120.1	1230	umhos/cm	1	5/11/99	5
05	01	surface water	Conductivity	EPA 120.1	1410	umhos/cm	1	11/9/98	11
11	01	surface water	Conductivity	GEN.-MINERALS	1,350	mg/L	5	6/1/00	6
10	01	surface water	Conductivity	GEN.-MINERALS	842	mg/L	5	3/7/00	3
09	01	surface water	Conductivity	GEN.MINERAL.	1510	umhos/cm	10	12/6/99	12
04	01	surface water	Conductivity	EPA 120.1	1280	umhos/cm	1	8/4/98	8
01	01	surface water	Conductivity	EPA 120.1	849	umhos/cm	1.00	12/9/97	12
02	01	surface water	Conductivity	EPA 120.1	1016	umhos/cm	1	3/3/98	3
03	01	surface water	Conductivity	EPA 120.1	1070	umhos/cm	1	5/26/98	5
10	01	surface water	Chloride	GEN.-MINERALS	102	mg/L	0.5	3/7/00	3
07	01	surface water	Chloride	EPA 325.3	135	mg/L	1	5/11/99	5
05	01	surface water	Chloride	EPA 325.3	176	mg/L	1	11/9/98	11
01	01	surface water	Chloride	EPA 300.0	147	mg/L	10.0	12/9/97	12
09	01	surface water	Chloride	GEN.MINERAL.	188	mg/L	1	12/6/99	12
08	01	surface water	Chloride	GEN.MINERAL	147	mg/L	1	9/28/99	9
03	01	surface water	Chloride	EPA 300.0	189	mg/L	50	5/26/98	5
10	01	surface water	Chloride	GEN.-MINERALS	102	mg/L	0.5	3/7/00	3
11	01	surface water	Chloride	GEN.-MINERALS	176	mg/L	0.5	6/1/00	6
08	01	surface water	Chloride	GEN.MINERAL	147	mg/L	1	9/28/99	9
11	01	surface water	Chloride	GEN.-MINERALS	176	mg/L	0.5	6/1/00	6

fldRound	fldWell	fldMatrix	fldNewName	fldMethod	fldWell1	fldUnits	fldDL	fldSampleDate	fldSampleMont
04	01	surface water	Chloride	EPA 325.3	162	mg/L	1	8/4/98	8
02	01	surface water	Chloride	EPA 300.0	120	mg/L	20	3/3/98	3
09	01	surface water	Chloride	GEN.MINERAL.	188	mg/L	1	12/6/99	12
06	01	surface water	Chloride	EPA 325.3	136	mg/L	1	2/10/99	2
02	01	surface water	Carbonate	SM406	2.3	mg/L	0.5	3/3/98	3
03	01	surface water	Carbonate	CARBONAT	1.94	mg/L	0.5	5/26/98	5
04	01	surface water	Carbonate	CARBONAT	3.53	mg/L	0.5	8/4/98	8
05	01	surface water	Carbonate	SM406	1.43	mg/L	0.5	11/9/98	11
07	01	surface water	Carbonate	SM406	1.84	mg/L	0.5	5/11/99	5
10	01	surface water	Carbonate	GEN.-MINERALS	ND	mg/L	0.5	3/7/00	3
08	01	surface water	Carbonate	GEN.MINERAL	ND	mg/L	0.5	9/28/99	9
11	01	surface water	Carbonate	GEN.-MINERALS	ND	mg/L	0.5	6/1/00	6
09	01	surface water	Carbonate	GEN.MINERAL.	ND	mg/L	2	12/6/99	12
01	01	surface water	Carbonate	SM406	ND	mg/L	1.00	12/9/97	12
06	01	surface water	Carbonate	SM406	2.55	mg/L	0.5	2/10/99	2
08	01	surface water	Calcium	GEN.MINERAL	81.4	mg/L	0.5	9/28/99	9
09	01	surface water	Calcium	GEN.MINERAL.	120	mg/L	0.5	12/6/99	12
02	01	surface water	Calcium	EPA 200.7	90	mg/L	0.2	3/3/98	3
04	01	surface water	Calcium	EPA 200.7	99.7	mg/L	0.1	8/4/98	8
01	01	surface water	Calcium	EPA 200.7	71.4	mg/L	0.100	12/9/97	12
06	01	surface water	Calcium	EPA 200.7	89.1	mg/L	0.1	2/10/99	2
10	01	surface water	Calcium	GEN.-MINERALS	61.4	mg/L	0.10	3/7/00	3
11	01	surface water	Calcium	GEN.-MINERALS	92.0	mg/L	0.1	6/1/00	6
07	01	surface water	Calcium	EPA 200.7	87.4	mg/L	0.1	5/11/99	5
03	01	surface water	Calcium	EPA 200.7	92.3	mg/L	0.1	5/26/98	5
05	01	surface water	Calcium	EPA 200.7	118	mg/L	0.1	11/9/98	11
07	01	surface water	Boron	EPA 200.7	0.215	mg/L	0.1	5/11/99	5
02	01	surface water	Boron	EPA 200.7	ND	mg/L	0.5	3/3/98	3
03	01	surface water	Boron	6010A	ND	mg/L	0.5	5/26/98	5
06	01	surface water	Boron	EPA 200.7	0.19	mg/L	0.1	2/10/99	2
05	01	surface water	Boron	EPA 200.7	0.244	mg/L	0.1	11/9/98	11
01	01	surface water	Boron	6010A	ND	mg/L	0.5	12/9/97	12
08	01	surface water	Boron	SM-4500-B	0.2	mg/L	0.2	9/28/99	9
09	01	surface water	Boron	SM-4500-B	ND	mg/L	0.2	12/6/99	12
10	01	surface water	Boron	SM-4500B	ND	mg/L	0.1	3/7/00	3
04	01	surface water	Boron	EPA 200.7	0.219	mg/L	0.1	8/4/98	8
11	01	surface water	Boron	SM-4500B	0.3	mg/L	0.1	6/1/00	6
01	01	surface water	Biochemical Oxygen Dem	EPA 405.1	2.5	mg/L	2.00	12/9/97	12
10	01	surface water	Biochemical Oxygen Dem	405.1	ND	mg/L	2	3/7/00	3

fldRound	fldWell	fldMatrix	fldNewName	fldMethod	fldWell1	fldUnits	fldDL	fldSampleDate	fldSampleMont
04	01	surface water	Biochemical Oxygen Dem	EPA 405.1	NS	mg/L	2	8/4/98	8
11	01	surface water	Biochemical Oxygen Dem	405.1	NS	mg/L	2	6/1/00	6
05	01	surface water	Biochemical Oxygen Dem	EPA 405.1	2.14	mg/L	2	11/9/98	11
02	01	surface water	Biochemical Oxygen Dem	EPA 405.1	NS	mg/L	2	3/3/98	3
08	01	surface water	Biochemical Oxygen Dem	405.1	ND	mg/L	2	9/28/99	9
03	01	surface water	Biochemical Oxygen Dem	EPA 405.1	ND	mg/L	2	5/26/98	5
06	01	surface water	Biochemical Oxygen Dem	EPA 405.1	NS	mg/L	2	2/10/99	2
09	01	surface water	Biochemical Oxygen Dem	EPA 405.1	NS	mg/L	2	12/6/99	12
07	01	surface water	Biochemical Oxygen Dem	EPA 405.1	ND	mg/L	2	5/11/99	5
03	01	surface water	Bicarbonate	BICARB	176	mg/L	1	5/26/98	5
07	01	surface water	Bicarbonate	SM406C	183	mg/L	1	5/11/99	5
04	01	surface water	Bicarbonate	BICARB	192	mg/L	1	8/4/98	8
11	01	surface water	Bicarbonate	GEN.-MINERALS	180	mg/L	1	6/1/00	6
01	01	surface water	Bicarbonate	SM406C	115	mg/L	1.00	12/9/97	12
06	01	surface water	Bicarbonate	SM406C	183	mg/L	1	2/10/99	2
02	01	surface water	Bicarbonate	SM406C	155	mg/L	1	3/3/98	3
09	01	surface water	Bicarbonate	GEN.MINERAL.	194	mg/L	2	12/6/99	12
08	01	surface water	Bicarbonate	GEN.MINERAL	172	mg/L	1	9/28/99	9
10	01	surface water	Bicarbonate	GEN.-MINERALS	118	mg/L	1	3/7/00	3
05	01	surface water	Bicarbonate	SM406C	178	mg/L	1	11/9/98	11
02	01	surface water	Arsenic	EPA 200.7	ND	mg/L	0.01	3/3/98	3
10	01	surface water	Arsenic	6010/7000	ND	mg/L	0.025	3/7/00	3
03	01	surface water	Arsenic	EPA 200.7	ND	mg/L	0.025	5/26/98	5
04	01	surface water	Arsenic	EPA 200.7	ND	mg/L	0.025	8/4/98	8
01	01	surface water	Arsenic	EPA 200.7	ND	mg/L	0.0250	12/9/97	12
08	01	surface water	Arsenic	{6010/7000}	ND	mg/L	0.005	9/28/99	9
09	01	surface water	Arsenic	{6010/7000}	ND	mg/L	0.005	12/6/99	12
05	01	surface water	Arsenic	EPA 200.7	ND	mg/L	0.025	11/9/98	11
07	01	surface water	Arsenic	EPA 200.7	ND	mg/L	0.025	5/11/99	5
06	01	surface water	Arsenic	EPA 200.7	NS	mg/L	0.025	2/10/99	2
11	01	surface water	Arsenic	6010BSCAN	ND	mg/L	0.025	6/1/00	6
09	01	surface water	Aluminum	GEN.MINERAL	0.2	mg/L	0.1	12/6/99	12
01	01	surface water	Alkalinity (CaCO3)	EPA 310.1	116	mg/L	1.00	12/9/97	12
04	01	surface water	Alkalinity (CaCO3)	EPA 310.1	196	mg/L	1	8/4/98	8
03	01	surface water	Alkalinity (CaCO3)	EPA 310.1	178	mg/L	1	5/26/98	5
02	01	surface water	Alkalinity (CaCO3)	EPA 310.1	157	mg/L	1	3/3/98	3
11	01	surface water	Alkalinity (CaCO3)	GEN.-MINERALS	180	mg/L	1	6/1/00	6
06	01	surface water	Alkalinity (CaCO3)	EPA 310.1	186	mg/L	1	2/10/99	2
05	01	surface water	Alkalinity (CaCO3)	EPA 310.1	180	mg/L	1	11/9/98	11

fldRound	fldWell	fldMatrix	fldNewName	fldMethod	fldWell1	fldUnits	fldDL	fldSampleDate	fldSampleMont
07	01	surface water	Alkalinity (CaCO3)	EPA 310.1	185	mg/L	1	5/11/99	5
08	01	surface water	Alkalinity (CaCO3)	GEN.MINERAL	172	mg/L	1	9/28/99	9
09	01	surface water	Alkalinity (CaCO3)	GEN.MINERAL.	194	mg/L	2	12/6/99	12
10	01	surface water	Alkalinity (CaCO3)	GEN.-MINERALS	118	mg/L	1	3/7/00	3

Water Resources Management in the Santa Margarita River

Water Quality Monitoring and Water Management

4 April 2001

Today's Presentation

- Santa Margarita River Challenges
- Addressing the Challenges
- Framework Monitoring Plan Overview
- Future Needs in the Watershed

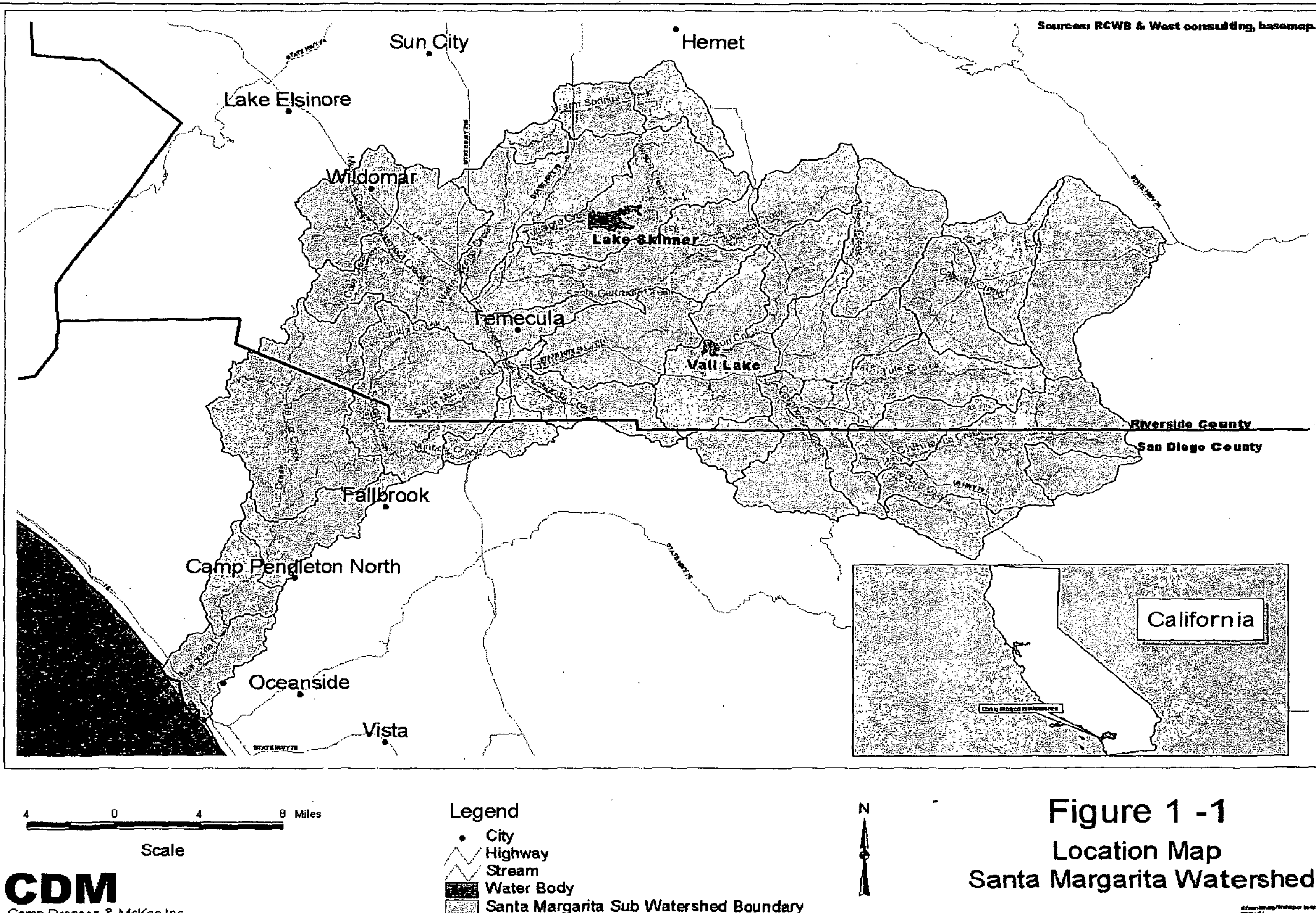


Figure 1 -1
Location Map
Santa Margarita Watershed

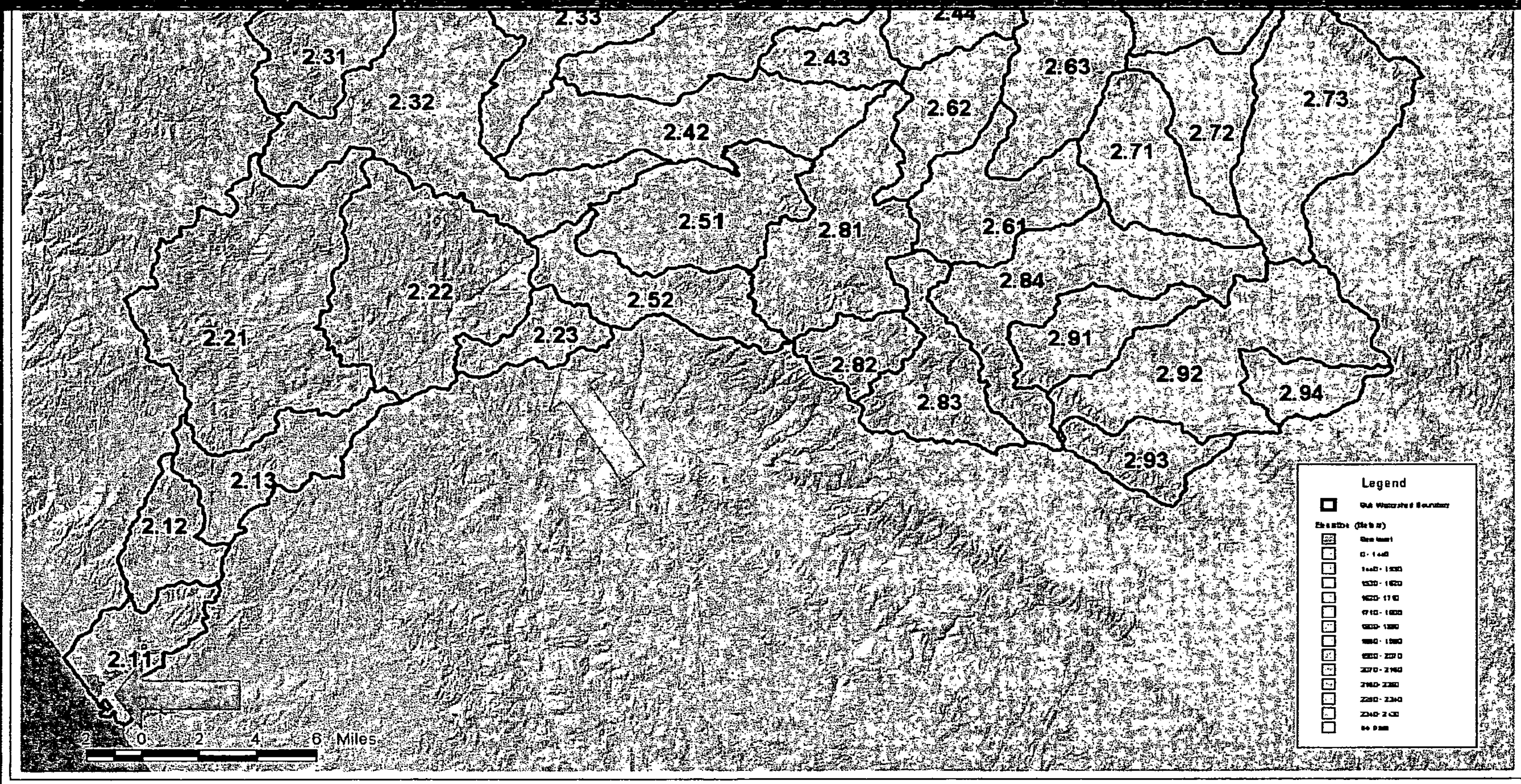
The Challenges

There are water resources challenges to agencies & individuals in the watershed

- Listed reaches do not meet water quality standards (CWA 303(d) Listing)
- Required Total Maximum Daily Load process will allocate loads or load reductions among sources
- Assimilative capacity of the system is an issue to all dischargers
- Habitat health especially for listed species
- Water rights and water management have water quality linkages
- Ongoing & anticipated growth in the watershed has relationship to all the above

1998 CA 303(d) Listed Sites in Santa Margarita Watershed

Listing state	ID	Waterbody	Parameter of Concern	Potential sources of Impairment
CA	CAE902.110 SANTA MARGARITA 1998	SANTA MARGARITA LAGOON	EUTROPHIC	NONPOINT/POINT SOURCE,
CA	CAR902.200 RAINBOW CREEK 1998	RAINBOW CREEK	EUTROPHIC	NONPOINT/POINT SOURCE,



Total Maximum Daily Load

- Sum of individual wasteload allocations for point sources, load allocations for non-point sources, and natural background pollutants, plus a margin of safety.
- Can be expressed in terms of mass loads or other appropriate measures.
- TMDLs are usually based on readily available information and studies.
- Santa Margarita Lagoon TMDL has potential to impact all upstream point sources and non-point sources.

Beneficial Uses

- Beneficial use designations could significantly impact organizations in the watershed
  - GWR: Groundwater recharge
  - REC-1: Contact water recreation
  - COLD: Cold freshwater habitat
  - RARE: Rare, threatened or endangered species
- Are the beneficial use designations justified & documented by monitoring?
- Monitoring required for an accurate designation

Will a "Cold" designation ultimately require temperature control activities in the river?

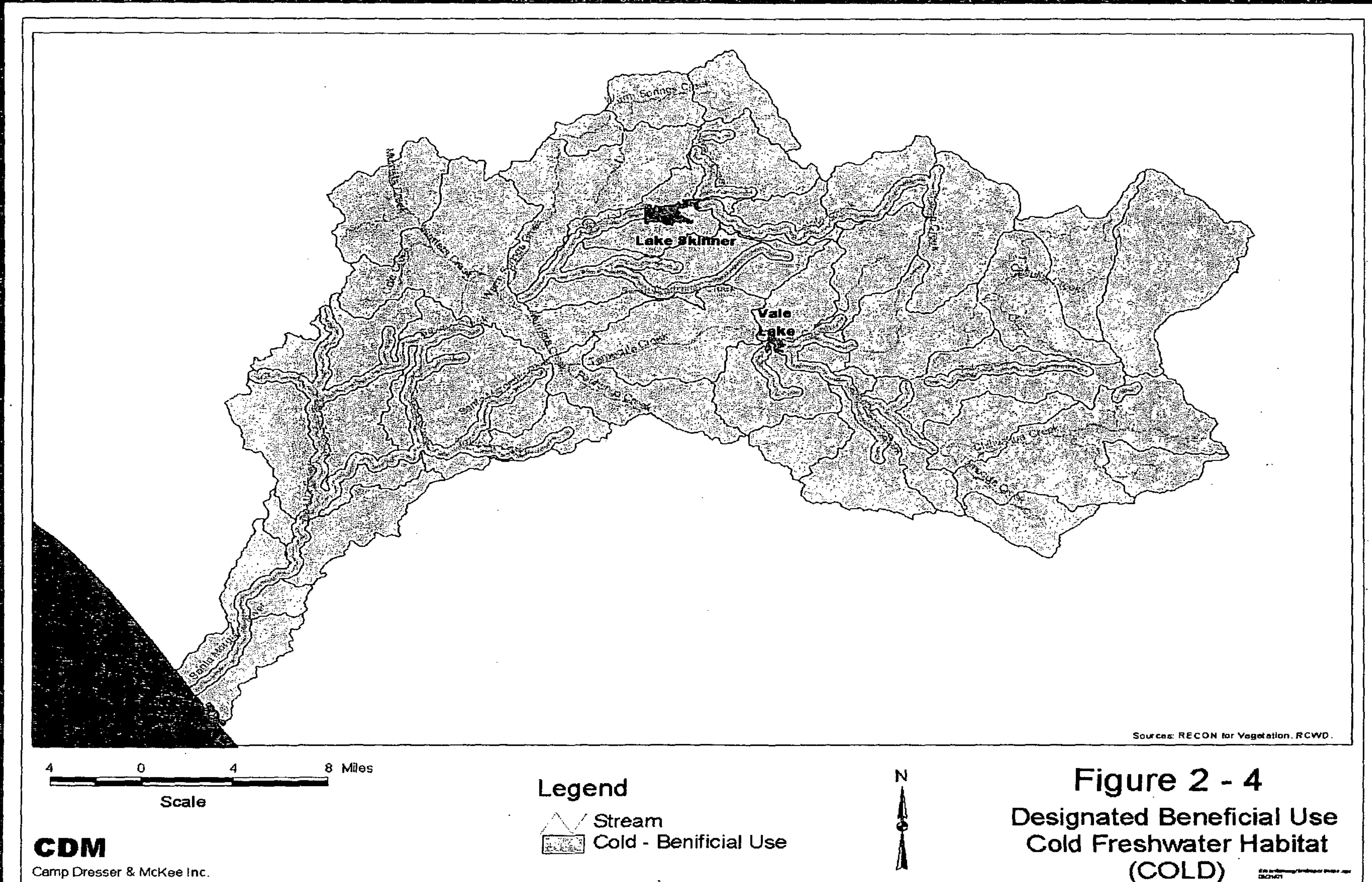


Figure 2 - 4
Designated Beneficial Use
Cold Freshwater Habitat
(COLD)

Just north of the Santa Margarita River:

Agency floats plan to protect trout habitat

March 12, 2001The Orange County Register

.... urge the National Marine Fisheries Service to declare a creek near San Clemente a protected habitat for steelhead.... The creek ... meanders 8 miles from the Cleveland National Forest through Camp Pendleton to the beach at Trestles.

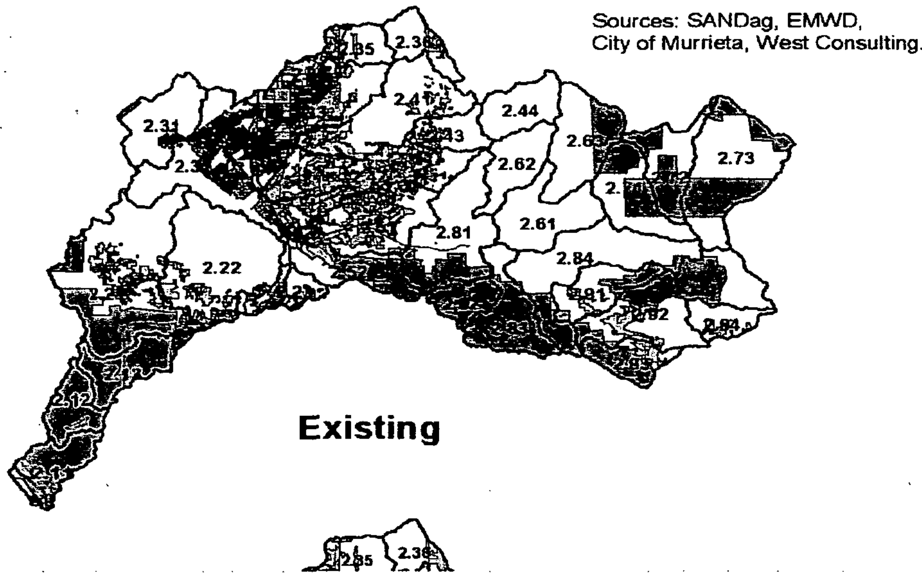
.... Until 1999, federal regulators thought Southern California steelhead no longer existed south of Malibu Creek.... Now environmental groups are pushing to extend federal protections south from Malibu Creek to San Mateo Creek.

.... "Our goal," he said, "is to restore the habitat within the stream back to what it was in the 1940s."

Existing and Future Land Use

- Tremendous growth in Temecula, Murrieta, and along the Interstate 15-215 corridor in the last ten years. Continued growth is anticipated for the foreseeable future
- The portion of San Diego County in the Watershed along the Interstate 15 corridor also continues to grow
- Preliminary review compares “Current” to “Future”
  - Change in use
  - Change in percent urbanization of subwatershed
- Focus sampling to anticipate & measure changes

Preliminary review illustrates anticipated urbanization in the watershed



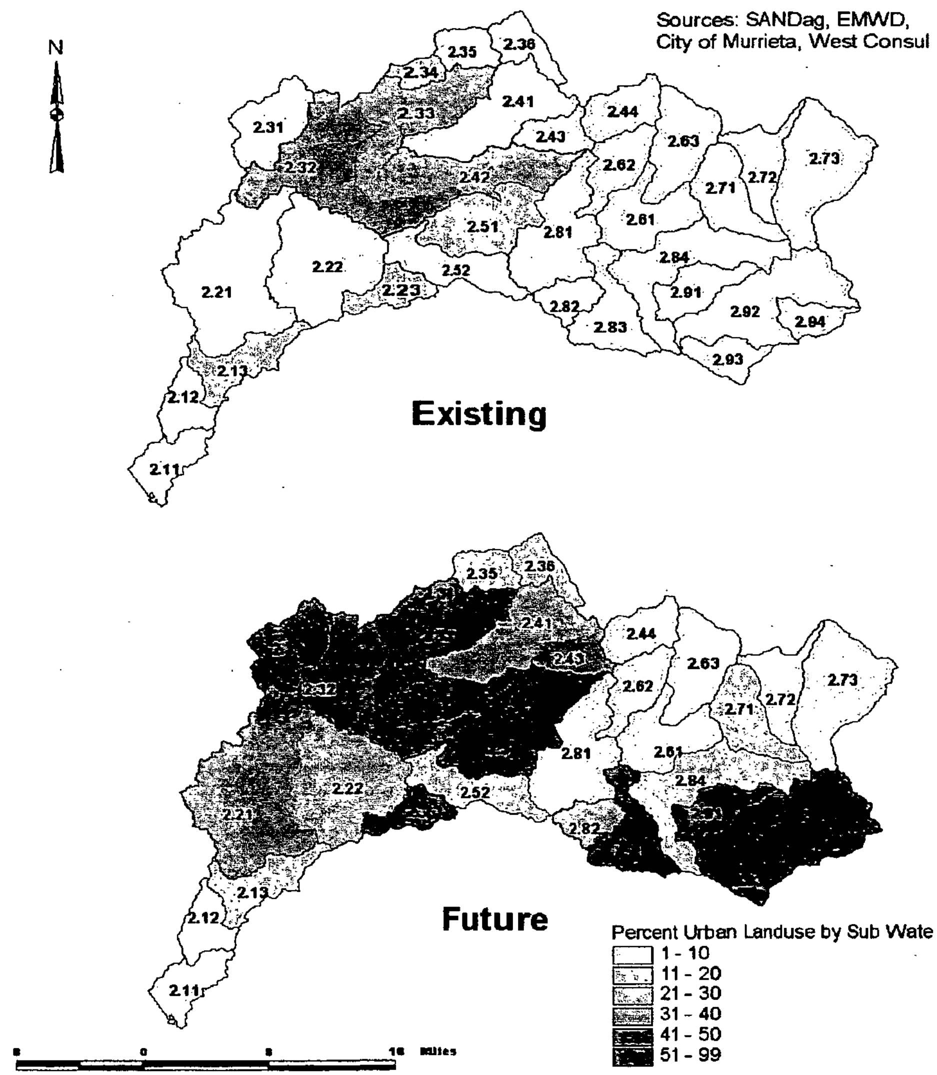


Figure 3 - 3
Percent Urban Land Use Maps

CDM
Camp Dresser & McKee Inc.

Point Source Discharges

- Camp Pendleton:
  - 5 NPDES permits associated with Wastewater Treatment Plants.
  - Total discharge of 6.6 mgd
- RCWD:
  - NPDES permit for discharge of 2.0 mgd of tertiary treated wastewater into Murrieta Creek.

Non-Point Source Discharges

- Non-point source discharges are reported to be the largest contributor to surface water pollution in the watershed.
- Non-point source discharges are typically associated with urban or agricultural runoff
- Factors that affect non-point source discharges
  - Existing and future land use
  - Stormwater Best Management Practices
  - Phase II stormwater regulations in 2003.

Preliminary List of Species to be Addressed in the Watershed

Animal Species

- CA red-legged frog
- Arroyo toad
- Arroyo chub
- Tidewater goby
- Southwestern Pond Turtle
- Least Bells Vireo

Plant Species

- San Diego ambrosia
- Nevin's Barberry
- Thread-leaved Brodiaea
- Salt marsh bird's-beak
- Slender-horned spineflower
- Coulter's goldfields
- Parish's meadow-foam

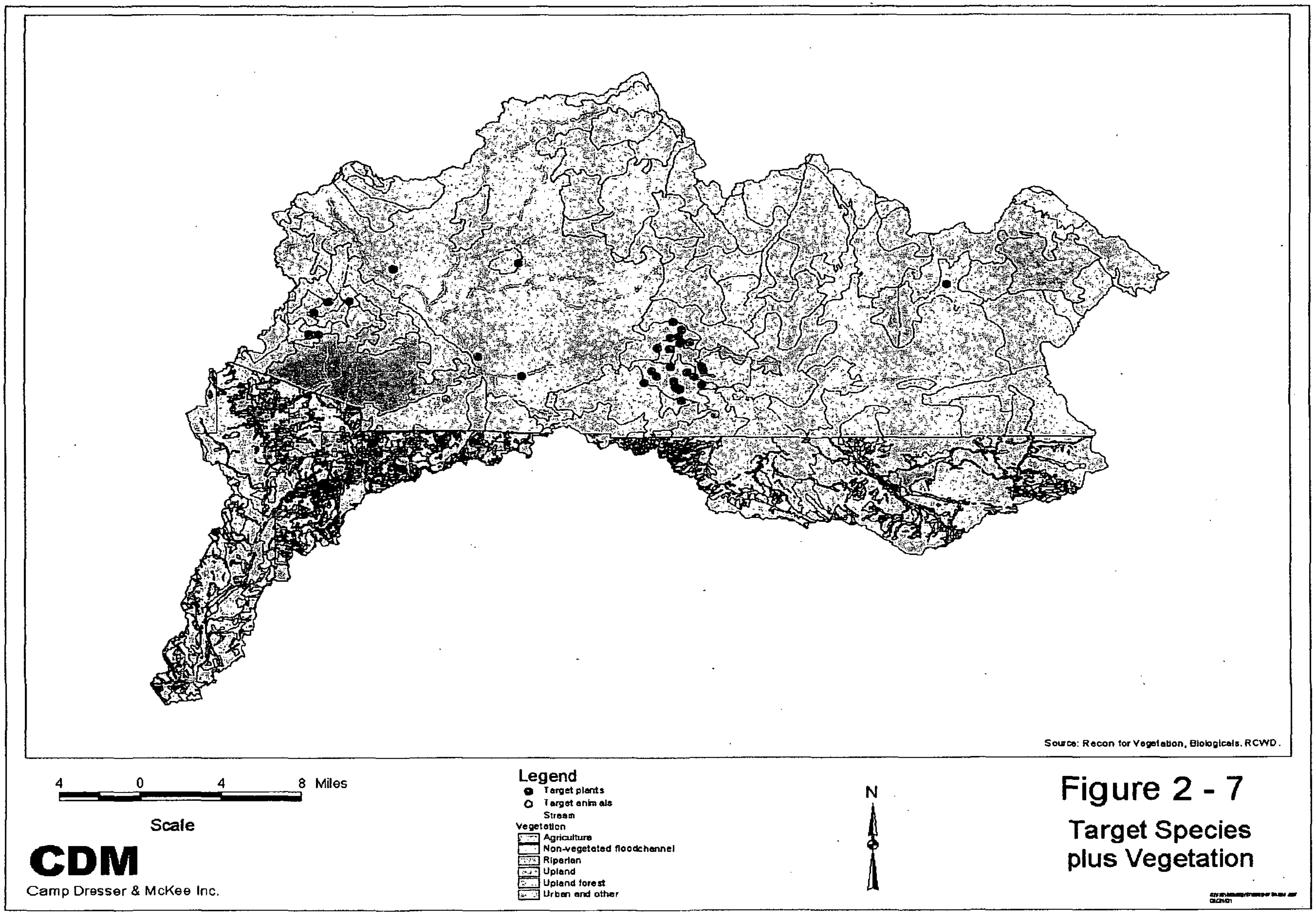
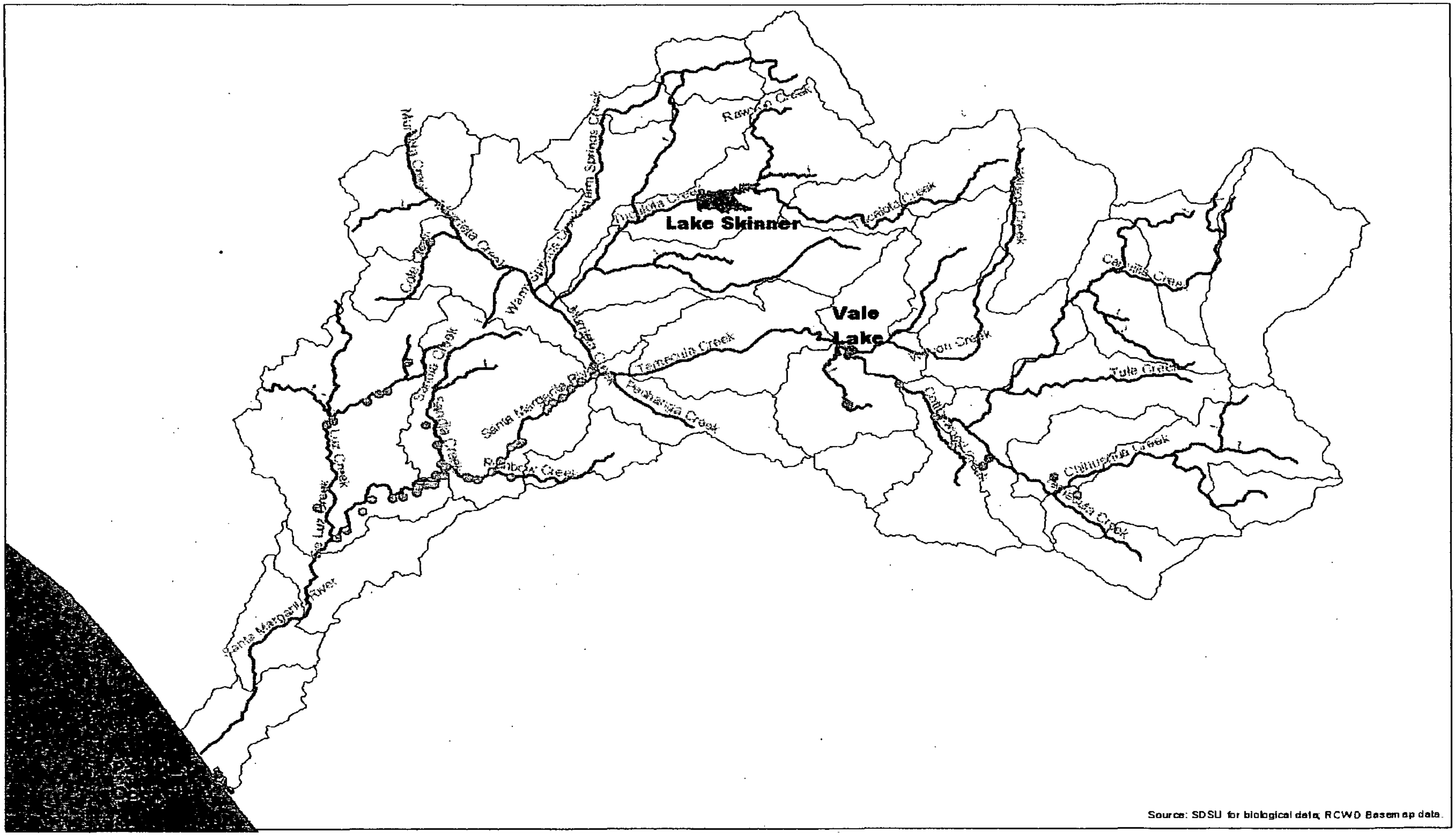


Figure 2 - 7
Target Species plus Vegetation



4 0 4 8 Miles

Scale

CDM

Camp Dresser & McKee Inc.

Legend

Arroyo Chub
Gila orcutti
SW Turtle
Clemys marmorata
Water Body
Streams
Watershed Boundary

N

Figure 2 - 8

Occurrence of
Arroyo Chub and
Southwestern Pond Turtle
from SDSU

Addressing the Santa Margarita River Challenges

Addressing the Challenges

- Good data is needed to make good decisions
  - Was adequate data available for Basin Plan & 303(d) listing?
  - Is adequate data available to set TMDL allocations?
- A number of organizations are independently collecting data – a coordinated effort is needed to address the significant challenges
- USBR has funded a Framework Plan for integrated monitoring in the Watershed

The Framework Monitoring Plan Guidance

- Santa Margarita River Watershed Water Quality Monitoring Group working with the USBR
  - Representatives from 29 organizations
  - List of members expanded over the course of the planning effort
- SMR Group developed list of goals for monitoring:

  facilitate development of water resources to meet demands in a manner consistent with sustainable use, human safety, and habitat and ecological needs, including protection of listed species

Membership List of Santa Margarita River Watershed Water Quality Monitoring Group (SMR Group)

- CALTRANS
- Cahuilla Band of Mission Indians
- CA Department of Water Resources
- Conservation Biology Institute
- Eastern Municipal Water District
- EMA Resource Conservation District
- Fallbrook Public Utilities District
- Fallbrook Naval Weapons Station
- Hines Nursery
- Marine Corps Base, Camp Pendleton
- Metropolitan Water District of Southern California
- Mission Resource Conservation District
- Murrieta County Water District
- Pauma-Yuima Band of Mission Indians
- Pechanga Band of Mission Indians
- Ramona Band of Mission Indians
- Rancho California Water District
- Riverside County FC&WCD
- San Diego County
- San Diego County Water Authority
- San Diego RWQCB
- San Diego State University
- Santa Margarita Watermaster
- U.S. Bureau of Indian Affairs
- The Nature Conservancy
- U.C. Cooperative Extension
- U.S. Bureau of Reclamation
- U.S. Environmental Protection Agency
- U.S. Geological Survey

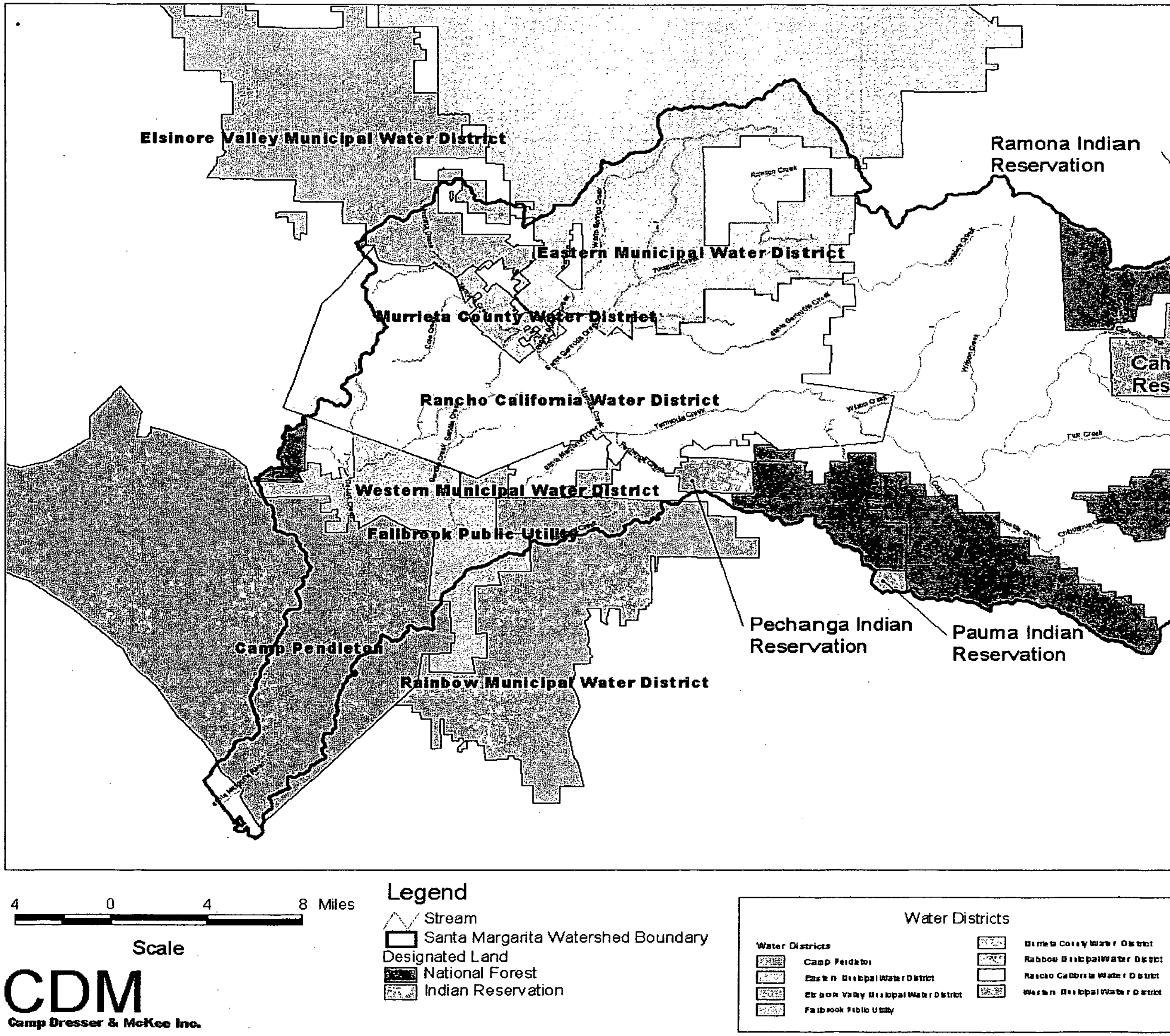


Figure 1-2
Santa Margarita River
SMR Group

Goals of the FMP - as identified by the SMR Group

- Assessment of regarding achievement of existing water quality standards
- Support scientific development of TMDLs
- Assess assimilative capacity for nutrients and total dissolved solids (TDS);
- Determine relationships between habitat health and water quality
- Identify water quality issues related to water supply alternatives
- Develop a scientific basis for decisions regarding CWA §303(d) listing;
- Identify the causes of beneficial use impairments by contaminant and source,
- Quantify pollutant loading from point and non-point source discharges, including stormwater.
- Evaluate sediment transport;
- Evaluate effectiveness of stormwater best management practices (BMPs);
- Verify regulatory compliance (as a replacement of all existing permit requirements for monitoring) and support for future permitting.
- Facilitate water recycling in the watershed

Framework Monitoring Plan Overview

Framework Monitoring Plan

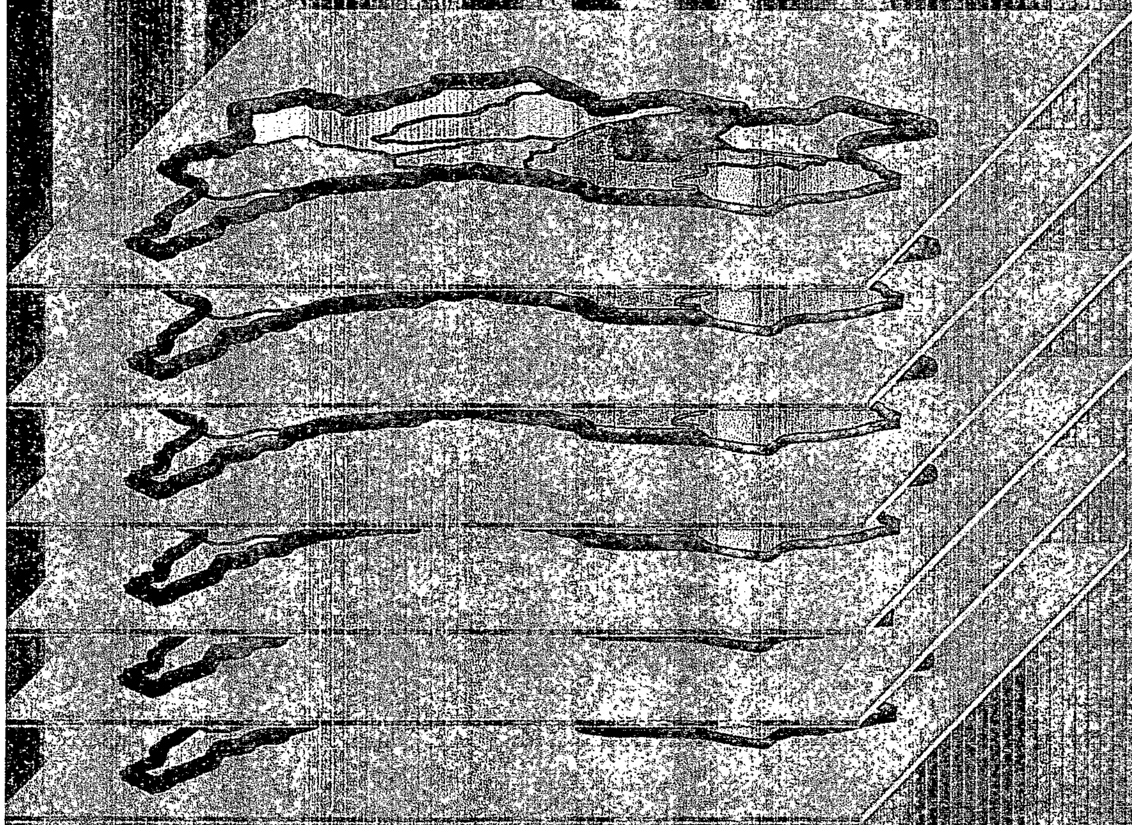
- **Statement of objectives:**
  - ...Monitoring plan to meet local goals and impending regulatory mandates
- **Project description:**
  - ...framework-monitoring plan with recommendations for fully developing the plan
- **Duration of Planning Effort**

  November 2000 to April 4, 2001

Framework Plan Products

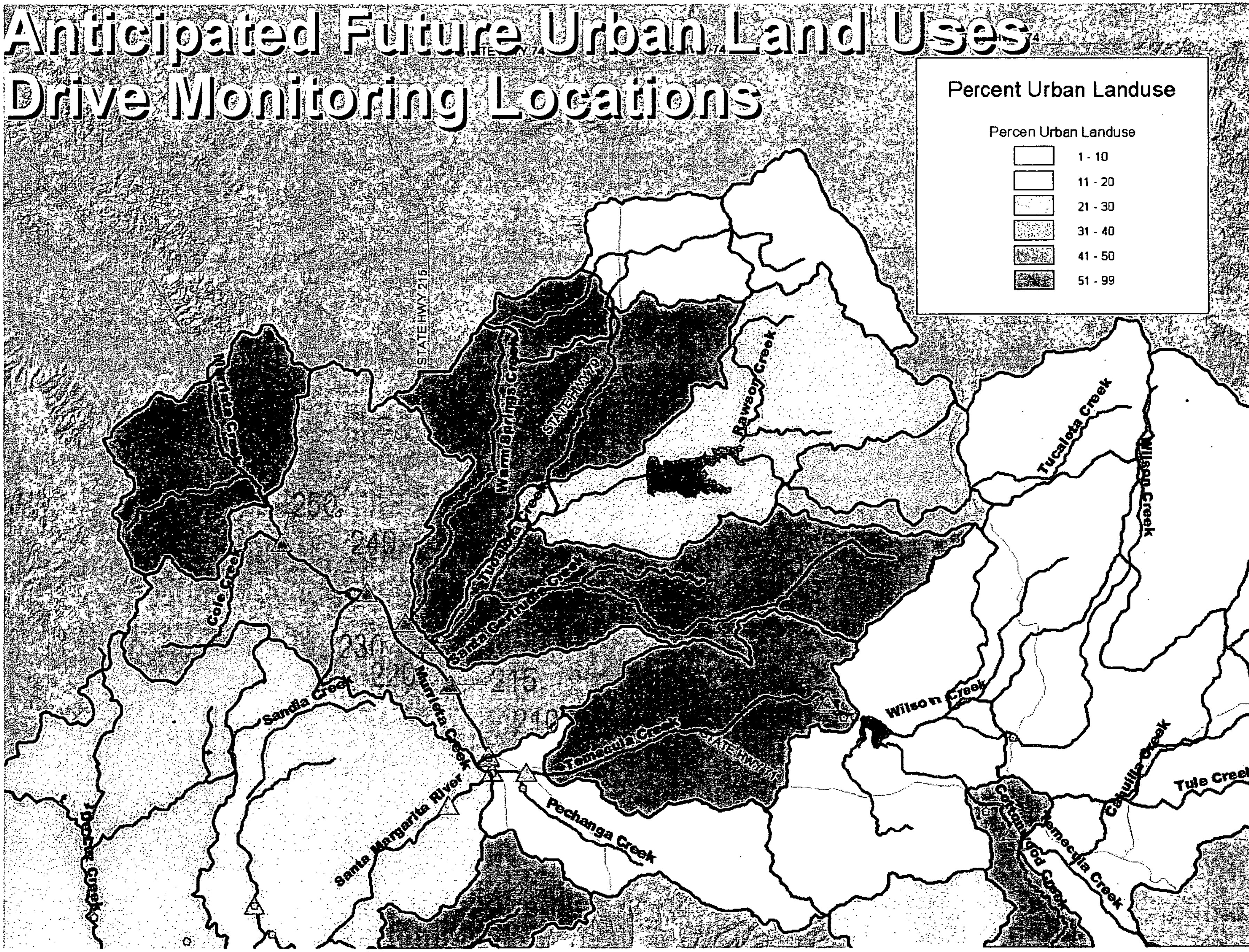
- Basemap highlighting
  - Current & proposed sampling locations
  - Drivers for change (e.g., 303d, hydrology,land use)
- Table of locations & parameters
- Narrative
- PowerPoint Presentation

Overlay Analysis of Data Used to Site Preliminary Sampling Locations

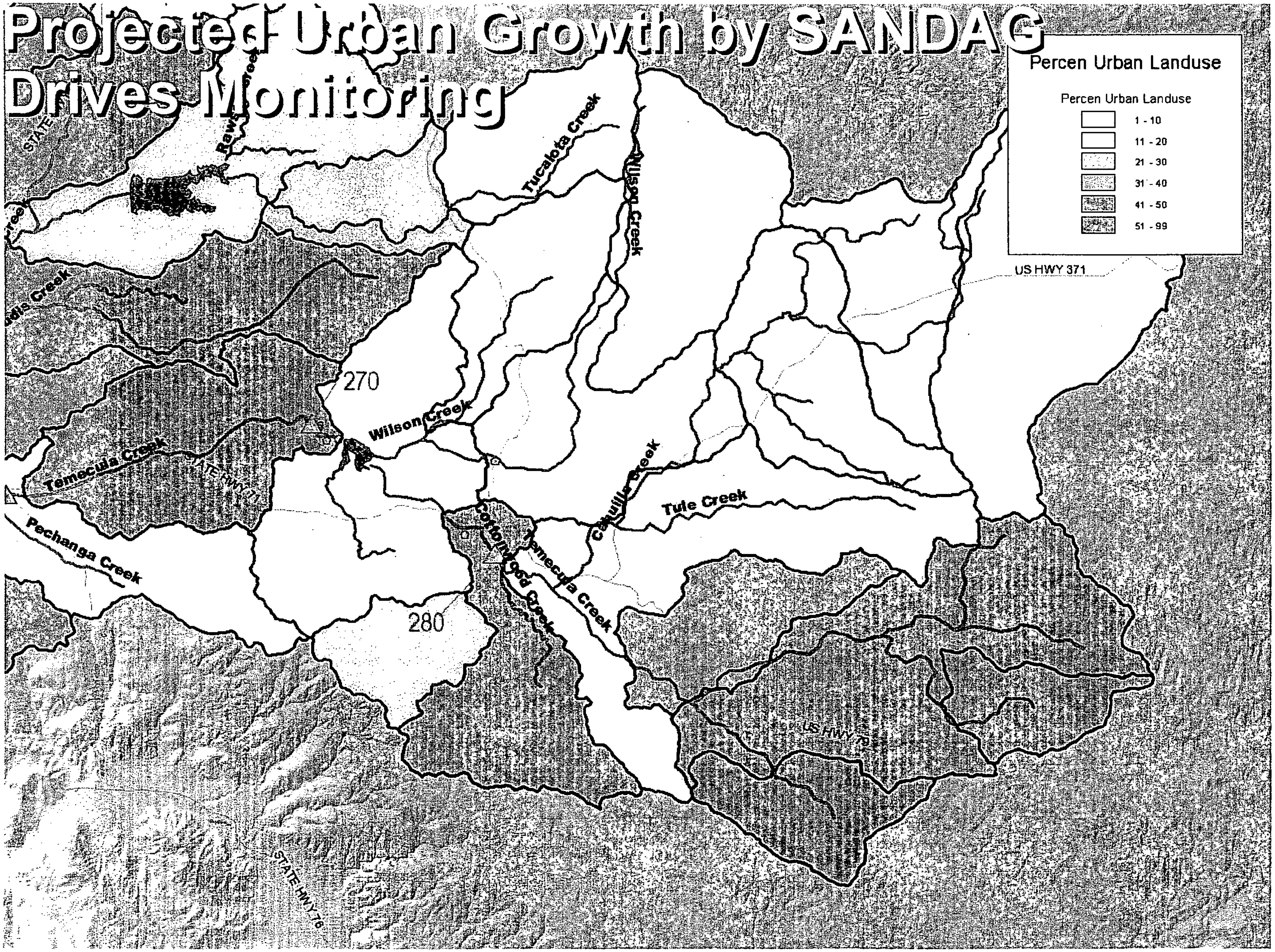


- Hydrologic units
- Stream gage locations
- Point discharges
- Current sampling locations
- T & E species locations
- 303d list
  - Hydro Unit
  - Pollutant/Stressor
- Land use
  - Current
  - Locations of change
- Agency boundaries

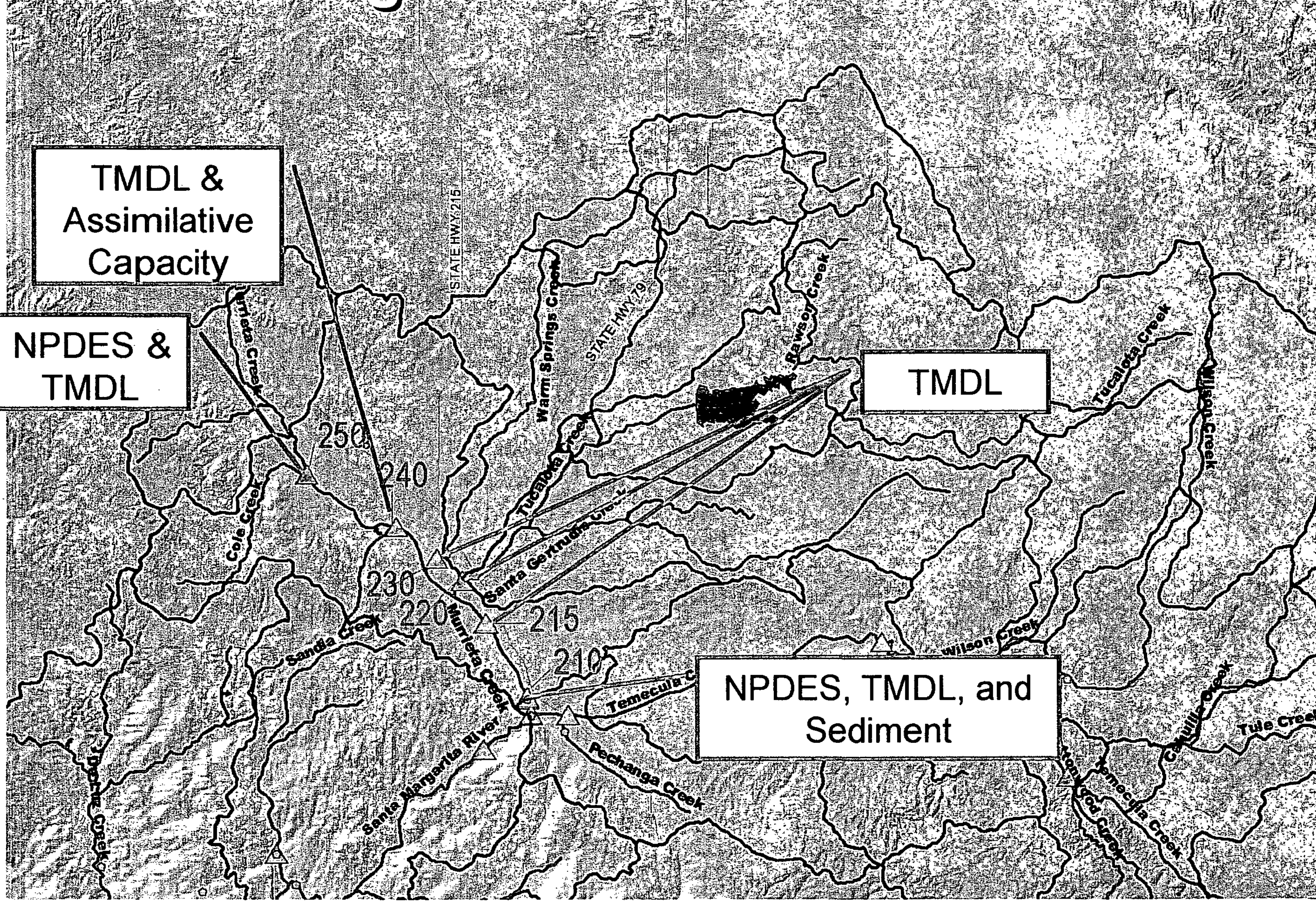
Anticipated Future Urban Land Uses Drive Monitoring Locations



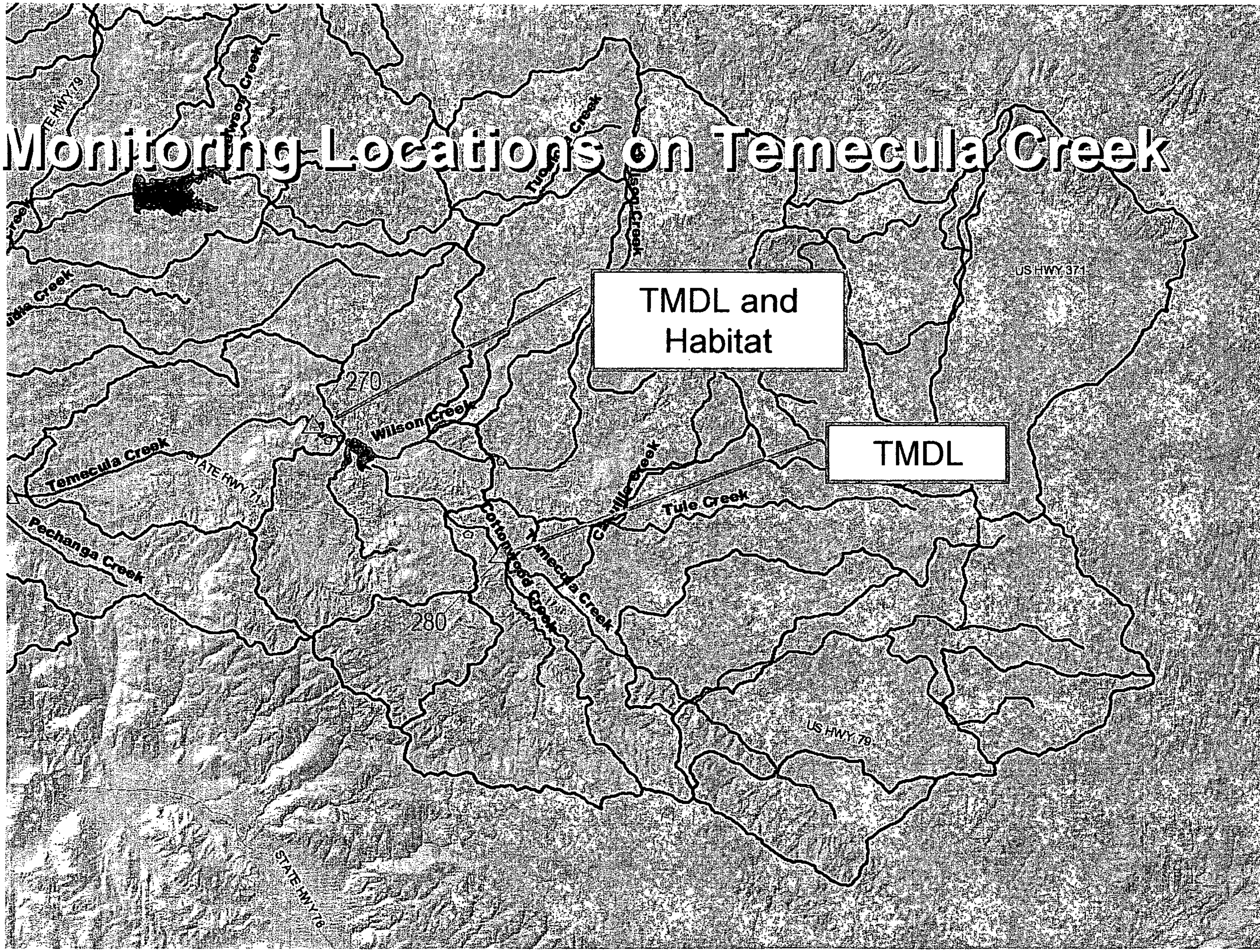
Projected Urban Growth by SANDAG Drives Monitoring



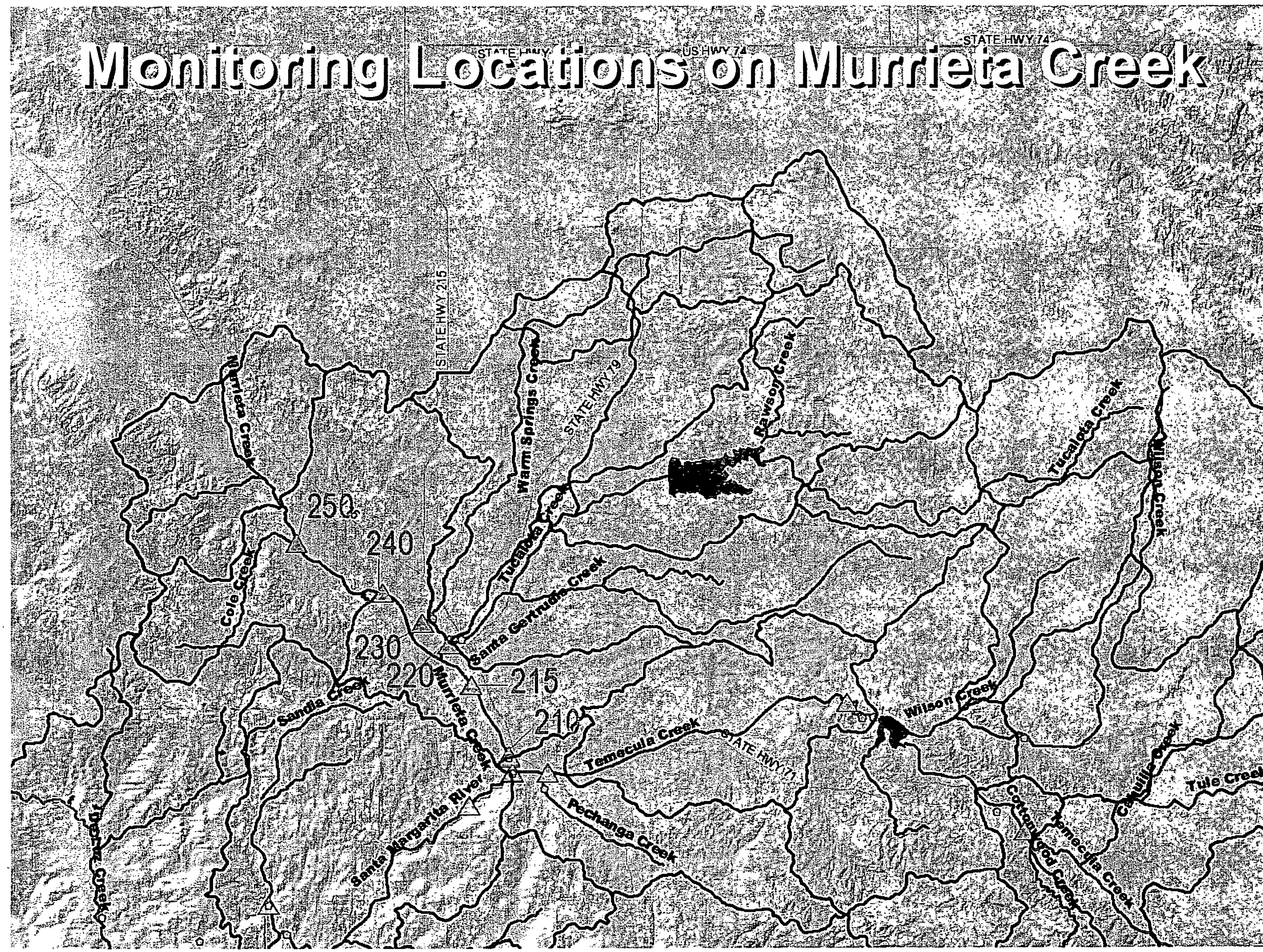
Monitoring Locations on Murrieta Creek



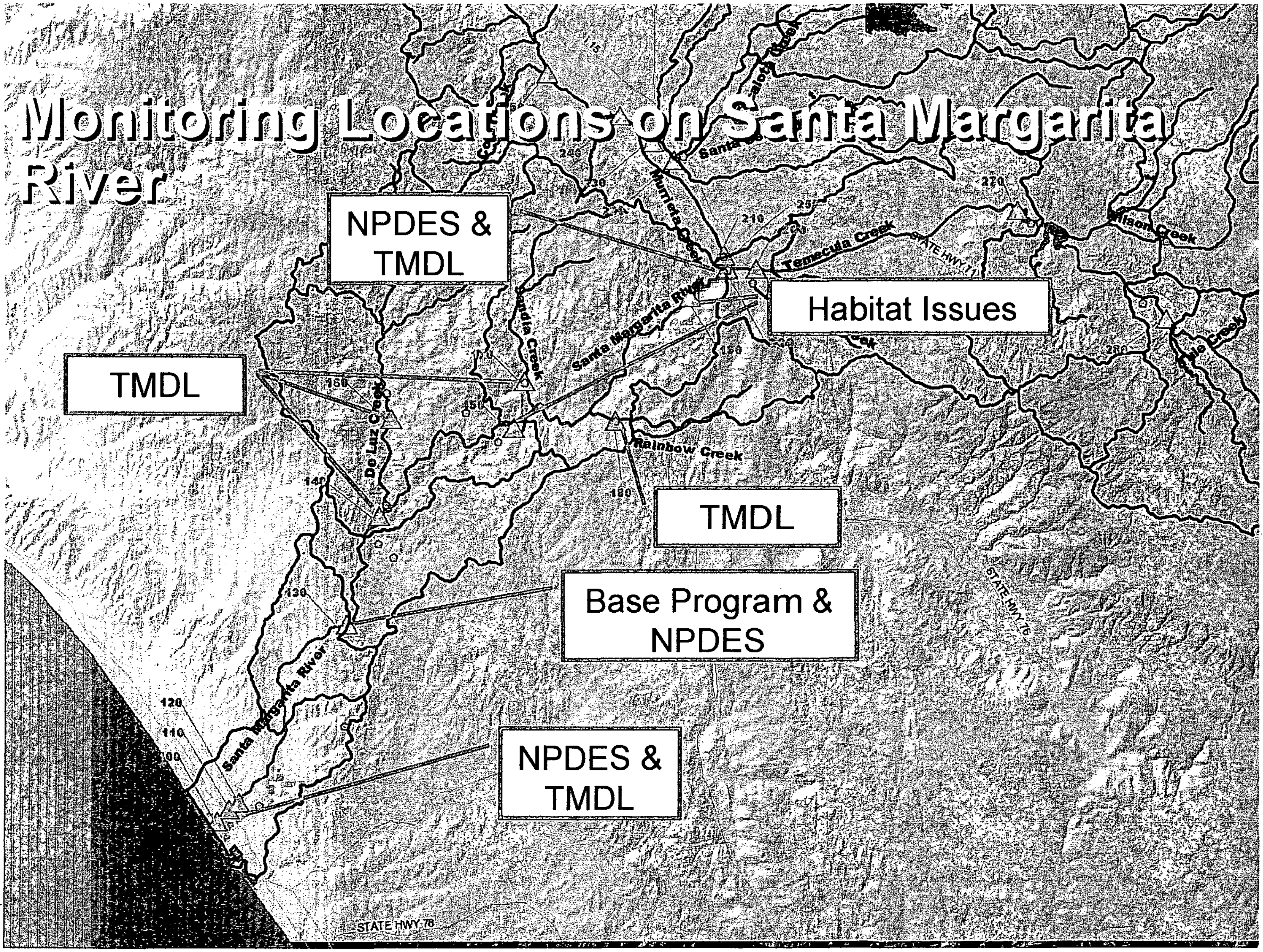
Monitoring Locations on Temecula Creek



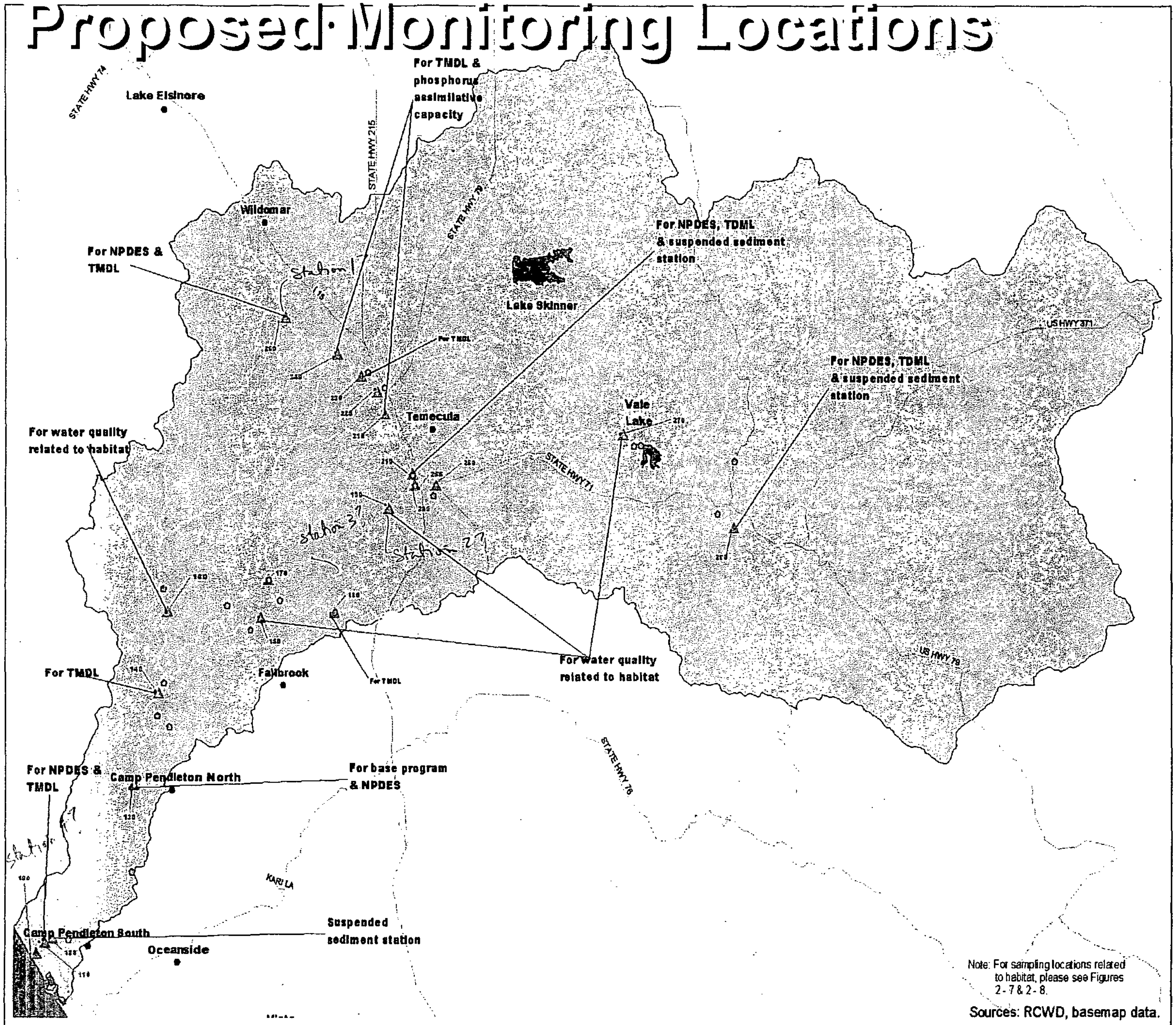
Monitoring Locations on Murrieta Creek



Monitoring Locations on Santa Margarita River



Monitoring Locations on Santa Margarita River



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02/02/01

Figure 3 - 4

Proposed Water Quality Sampling Locations

Legend

- USGS Flow Gage
- WQ Sample
- City
- Stream
- Highway
- Lake
- Santa Margarita Watershed

140 Sample Location ID (Table 3 - 4)

N

3 0 3 6 9 Miles

Scale

CDM

Camp Dresser & McKee Inc.

Future Activities to Address Challenges

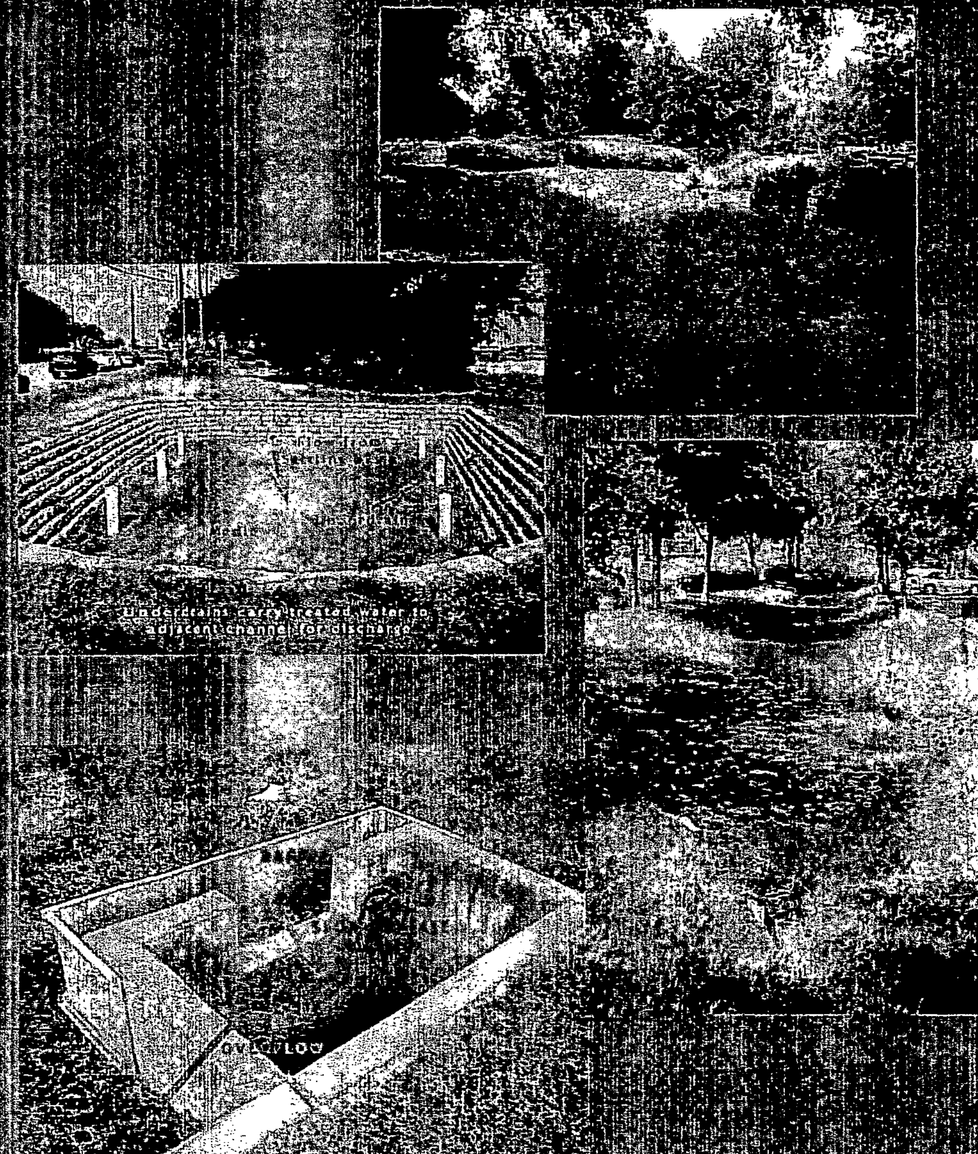
- Complete a Comprehensive Plan through partnership of USBR & SMR Group members
  - Support Congressional funding
  - Provide local contribution
- Future tasks are needed
  - Evaluate the data
  - Set stage for rationale TMDL process
  - Link water quality to water supply and management

A Comprehensive Monitoring Plan is the Next Step to Address the Challenges

- Create of database design for all water quality sampling;
- Prepare a standard GIS format for the SMR Watershed;
- Analyze water quality data;
- Develop a screening level model to identify key water quality areas;
- Develop a Stormwater BMP Pilot Program;
- Prepare standard Sampling and Analysis Plan
- Coordinate with SDRWQCB for approval

Pilot Testing BMPs

- Quantify water quality benefits,
- Assess technical feasibility,
- Estimate Costs, and
- Operation and maintenance requirements
- Opportunities and constraints relative to
  - siting,
  - design,
  - construction



Other Tasks to Address Goals Using Monitoring Program

- Support scientific development of TMDL;
- Estimate assimilative capacity of the SMR;
- Identify relationship between habitat health & water quality;
- Identify relationship between water supply rights & water quality;
- Address water recycling water quality issues;
- Identify beneficial use impairments;
- Support regulatory compliance using integrated data;
- Support implementing Phase II stormwater regulations
- Apply new data to existing sediment transport model

FINAL REPORT

SANTA MARGARITA RIVER
Hydrology, Hydraulics and Sedimentation Study

Prepared for
U.S. Army Corps of Engineers
Los Angeles District
Contract DACW09-97-D-0022
Delivery Order No. 0006

Prepared by
WEST Consultants, Inc.
11848 Bernardo Plaza Court
Suite 140B
San Diego, CA 92128

July 2000

WEST CONSULTANTS, INC.

FINAL REPORT

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Executive Summary

The purpose of the present study was to develop a set of working hydrologic, hydraulic and sediment transport analytical tools to address water resource and sedimentation problems/issues on the Santa Margarita River Watershed for the Marine Corps Base, Camp Pendleton (the Base). This report documents the background data review and model development performed for the study.

Chapter 1 of this report introduces the purpose and scope of the study while Chapter 2 presents background information on the Santa Margarita River Watershed. An annotated bibliography, presented in Appendix A, summarizes findings from some of the more important references encountered during the background information search and literature review.

Chapter 3 (Hydrology) presents the development of the hydrologic model for the basin as well as the frequency analyses. The hydrologic model results are compared with observed values for three different historic storms. Overall, the model provides good estimates. It is therefore believed that the hydrologic model will be useful as a tool for prediction of flows over a wide range of storm events. The peak flow-frequency analyses provide estimates of peak flow for different recurrence intervals at three different locations along the Santa Margarita River. Using this information with the volume-frequency analyses for these locations, balanced hydrographs are developed which preserve the peak flow and volume for different recurrence intervals at these locations.

Chapter 4 presents the development of the hydraulic model. The model is constructed using the peak flows generated in the hydrologic analyses and channel geometry data from several sources. Roughness (Manning's "n") values are estimated based on professional judgement, field visits and standard engineering references. There is concern regarding the accuracy of the survey data that forms the basis for the cross section geometry. These concerns include deficiencies found by other investigators in data from earlier surveys, lack of detail in cross section geometry, and use of five-foot to twenty-foot contour data. Consideration should be given to new surveys in the study reach. Floodplain inundation limits are developed for the 10-, 50-, and 100-year flows and are shown in Appendix E.

Chapter 5 presents the results of the sediment yield analysis. Using several different methods, average annual sediment yield is determined for the subbasins developed for the hydrologic model. A weighted averaging of the results from the different methods produces a unique yield for each subbasin. Based on the distribution of yields over the entire watershed, each subbasin is qualitatively classified as "High," "Normal," or "Low" in terms of sediment production. Although the methods use different input parameters for sediment yield estimates (land type, vegetation, etc.), we found that ground slope is a good general indicator of qualitative yield classification.

Chapter 6 presents a discussion of the sediment transport modeling efforts. A base conditions sediment transport model is produced based on the hydraulic model described in Chapter 4. Sediment inflows to the modeled area are calculated based on both the sediment yield analysis (Chapter 5) and equilibrium transport concepts. The latter estimates are used as input to a separate calibration model. Model parameters such as movable bed limits, time step, and inflowing sediment load are adjusted in the calibration model to qualitatively reproduce historic river response after channel dredging in 1993. The calibrated parameters are then used in the base conditions model. Balanced hydrographs developed in the hydrologic part of the study (Chapter 3) are used as model input. The model results provide estimates of aggradational (deposition) and degradational (erosion) areas and sand delivery to the estuary (downstream of the Interstate 5 bridge). Sensitivity of the model results to roughness values, sediment inflow amounts, and sediment transport function is also investigated. Recommendations are provided for future data collection to improve model results.

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1 Introduction

1.1 Purpose

The purpose of the present study is to develop a set of working hydrologic, hydraulic and sediment transport analytical tools to address water resource and sedimentation problems/issues on the Santa Margarita River watershed for the Marine Corps Base, Camp Pendleton (the Base). This report documents the background data review and model development performed for the study.

1.2 Authorization and Scope

This study was authorized by the U.S. Army Corps of Engineers, Los Angeles District (the District) under contract DACW09-97-D-0022, Delivery Order Number 0006 for the Office of Water Resources, (OWR), Marine Corps Base, Camp Pendleton. The scope of the study includes:

1. Review of prior hydrologic, hydraulic and sediment studies for the Santa Margarita River watershed and preparation of an annotated bibliography.
2. Compilation of historical data on rainfall, streamflow and sedimentation, aerial photos, topography, GIS/CADD data and other pertinent information.
3. Field reconnaissance of the study area to observe existing channel hydraulics, watershed runoff and sediment transport characteristics.
4. Development of a detailed hydrologic model of the entire watershed and calibration to measured storm events.
5. Determination of peak discharge frequency and volume frequency relationships for key locations.
6. Development of a hydraulic model for the lower basin and delineation of flood prone areas for different frequency events.
7. Estimation of average annual sediment yield for subareas of the entire watershed.
8. Construction of an uncalibrated sediment transport model of the lower river utilizing information from this and other studies.
9. Refinement and calibration of the sediment transport model.
10. Compilation of this report documenting the procedures, data used and results of the analyses.

1.3 Acknowledgements

Mr. Martin Teal was the WEST Consultants, Inc. (WEST) project manager for this study. Dr. David Williams, as principal-in-charge, provided overall guidance and quality assurance. Mr. Ejaz Mohammad performed hydrologic modeling and GIS services. Ms. Selena Forman provided hydrologic frequency and database development expertise. Messrs. Thomas Grace, Rodney Lubojasky and Krishna Poudyal furnished their technical services in the course of the study. Mr. Tim Landis of P&D Consultants gave his assistance in coordinating parts of the study.

Mr. Rand Allan of San Diego County Department of Public works, and Mr. Steve Clark of Riverside County Flood Control and Water Conservation District (RCFC&WCD) provided valuable assistance in collecting rainfall data for the hydrologic model calibration. Mr. Bob Cullen of RCFC&WCD assisted in obtaining background data and reports and provided his experience and knowledge of the upper basin.

Mr. Steve Cox of Winzler & Kelly, Dr. Robert MacArthur of Northwest Hydraulic Consultants and Dr. Jeffrey Haltiner of Phillip Williams and Associates provided previous reports, studies, GIS, and model information.

Dr. James Chieh, project manager for the U.S. Army Corps of Engineers, provided invaluable assistance in managing the contract and addressing technical comments, as did Mr. Joseph Evelyn and Mr. Rene Vermeeren.

Finally, personnel of the Office of Water Resources, MCB Camp Pendleton, gave generously of their time and resources, in particular Mr. Larry Carlson. Without his assistance the study would not have been possible.

2 Background

2.1 Basin Description

The Santa Margarita River basin lies in northern San Diego and western Riverside Counties, as shown in Figure 2-1, and encompasses approximately 740 square miles (mi^2). The cities of Temecula and Murrieta, and portions of Camp Pendleton and the City of Fallbrook lie within the basin. Also within the basin are portions of the Cleveland and San Bernardino National Forests and the Cahuilla and Pechanga Indian Reservations. Two major drainage basins compose the upper watershed: Temecula Creek (360 mi^2) and Murrieta Creek (220 mi^2). These join near the City of Temecula to form the Santa Margarita River, which flows in a southwesterly direction through Camp Pendleton to the Pacific Ocean near Oceanside, California.

2.1.1 Topography

Topography of the upper basin is generally mountainous along the northern, eastern and southern boundaries, with valley and mesa lands in the western portions, particularly in the Murrieta Creek drainage area. A shaded relief map of the basin is shown as Figure 2-2, which includes the numbered subbasins used for the hydrologic analysis described in Chapter 3. Elevations range from 960 feet (using the National Geodetic Vertical Datum or NGVD) at the confluence of Murrieta and Temecula Creeks to 6812 feet at Thomas Mountain and 6138 feet at Mount Palomar. Most of the valley and mesa lands in the upper basin lie between 1000 and 1500 feet.

The topography of the lower basin is mountainous in the eastern two-thirds of the drainage area, with valley and mesa lands in the lower one-third. Elevations range from sea level at the Pacific Ocean up to about 2500 feet. In the lower basin the Santa Margarita River flows in a narrow, precipitous gorge for about 18 miles from Temecula downstream to a point below its confluence with De Luz Creek, where it emerges onto the coastal plain.

2.1.2 Climate

The climate of the basin varies in relation to the topography with temperature and precipitation varying directly with elevation and distance from the coast. The mean annual temperature for the coastal area of the basin, as taken from records at Oceanside from 1953 to 1998, is 61 degrees Fahrenheit, with a mean monthly winter low of 45 degrees and a mean monthly summer high of 72 degrees. The average maximum temperature is 68 degrees while the average minimum temperature is 53 degrees. For the high elevation areas of the basin, as represented by records from the Palomar Mountain Observatory (1948-1998), the average maximum temperature is 66 degrees while the average minimum temperature is 45 degrees.

The mean annual rainfall for the entire basin is approximately 16 inches (California Rivers Assessment, 1999) although the average annual rainfall for gages within the basin ranges from 11 to 27.5 inches. Over 90% of the rainfall usually occur between the months of November and April. Using the Köpen system of climatic classification, the basin would be divided into "Steppe" areas in the lower basin and "Mediterranean hot summer" areas in the upper basin (Hornbeck, 1983). The steppe climate is characterized as a dry semi-arid environment with grassland and shrubs where evaporation exceeds precipitation on the average throughout the year. The Mediterranean hot summer classification is for areas with mild, mesothermal climates with hot, dry summers.

2.1.3 Soils

The soils of the watershed vary widely as reported by the Natural Resources Conservation Service (NRCS) soil surveys for San Diego and Riverside Counties. Coastal plains soils are typically well-drained sandy loams with a component of sandy clay which contributes to a relatively high fertility. Soils in this area are generally used for citrus, truck crops, avocados, and flowers (Steinitz, 1996). Foothills soils are very to moderately well-drained sandy loams to silt loams that have a coarse sandy loam to clay subsoil. Soils in this region are used for citrus avocados, and irrigated field crops. Mountain soils are excessively drained to well-drained loamy coarse sands to loams. In most areas, rock outcrops and large boulders are distributed widely. Soils in this area are generally unusable for crop production and are suitable only for range and wildlife habitat.

2.2 Literature Review

Previous reports and studies were reviewed and the major findings summarized. An annotated bibliography is presented as Appendix A.

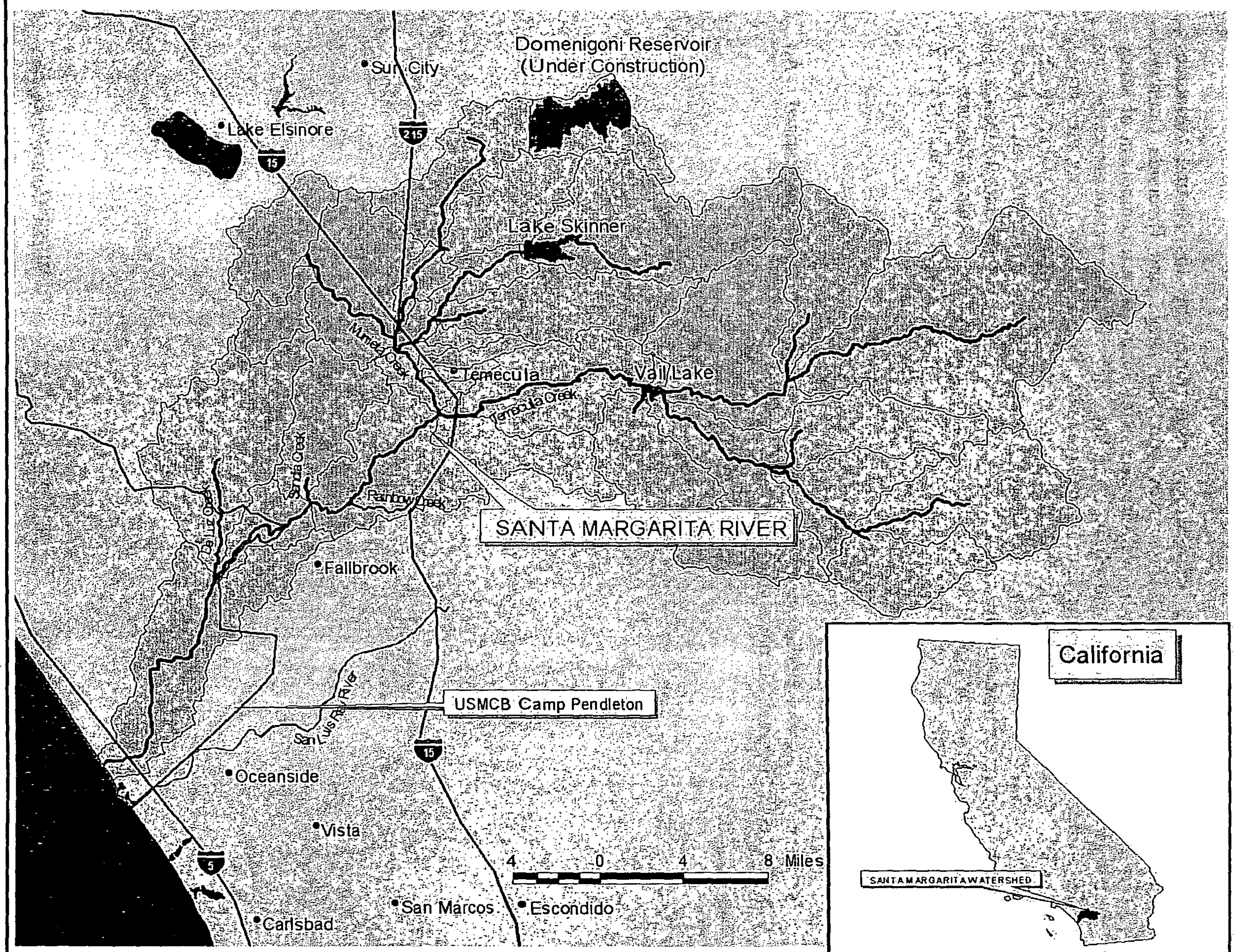

FIGURE 2-1.
Location Map for the
Santa Margarita Watershed

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Watershed Topography

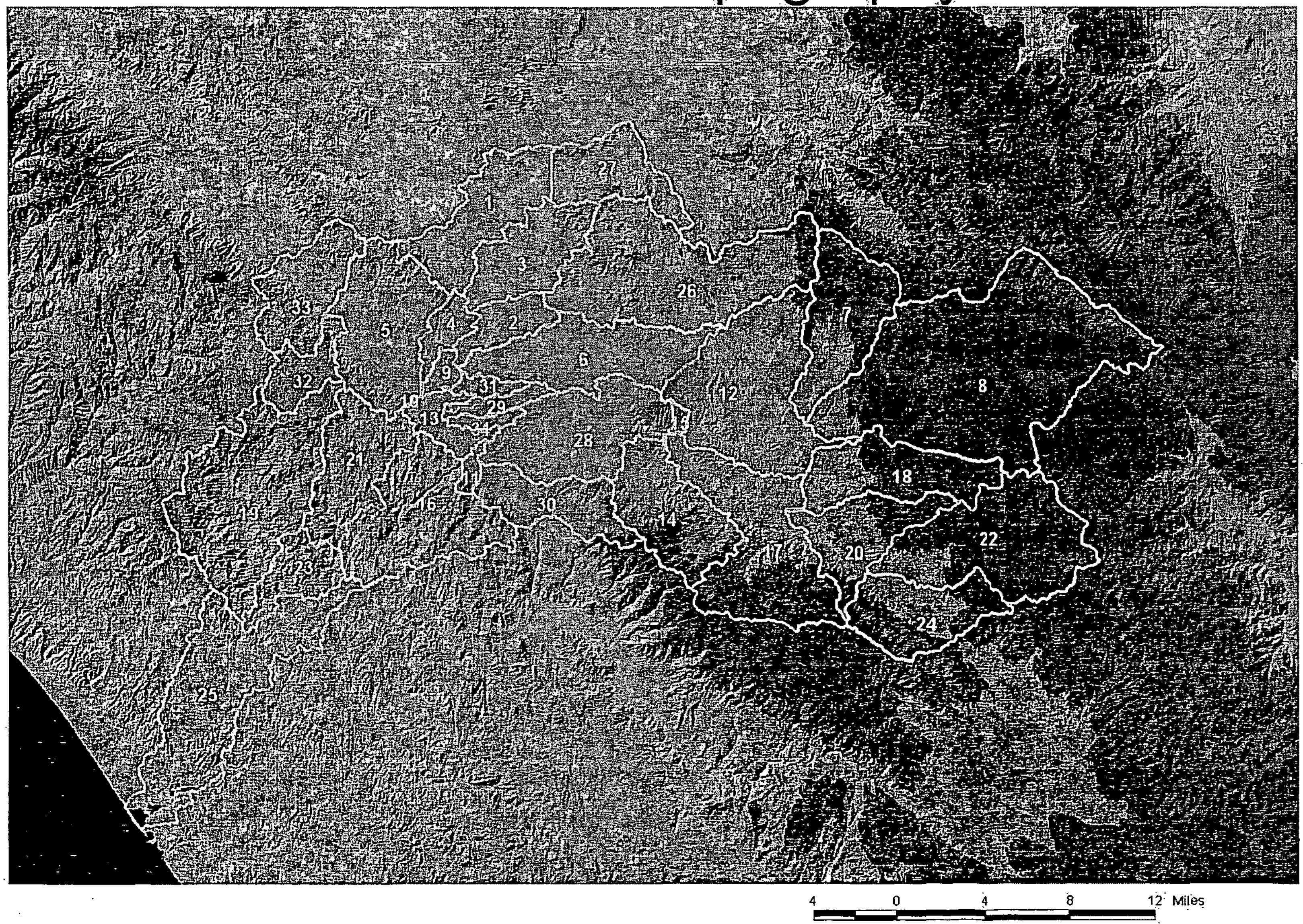

Figure 2-2
Watershed Topography

Elevation in Meters

	-2 - 0
	0 - 250
	250 - 500
	500 - 750
	750 - 1000
	1000 - 1250
	1250 - 1500
	1500 - 1750
	1750 - 2000
	2000 - 2250
	2250 - 2500
	No Data

N

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3 Hydrology

3.1 Introduction

3.1.1 Purpose

WEST performed hydrologic analyses of the Santa Margarita watershed with two main goals in mind:

1. Develop a working hydrologic model based on previous studies.
2. Determine frequency relationships (discharge and volume) for key locations.

An additional goal was to generate the background hydrology needed for input for the sediment transport modeling.

3.1.2 Previous Studies

Previous hydrologic studies include those by Leedshill-Herkenhoff, Inc. (1987), the U.S. Army Corps of Engineers (USACE, 1994), and Phillip Williams and Associates (PWA, 1998). These reports were reviewed and are summarized in the annotated bibliography.

3.1.3 Watershed Description

The Santa Margarita River Watershed covers approximately 740 sq. miles in the southwestern part of California (Figure 2-1). The elevation of the basin rises from sea level at the Pacific Ocean to 6,811 feet at the top of Thomas Mountain. Temecula and Murrieta Creeks, the main waterways in the upper watershed, combine near the city of Temecula to form the Santa Margarita River. The upper basin (part of the watershed upstream of the confluence) accounts for nearly eighty percent of the total watershed area. More detailed descriptions of the basin can be found in the studies cited above.

Of particular importance for hydrologic analyses are the three reservoirs located within the basin. Vail Dam, built in 1948, controls 320 square miles or 43% of the total watershed area. Skinner Lake, finished in 1974, controls 51 square miles or 7% of the total watershed. Domenigoni Reservoir, currently under construction, will control approximately 17 square miles or 2% of the watershed.

3.2 Hydrologic Model

Surface water hydrologic models, in the simplest of terms, take user-specified precipitation and compute in-stream flows at points of interest in a watershed. One of the aims of the present study was to construct a hydrologic model of the Santa Margarita watershed that would be able to predict streamflow at points of interest in the basin given a certain rainfall event (including spatial and temporal distribution). The hydrologic modeling software used for this study is the latest version of HEC-1 (Version 4.1, June 1998; USACE, 1990). Although we believe that HEC-HMS, the program intended to replace HEC-1, will be valuable tool for the ultimate working model, the current HEC-HMS program (Version 1.1, March 1999;USACE, 1998a) is not yet ready for practical applications. Currently, HEC-HMS cannot save user-input unit hydrograph values, making it unsuitable for the present study. This problem is supposed to be fixed in Version 2.0 (expected release in summer 1999).

The different components needed for the hydrologic model are:

- Precipitation – this determines both the total volume of water that falls on the basin and the distribution of the rainfall amount in time.
- Loss Rate – this determines how much of the precipitation is intercepted (for example, going to groundwater, ponding in local depressions, intercepted by vegetation). The precipitation amount not lost is free to flow to streams and is called runoff.
- Runoff Transform – this determines how the runoff over a basin for a given period of time will be transformed into a flow hydrograph at the basin outlet.

Channel Routing – this determines how a flow hydrograph at one point in a watershed will be transformed as it moves downstream to another point of interest in the basin.

The loss rate, runoff transform and channel routing components, described in the following sections, were based on data from previous studies. Observed storm precipitation amounts from three rainfall events (1993, 1995, and 1998) were used to test the overall accuracy of the preliminary model. Computed hydrographs from HEC-1 were compared to observed (measured) hydrographs at various locations to judge the accuracy of the model. Some model parameters were subsequently modified, when reasonable, to improve the accuracy of the results.

As a starting point, WEST used the HEC-1 models produced by Phillip Williams and Associates (PWA) from their recent study performed for the Riverside County Flood Control and Water Conservation District (RCFC&WCD) and the California State Coastal Conservancy (PWA, 1998). A brief summary of that report is given in the annotated bibliography. The PWA models build upon the one produced previously by the Corps of Engineers (1994) and incorporate extensive use of Geographic Information System (GIS) data for loss rate estimation. The PWA model chosen for the present study was that developed for existing land-use. WEST made subsequent modifications to the model as described in the following sections. A schematic of the WEST model structure showing subbasins, nodes, and routing reaches is presented in Figure 3-1(A). The location of the HEC-1 nodes and routing reaches in the watershed are shown in Figure 3-1(B).

3.2.1 Loss Rate Method

A number of loss rate methods are available to determine how much of the rainfall is transformed to runoff. The PWA HEC-1 models use the SCS Loss Rate method. PWA computed the loss rate parameters for this method using GIS land use/land cover and soils coverage maps. WEST used identical loss rate parameters in our first set of models for the verification events (described in section 3.3). The SCS loss rate method represents the basin loss rate in terms of Curve Number (CN). The CN is obtained from tables (SCS, 1986) that relate the CN to combinations of hydrologic soil group and land use. PWA used GIS themes to represent the watershed hydrologic soil group and land use on a 30-meter by 30-meter grid scale. Next, PWA computed the CN for each grid node using the SCS lookup-table. Finally, PWA computed the average CN for each subbasin. This was used as the representative CN for the subbasin for HEC-1 modeling.

The second set of WEST models used the equivalent Initial and Uniform Loss Rate developed by RCFC&WCD. Because RCFC&WCD used this method in their review of PWA's models, we decided to include this method in our verification analysis to see if better results might be obtained. The equivalent parameters used for this method were obtained from the PWA memorandum to RCFC&WCD (dated September 22, 1998). The equivalent parameters were computed on subbasin scale, transforming CN to equivalent Initial and Uniform loss parameters.

The Initial and Uniform Loss rate method models rainfall losses using two parameters called Initial Loss (STRTL, unit of depth) and Constant Loss Rate (CNSTL, unit of depth/hour). With this method, all rainfall is lost until the volume of initial loss is satisfied. After the initial loss is satisfied, rainfall is lost at the constant rate, CNSTL. On the other hand, the SCS loss rate method determines the runoff in terms of CN and accumulated precipitation (ACRAN) at any time. For a relatively small ACRAN (as in the early part of storm for this study), this method is identical to the Initial and Uniform Loss Rate method, where all rainfall is lost when ACRAN is less than the Initial Abstraction (IA), defined as a function of CN. After the accumulated rainfall exceeds IA, loss rates decrease exponentially to a relatively constant value. For a relatively large ACRAN (as in the middle part of the storm for this study), the loss rates decrease to a very small value (i.e., all rainfall is converted to runoff). Comparing the SCS loss rate method with Initial and Uniform Loss rate method, relatively more loss takes place early in the storm but less loss takes place in latter part of the storm. This may result in the SCS method hydrograph producing smaller flows than those obtained by the Initial and Uniform method during the rising limb of the hydrograph (initial part of a storm event). Similarly, this may result in SCS method hydrographs having larger flows than those obtained by Initial and Uniform method during the falling limb of the hydrograph (latter part of a storm event).

The SCS TR-55 manual (SCS, 1986) states that the SCS loss rate method was developed for simulating design storms and that the model accuracy decreases when reconstituting historical events. This limitation of the method should be considered while performing model calibration.

3.2.2 Runoff Transform

Once the loss calculations are performed, the remaining precipitation (called "excess precipitation" or runoff) is transformed into a series of flow over time at the outlet of each subbasin. For the present study, WEST adopted the methodology from the PWA analysis where synthetic unit hydrographs were employed. With this method, a unit input of excess precipitation is transformed to a hydrograph (series of flow over time) at the subbasin outlet.

The LAPRE-1 software package (USACE, 1989) was used to estimate unit hydrographs for each subbasin. The software includes unit hydrograph data (in the form of S-curves) derived from the measured response of various southern California and Arizona watersheds. The unit hydrographs are based on geographic location and topography. PWA chose three of these unit hydrographs for the Santa Margarita basin ("valley", "foothill", and "mountain"). Unit hydrographs were assigned to subbasins based on the average of GIS cell slopes within each subbasin. Subbasins with average slopes of 0-5% were assigned "valley" S-graphs, from 5-10% "foothill", and 10% and above "mountain."

One additional parameter needed to develop explicit unit hydrographs from the S-curves is the lag time for each subbasin. This represents an estimate of the response time between the occurrence of a rainfall event and the streamflow at the subbasin outlet. PWA computed lag time based on current guidelines from Riverside County (RCFC&WCD, 1978). Basin model parameters are given in Table 3-1.

3.2.3 Channel Routing Method

The Muskingum-Cunge (M-C) channel routing method is used in the PWA model. This method works well for very wide range of conditions. The advantage of this method over all other routing methods is that, 1) the parameters of this method are physically based thus reducing the calibration effort for routing parameters, and 2) several studies have shown that the method results compare very well with these using the full unsteady flow equations. The method is independent of the user specified computational time step. Instead the routed hydrograph is computed at a suitable internal time step and then the results interpolated to the user specified time step. This method should not be used if there is appreciable backwater effect in the routing reaches. For the Santa Margarita watershed the upper reaches of the watershed are steep and appreciable backwater effects are not expected. For the lower reaches the backwater produced by the bridges and weir is not significant in light of the routing reach lengths and associated floodplain storage. All channel slopes are greater than 9 ft/mile, considered steeper than "mild channel" slopes. All these conditions make M-C routing method suitable for this study.

The WEST models initially used the M-C method for all routing reaches. However, we found that for some of the routing reaches the routed peak flow values were larger than the inflow peak flow values. The HEC-1 User's Manual (September 1990) states that if the peak flow computed from the internal computation interval is markedly greater than the hydrograph interpolated back to the user-specified computational interval, the user specified computation interval should be reduced and the model should be executed again. WEST found that reducing the computational time interval from 30 minutes to 15 minutes did not reduce the interpolated peak flow values appreciably. The total number of computational time steps used in M-C channel routing also limited the HEC-1 model time step. Therefore, we changed the routing method to normal depth channel routing for two reaches (15 and 17) where routed peaks were markedly bigger than the inflow to the routing reach. We verified the suitability of normal depth routing in these reaches based on hydrograph rise time, channel slope and channel shape/size. We computed the number of routing steps (NSTPS) for normal depth routing in these reaches using normal depth flow velocity. We found that reach 15 is a small (845 feet long) and relatively narrow (50 feet wide) routing reach resulting in a NSTPS value much smaller than 1. This indicates a very small routing effect through reach 15. We therefore decided to remove this routing reach (reach 15) from the model anticipating very small or no change in model results.

To provide hydrograph information at locations important to the Marine Corps Base, Camp Pendleton, the following changes were made to the routing reaches from the PWA model. The routing reach for the Santa Margarita River between the De Luz Creek confluence and the Pacific Ocean was divided into two routing reaches by adding an additional node at the Basilone Road crossing. Although hydrograph information at the O'Neill Lake Diversion and Stewart Mesa Road crossing is also important to Camp Pendleton staff, nodes were not added at these locations because of their proximity to the De Luz Creek confluence and the mouth of the Santa Margarita River, respectively. In other words, hydrographs at the desired locations will essentially be the same as those at existing nodes.

3.3 Verification Events

Flow data were obtained from the USGS (described below) and plotted in order to identify significant rainfall-runoff events for verifying the hydrologic model results. Three events (January 1993, January 1995, and February 1998) were selected based on data availability for precipitation and flows. The WEST models were then used for these storm events to verify adequate model performance. Streamflow hydrographs computed with HEC-1 for both loss methods described above were compared with observed hydrographs at key gage locations in the watershed. As previously mentioned, both loss methods were used to see if one would yield superior results compared to the other.

3.3.1 Recorded Data

Both recorded precipitation data (for input to the models) and flow data (for verification of the resulting hydrographs) were obtained as described below.

3.3.1.1 Flow Data

All recorded mean daily flow and yearly peak flow data for this watershed were downloaded from the U.S. Geological Survey (USGS) web site (USGS, 1999) or obtained directly from the USGS office in Sacramento, California. The data were converted to HEC-DSS file format (USACE, 1995a). The data are summarized in Table 3-2. Figure 3-2 shows the location of these gages in the watershed. Table 3-3 summarizes contributing area to each USGS gage. Thirty-minute recorded flow data were obtained from the USGS by special request for the gages shown in Table 3-4. The thirty-minute interval data are instantaneous flows while 1-day interval data are mean daily flows. Annual instantaneous peak flow and peak time data were used in the comparisons between computed and measured results where thirty-minute interval instantaneous flow data were missing.

3.3.1.2 Precipitation Data

The majority of the precipitation gage data were obtained from Riverside County (16 gages) and San Diego County (7 gages). Information for three other gages (Las Flores and Target Range for the 1995 and 1998 events and Case Springs for the 1998 event) were obtained from the California Data Exchange Center (CDEC) web site (CDEC, 1999). Also, 1993 event precipitation data for the Las Flores gage were obtained from the California Department of Forestry by special request. Records from the San Diego State University field station gage at the Santa Margarita River Ecological Reserve near Temecula were obtained by special request for the 1993 and 1995 events. Records for the San Diego County gage at Oceanside were missing for the 1993 event. These were replaced with National Weather Service gage data at the same location, which were also provided to us by San Diego County. All data sets were converted to HEC-DSS database file format using DSSTS computer program (USACE, 1995a). Table 3-5 summarizes the precipitation data obtained. Figure 3-2 shows location of these gages in the watershed.

3.3.2 Model Precipitation

The HEC-1 model needs total precipitation for each subbasin and a temporal pattern to distribute the precipitation over the storm duration. To compute the total precipitation for each subbasin, we used the following procedure. First, total precipitation at each gage was computed for the event time span. Table 3-6 shows the total precipitation at each gage for the three selected events. Second, precipitation values were interpolated from the gage values for nodes on a 100-foot square grid draped over the basin. Third, the interpolated grid data were averaged over each subbasin to compute the precipitation for the particular event. Figure 3-3 through 3-5 show the measured gage precipitation and estimated precipitation contours over the watershed for the three storm events. To compute the temporal distribution of the precipitation over the storm period for a subbasin, a temporal gage was selected for each subbasin. The temporal gage was chosen based on proximity to the centroid of the subbasin and had a data collection frequency of 1 hour or smaller. The pattern of precipitation with time of the temporal gage was used to distribute the computed subbasin precipitation for the storm period. Table 3-7 summarizes the mean precipitation over each subbasin for each event and the selected temporal gage to represent the time distribution of the storm.

3.3.3 Subbasin SCS Loss Parameter Estimation

The subbasin SCS loss parameters were estimated by PWA for Antecedent Moisture Conditions (AMC) II (average conditions) and adopted by WEST. However we performed a model sensitivity analysis for the SCS loss parameter which is discussed later in the Sensitivity Analysis section.

3.3.4 Reservoir Data

The storage level of reservoirs at the beginning of a simulation can have a major impact on resulting hydrographs in the watershed below. Initial conditions for the verification events were obtained from published data. Starting storage values for Vail Lake were obtained from daily records for USGS gage 11042510, "Vail Lake near Temecula, CA." Skinner Reservoir daily storage data recorded by the Metropolitan Water District were obtained from the Santa Margarita Watershed Watermaster. For each event, the storage from the night prior to the simulation start date was used as the starting storage in the model (see Table 3-6 for model simulation dates). The storage-discharge curves for both reservoirs are the same as were used in the PWA (1998) models. Although the PWA report states that they used the same curves as employed by the Corps (USACE, 1994), we found that the storage-discharge relation for Lake Skinner differed from that in the Corps model made available to us (model SM_WR_FU.LA1 for future conditions, dated Feb. 1994). However, the PWA curves do match those published in the Corps report (USACE, 1994). Therefore, the PWA relations were used in the WEST models.

In a personal communication, Mr. James Jenks (Watermaster, Santa Margarita River Watershed) said that Vail Lake impounds all inflows until water rises above the spillway crest. The outflow from this reservoir is uncontrolled. Mr. Jenks added that the spillway has only been in service twice in the dam's history – in 1980 and in late February 1993. Therefore, during all three verification events the water surface level in the reservoir remained below spillway crest elevation, indicating very little or no outflow from the reservoir.

Lake Skinner is a water supply reservoir. This lake impounds inflows from Tucalota Creek and the reservoir operator controls releases from the reservoir. The operator maintains a daily record of water inflow and outflow volume. We transformed the recorded average daily outflow volume from the reservoir to average daily outflow discharge for the three storm events for comparison purposes (the comparison is discussed in the Results section). We found that for the January 1993 event, the computed flow was much higher than the observed values. Because outflow from this reservoir is manually controlled (as long as the water level remains below the spillway crest), the fixed operation reservoir routing algorithm in the HEC-1 model will not apply at all times. Therefore, we changed the reservoir storage-discharge (HEC-1 SV/SQ cards) relationship such that the modeled outflow matched recorded flows for the 1993 storm event. This change was made only to the 1993 flood-event model as the outflows were satisfactory for the other events. In future modeling efforts, the reservoir storage-discharge relationship may need to be modified to reflect the actual controlled releases. Table 3-8 shows the changes made to the storage-discharge relationship for Vail Lake for the January 1993 storm event model.

Domenigoni Reservoir is not constructed yet. Therefore, the current HEC-1 model does not model this reservoir.

3.3.5 Results

Hydrograph plots in Appendix B show those computed using the original SCS loss method (dashed line labeled CALC), the Initial and Uniform loss method (dotted line labeled CALC RCFCD) and the USGS recorded values (solid line labeled OBS for observed). Flow values for periods of missing data are plotted with bold X's and interpolated between the observed values bracketing the missing period.

The 30-minute observed flow data from the USGS were used for model verification purposes. Wherever 30-minute frequency data was missing, the estimated annual peak flow obtained from the USGS was used in the comparison.

Peak flow, time to peak and hydrograph volume (in depth units over the subbasin) results are presented in Table 3-9 for the models using the SCS loss rate method. The results obtained by the Initial and Uniform Loss method are not presented here for two reasons. First, the SCS loss parameters are computed from more detailed land use and hydrologic soil group watershed information while the Initial and Uniform Loss Rate parameters are derived from subbasin scale lumped SCS loss parameters. Second, results obtained by the SCS loss rate method are, in general, better than that obtained by Initial and Uniform Loss Rate method.

Appendix C shows the plots of computed and observed storage in the two reservoirs (Skinner and Vail) for the three modeled events. It should be noted that the reservoir storage levels are affected by the inflow from sources other than the upstream subbasin runoff. These two reservoirs are intended for water supply purposes. The storage can fluctuate due to water supply outflow or inflow.

The following observations are made regarding the results. For the purpose of presenting the summary, the following four flow gages are classified as "Major" point-of-interest gages: Murrieta Creek at Temecula, Santa Margarita River near Temecula, Santa Margarita River at FPUD Sump, and Santa Margarita River at Ysidora. The following five gages are classified as "Minor" point-of-interest gages: Warm Springs Creek near Murrieta, Santa Gertrudis Creek near Temecula, Pechanga Creek near Temecula, Sandia Creek near Fallbrook, and De Luz Creek near De Luz.

1. The model flood peak times are between –1 and +3 hours of observed flood peak times at major point-of-interest gages, and between –7 and +2.5 hours at minor point-of-interest gages. Computed hydrograph peak times are within 3 hours of observed hydrograph peak times for all gages with the exception of Warm Springs Creek near Murrieta for the 1993 storm event and Pechanga Creek Near Temecula for the 1998 event. Therefore, hydrograph peak timing can be considered acceptable.
2. The error in flood hydrograph volume with respect to observed hydrograph volume is between –36 and +145 percent with the majority of the error for observed gages (10 of 18) between –36 and +34 percent. The error is more than 100 percent for three gages out of 18. Therefore, errors in hydrograph volume estimates, in majority of the cases, may be considered acceptable.
3. The error in computed flood hydrograph peak values with respect to observed hydrograph peak values is between –44 and +48 percent for large number of gages (21 of 26), with maximum absolute error for all gages equal to 85 percent. Therefore, we can conclude that the error in peak flow estimation is reasonable for most of the gages.
4. Computed hydrograph shapes matched observed hydrograph shapes in most cases.
5. The model generated very good results for the 1993 event at major point-of-interest gages. All computed peak flow values for the major point-of-interest gages are between –12 and +5 percent of recorded (or estimated) peak flow values.
6. In general, the model-generated peak flows for the 1995 event are good for the major point-of-interest gages. Errors in water volume under the hydrograph vary between –19 and +145 percent, with most of the errors being positive (i.e., computed greater than observed). This indicates the need to estimate the loss parameters (CN) based on antecedent moisture conditions.

7. In general, the model generated peak flows and volumes for the 1998 event that are too low. This may indicate the need to modify the loss parameters based on rainfall over the watershed before the storm event.
8. The storage results for Vail & Skinner Reservoirs were fair for the 1993 event, poor for the 1995 event, and good for the 1998 event. The water supply inflow and outflow do, however, have an affect on reservoir volume.
9. The HEC-1 model computed the outflow from Vail Lake around 1 cfs. This agreed with the observation that the reservoir did not spill during any of the three storm events.
10. Computed peak flows from Lake Skinner are 1 cfs which agree with comparably small recorded maximum daily-average outflow rates of 9 cfs, 6 cfs, and 9 cfs for the January 1993, January 1995 and February 1998 storm events, respectively.

From the previous observations, we conclude that the model produces reasonably good results, keeping in mind the limitation that SCS method is not designed for recreating historical events. It is not apparent that further calibration of model channel routing parameters would provide better results at gage locations sensitive to routing. One possible improvement to the verification analysis would be estimation of rainfall at subbasin level at each time step, rather than distributing the total storm rainfall using one temporal gage per subbasin. Another possible improvement would be to estimate the SCS loss parameter Curve Number for each subbasin before the storm event based on the past spatial distribution of precipitation over the watershed and soil properties such as permeability and retention capacity.

In comparing the computed versus observed storage results, it should be noted that the storage-outflow curves for Skinner Lake probably do not match actual reservoir releases during the verification events (this fact was verified by spot-checking Lake Skinner records for the selected events). This is because outflow from the Skinner Lake is manually controlled, as compared to a fixed storage-outflow relationship in the model.

Overall, the existing WEST model using the SCS loss method is satisfactory for general watershed modeling purposes. Rather than calibrating tightly to one particular event, the model provides fair results over three different storms. The good agreement between computed and observed results for the 1993 event, the largest storm on record for most of the basin, is encouraging.

3.3.6 Comparison with PWA Model & Results

PWA (1998) made adjustments to their preliminary model to produce a "calibrated" model for the 1995 event – it is this calibrated model that formed the basis for WEST's model.. The major differences in the models are routing method (Muskingum-Cunge versus normal depth for reach 17 and removal of routing reach 15), basin rainfall estimation, Vail Lake rating curve, and simulation period. The routing methods have been discussed in a preceding section. PWA used an inverse distance weighting interpolation technique for hourly precipitation data at point gages while WEST used the 12-point-spline method with tension weight of 1.0 for total event precipitation. PWA used a simulation period of January 10 through January 11, ending at 1300 hours while WEST used the same days except ending at 1000 hours. There were some differences in total gage precipitation at various gages, which we attribute to changes in data sources. Although not in possession of PWA model output, using the PWA report Figures 3.24 through 3.30, we estimate that PWA computed peaks varied by –50% to +30% when compared to observed values. This compares with –40% to +60% for the WEST results with the SCS loss method.

3.3.7 Sensitivity Analysis

The potential calibration parameters for this model are 1) loss parameters, and 2) the channel routing parameters. The channel routing is based on the Muskingum-Cunge method. This method is physically based and has been verified to work well. The model parameters for this method are channel shape, size, length and Manning's n. All these parameters, except Manning's n, can be estimated objectively by field observations. PWA performed a calibration of Manning's n values. WEST assumed these parameters as calibrated by PWA. Therefore, a sensitivity analysis for channel routing parameters was not performed.

The rainfall loss parameters are function of soil antecedent moisture condition and other soil properties such as permeability and retention capacity. The antecedent moisture condition is largely affected by past rainfall. However, there is no existing method in the literature to relate the soil moisture content and other soil properties to the SCS loss parameter(s). Therefore, it is necessary to calibrate the loss parameter for a particular event. A sensitivity analysis of the model results with respect to SCS curve number was performed. The January 1995 event was chosen for analysis. SCS parameters for AMC III conditions (wet conditions) and AMC I conditions (dry conditions) were estimated on a subbasin scale using the adjustment relationship provided by the RCFC&WCD (1978; Plate D-5.7, 1 of 12). The loss parameters for AMC II and AMC III conditions are listed in Table 3-10. Two additional HEC-1 runs were made with SCS curve numbers corresponding to AMC III and AMC I. Table 3-11 shows the analysis results. The analysis shows that the model results are very sensitive to SCS curve number.

The sensitivity analysis shows that for the January 1995 storm event, AMC II and AMC I result bracket the observed hydrograph peak flows and volume. Appendix C shows plots of precipitation starting one week before the storm event. The storm event that caused the largest flood peak occurred in January 10 and 11. The plots show that the precipitation magnitude and intensity for the January 4 and 5 event was larger than that for January 10 and 11 event. However, observed flood hydrographs show that the flood peak magnitudes were larger for the January 10 and 11 storm. This was because the first storm (January 4 and 5) helped saturate the soil, thus making it possible to generate more runoff with smaller storm event of January 10 and 11. Thus SCS loss parameter (Curve Number) for the January 10-11 storm event can be represented by a condition somewhere in between AMC II and I. The ground saturation by the first storm was just enough to make it less wet than AMC II and more wet than the AMC I condition. Also, the deviation of curve numbers from the AMC II condition is based on spatial distribution of rainfall and soil characteristics.

As discussed previously, the SCS loss method is not well suited for reconstituting historical events. The method is intended for design storms. Actual calibration of the loss parameters for any single event was not performed in this study since results would be valid for that particular storm only. Instead, looking at results for the three storms, the existing curve numbers provide fair results for all three. Sensitivity analysis was performed to show that the model results do bracket the observed hydrographs between two AMC conditions.

3.4 Frequency Analysis

3.4.1 Flow Frequency Analysis

The USGS annual peak flow data were used to perform flow-frequency analyses for three gaging stations on the Santa Margarita River. Because over fifty percent of the basin is regulated by Vail Dam, only recorded peak values after closure of the dam (1949) were considered in the analyses. Although Skinner Reservoir also regulates a portion of the basin the smaller regulated area (seven percent) compared to Vail Dam's and the requirement for Metropolitan Water District (Skinner's operator) to release all inflows makes the effects of this reservoir on peak flows inconsequential compared to Vail Dam's effects. The expected effect of the dams on the frequency analysis is discussed in more detail following discussion of the individual gages.

Flow frequency analyses for USGS Station 11044000 (Santa Margarita R Nr Temecula), Station 11044500 (Santa Margarita R Nr Fallbrook) and Station 11046000 (Santa Margarita R A Ysidora) are described in the following paragraphs. . The flow frequency analyses were carried out for peak annual flows using the computer program HEC-FFA (USACE, 1992b) and procedures from Bulletin 17B (USGS, 1982). Although analytical methods were used to compute flow frequency at each station, we observed that the analytical frequency results provided a poor fit to measured data, most likely due to the regulation of the basin by dams and diversion of waters for irrigation and conservation. As graphical techniques must be used where analytical techniques provide poor frequency estimates (USACE, 1993a), the adopted flow frequency curves were obtained by using graphical analysis.

3.4.1.1 Santa Margarita River at Ysidora Gage

The Ysidora gage began recording in February 1923 and is temporarily located at the O'Neill Diversion Weir. The gage location has been moved several times. From installation until destroyed by a flood in February 1927, the gage was located 4.4 miles downstream of the Basilone Road crossing. From February 1931 until February 1970 the gage was located 5.4 miles downstream of the crossing, and from February 1970 to December 1980, at a site 6.2 miles downstream of the crossing. From 1980 until 1999 the gage was located on the upstream side of the Basilone Road Bridge, 7.9 miles upstream from the mouth of the Santa Margarita River. The gage will be returned to this location after the new bridge is completed. Records for this gage are deemed "fair" by USGS standards, except for estimated daily discharges, which are "poor." The changes in gage location are not expected to impact the frequency analysis as the change in contributing area for the different locations is small.

Although 47 events are available for this gage after 1949 (WY 1950-1998, WY 1994 missing), 18 of those are zero flows. Because the zero or missing data make up more than 25 percent of the total data, analytical procedures outlined in Bulletin 17B are not applicable, according to that publication (USGS, 1982). However, a conversation with one of the original committee members responsible for publication of Bulletin 17B revealed that the 25% limit was largely arbitrary and that the USGS flow frequency computer program allows up to 50% of the data to be zero or missing. Therefore, an analytical analysis was performed although results from the graphical analysis were ultimately adopted.

Median plotting positions were calculated with HEC-FFA and plotted on log-frequency scales. The median plotting positions were adopted instead of Weibull plotting positions as the former give better results for negatively skewed data such as found in this study (Chow et al., 1988). The U.S. Army Corps of Engineers (USACE, 1994) reconstituted historic flood events with regulation in place and found that the peak discharge at Ysidora for the largest historical event (1916) would have been between 28,000 and 45,000 cfs. Because the highest historic peak would be less than or equal to the peak of record (1993 peak of 45,000 cfs), the historic period was extended to 1916 and the 1993 event was treated as a high outlier as per Bulletin 17B procedures (note that high outliers are **not** excluded from the analysis – a different weighting is applied to the frequency values). Therefore, a systematic record of 48 years (1950-1998, 1994 value missing) and a historical period of 83 years (1916-1998) was used to determine plotting positions. For the analytical analysis, a generalized skew value was obtained from the Bulletin 17B map and a conditional probability adjustment applied to the ordinates. Three points were also identified as low outliers and excluded from the analysis. The final output table from the HEC-FFA program for this gage is shown as Table 3-12. Computed and expected frequency curves and confidence limits are shown in Figure 3-6 along with the median plotting positions of observed values. For the graphical analysis, a curve (also shown in the figure) was fit to the plotting position points using engineering judgement. The adopted results from the graphical analysis are shown in Table 3-13.

Table 3-14 shows the 100-year discharge for flood frequency analyses performed by different entities for the gage at Ysidora. One should note that the present analysis incorporates the peak from 1998, which was unavailable for previous studies. This peak (18,400 cfs) is the fifth highest recorded peak after Vail Dam construction.

3.4.1.2 Santa Margarita River near Fallbrook Gage

This gage, located near Fallbrook and downstream of the confluence with Sandia Creek, recorded data from 1924 to 1980. However, gage information is also available at the Fallbrook Public Utility District (FPUD) sump near Fallbrook gage (11044300) about a mile further upstream (0.3 miles upstream of the Sandia Creek confluence) and also for the Sandia Creek gage (11044350) for the period 1990-1998. The Fallbrook gage record was therefore extended in the following manner.

Analyzing the peak flow records of the FPUD and Sandia gages, one can see that the peak flows occur on the same day for only one of the nine water years on record. For the year when peaks occurred on the same day, the peak discharges from the Sandia Creek and FPUD gages were added to obtain the equivalent peak flow at the Fallbrook gage location. For the other eight years of record, the peak flow at the FPUD gage was added to the mean daily flow on Sandia Creek for the day when the peak occurred. The nine peak flows computed in this fashion were added to the Fallbrook gage record to extend the period of record to include the 1990-1998 period.

Median plotting positions were computed in the same manner as described for the gage at Ysidora using the HEC-FFA program. The systematic record contains 40 events, and the historic period is 83 years (1916-1998; based on the analysis at the Ysidora gage, it was assumed that the 1916 event has also not been exceeded at this location since 1916). Plotting positions and the graphical frequency curve are shown in Figure 3-7. Results for specific flood events from the adopted curve are given in Table 3-15. Analytical results are shown on the same plot for comparison, and were computed with HEC-FFA using a generalized skew coefficient obtained from the Bulletin 17B map. The final output table from the HEC-FFA program for this gage is shown as Table 3-16. As previously mentioned, the analytical results showed poor agreement with measured flows (plotting position points), especially for less frequent flows. The reader should note that the period of record for this gage is smaller than those of the other two gages analyzed. No previous frequency analysis was found for this gage.

3.4.1.3 Santa Margarita River near Temecula Gage

This gage is located at the entrance to the Santa Margarita River gorge, just downstream from the confluence of Murrieta and Temecula Creeks. The flow frequency analysis was carried out for peak annual flows using the computer program HEC-FFA and procedures from Bulletin 17B (USGS, 1982). No previous studies were found for this location. Median plotting positions were computed for a systematic record of 49 events (1950-1998) with a historic period of 83 years as per the other two gages analyzed. The plotting positions and graphical frequency curve are shown in Figure 3-8. Flow-frequency results for specific events from the graphical curve are given in Table 3-17 below. Analytical results are also shown on Figure 3-8 for comparative purposes, and were computed with HEC-FFA using a generalized skew coefficient obtained from the Bulletin 17B map. The final output table from the HEC-FFA program for this gage is shown as Table 3-18. As previously mentioned, the analytical results showed poor agreement with measured flows (plotting position points), especially for less frequent flows. Therefore, the graphical results were adopted.

3.4.1.4 Effect of Dams on Frequency Analysis

In general, one would expect the low flows of the study reach of the Santa Margarita River to be relatively unaffected by the dams. This is because these flows are generated by events occurring over only a small portion of the total watershed or, in very dry years, are produced by return flows from groundwater and irrigation. Large flows, produced when most parts of the basin contribute runoff from a widespread (general) storm, will be most affected by the reservoir. The storage of the reservoir will make large flows less frequent downstream. This tends to flatten the discharge-frequency curves such as those shown in Figures 3-6 through 3-8 (i.e., the slope of the curve will be less than under pre-dam conditions). However, for very large storm events, the storage action of the dam becomes less important because the reservoir is rapidly filled, and has a lesser impact on the peak discharge released from the dam. The frequency curve will become steeper and approach that of pre-dam conditions under these circumstances.

As described previously in the report, Vail Lake exerts significantly more influence on the downstream hydrology than Lake Skinner, but neither Skinner nor Vail Dam has recorded a spill coincident to an annual peak storm event. Referring to the above general discussion of dam influence, it is believed that the existing peak flow data reflect the flattening effect of the dams on large post-dam floods. Vail Lake did spill during the two years with the greatest post-dam discharges (1980 and 1993), although after the peak flow had passed. This indicates that these two storm events are approaching a frequency where the dam storage will become less of a factor for peak downstream flows. The "hinge point" where the slope of the frequency curve will increase toward pre-dam conditions is therefore believed to be just beyond the exceedance frequency limits of the current analysis, perhaps between the 200 to 500-year recurrence interval.

3.4.2 Volume Frequency Analysis

Mean daily discharges from the three USGS gauging stations described in the preceding sections were analyzed for the maximum 1-, 2-, 3-, and 5-day flows. Only post Vail Lake data were included in the analysis (WY 1950 – WY 1998). For each duration (1, 2, 3, or 5 days), discharges were ranked and plotted using the same plotting positions developed for the peak discharge frequency analysis. Using the peak discharge curve as a guide, smooth curves were drawn through the plotted points. The data points and curves are shown in Figures 3-9, 3-10 and 3-11 for the Ysidora, Fallbrook, and Temecula gages respectively.

3.5 Balanced Hydrographs

A balanced hydrograph is defined as a hydrograph that combines the shape characteristics representative of flood hydrographs from the basin with discharge-frequency information. A balanced hydrograph will have the approximate shape of the representative pattern hydrograph and will have peak and volume-duration magnitudes that correspond to the specified frequency. Balanced hydrographs were generated for this study at each of the three gages analyzed for later use with sediment transport modeling.

Balanced hydrographs were developed, using HEC-1, for the 2-, 10-, 25-, 50- and 100-year events for the Santa Margarita River at Temecula, Fallbrook and Ysidora. Because the shape and timing of hydrographs at the three gages were very similar, a single representative pattern hydrograph was initially used for all three locations. Volume-duration results from the computed balanced hydrograph were compared to the values from the volume-frequency analysis for the 100-year event at each location. Based on the comparison, the pattern hydrograph was then modified such that the volume difference between HEC-1 100-year balanced hydrograph and the volume frequency values were less than one percent for the 1-day duration, and three percent for the 2-, 3-, and 5-day durations. The "calibrated" pattern at each gage location was then used as the pattern for the remaining frequency events (2- through 50-year). The balanced hydrographs are shown in Figures 3-12 through 3-14. Analysis of volume in the generated balanced hydrographs versus volume from the duration-frequency analysis shows that volume differences are within one percent for a one-day duration and within five percent over a five-day duration.

3.6 Conclusions

The overall variation of the hydrologic model results from observed values was not surprising as rainfall patterns, antecedent moisture conditions and routing parameters will vary from storm to storm and must be approximated in any model. The WEST model, created using the PWA existing conditions model as a basis, provides good results when considering all three verification events. There is no question that more exact results could be obtained for any single event by adjusting basin curve numbers, routing parameters and rainfall distribution. However, the goal of this study is to produce a tool that will provide good results over a range of many different storm events. The current model using the SCS loss method, satisfies this requirement. Because of this, the HEC-1 model can be used with confidence as a predictive tool.

Table 3-1. Hydrologic Parameters of the Santa Margarita River Watershed Subbasins

sub-basin	A (acres)	A (sq. mi.)	L (feet)	L (miles)	Lca (feet)	Lca (miles)	Max El (feet)	Min El (feet)	S (ft/mi)	1990+ Conditions Curve Number	n	Tlag (hours)	DEM Slope (%)	S-Graph (LAPRE)
1	14316	22.37	66072	12.514	23939	4.534	1969	1260	56.6	77.7	0.054	2.78	4.0	Valley
2	5187	8.10	37330	7.070	21077	3.992	1575	1079	70.1	77.6	0.093	3.52	3.6	Valley
3	11776	18.40	50834	9.628	22993	4.355	2520	1260	130.9	78.9	0.067	2.65	5.4	Foothill
4	3643	5.69	34505	6.535	21069	3.990	1752	1033	109.9	78.7	0.073	2.48	4.5	Valley
5	19502	30.47	59705	11.308	30509	5.778	2195	1033	102.7	79.3	0.071	3.44	6.0	Foothill
6	17629	27.55	85790	16.248	40689	7.706	2559	1079	91.1	75.1	0.095	6.03	4.4	Valley
7	15744	24.60	61462	11.641	33841	6.409	4465	2113	202.1	77.6	0.082	3.69	12.0	Mountain
8	56603	88.44	117746	22.300	60669	11.490	5512	2113	152.4	72.4	0.077	5.88	7.3	Foothill
9	1612	2.52	17563	3.326	9458	1.791	1201	1033	50.3	75.5	0.082	1.84	3.3	Valley
10	114	0.18	6793	1.287	1639	0.311	1739	1033	548.3	77.8	0.080	0.41	3.0	Valley
11	1206	1.88	12677	2.401	4345	0.823	2343	978	568.4	80.8	0.074	0.69	10.1	Mountain
12	27082	42.32	65106	12.331	38952	7.377	3550	1398	174.5	74.4	0.072	3.58	7.5	Foothill
13	4292	6.71	28850	5.464	10948	2.074	1227	978	45.6	82.6	0.056	1.65	6.0	Foothill
14	15089	23.58	62176	11.776	27625	5.232	4711	1398	281.4	69.2	0.068	2.66	16.1	Mountain
15	643	1.00	13394	2.537	6697	1.268	2418	1398	402.2	80.4	0.059	0.71	9.9	Foothill
16	21017	32.84	61932	11.730	29774	5.639	2175	377	153.3	78.3	0.080	3.63	13.3	Mountain
17	24641	38.50	88944	16.845	54334	10.291	6093	1398	278.7	71.7	0.067	3.88	15.6	Mountain
18	14197	22.18	71725	13.584	38238	7.242	5673	1900	277.7	76.4	0.070	3.30	9.3	Foothill
19	30586	47.79	85491	16.192	40508	7.672	2005	138	115.3	75.0	0.090	5.49	13.9	Mountain
20	11547	18.04	66900	12.671	27971	5.298	4944	1900	240.3	74.5	0.070	2.93	10.8	Mountain
21	13815	21.59	63408	12.009	29966	5.675	1860	377	123.5	83.9	0.103	4.92	11.4	Mountain
22	24413	38.15	79672	15.089	42778	8.102	5932	2628	219.0	75.2	0.074	3.95	10.6	Mountain
23	6771	10.58	43609	8.259	22900	4.337	1217	138	130.7	69.2	0.094	3.50	11.9	Mountain
24	12678	19.81	43489	8.237	18898	3.579	4472	2628	223.9	73.9	0.079	2.45	13.6	Mountain
25	28082	43.88	109628	20.763	50045	9.478	965	0	46.5	74.7	0.094	8.08	6.8	Foothill
26	32334	50.52	99224	18.792	41108	7.786	4551	1398	167.8	76.4	0.075	4.54	8.0	Foothill
27	8588	13.42	38123	7.220	17458	3.306	2408	1476	129.0	81.9	0.111	3.53	9.0	Foothill
28	18791	29.36	72229	13.680	31367	5.941	2549	997	113.4	73.0	0.085	4.43	7.5	Foothill
29	2524	3.94	34539	6.542	18581	3.519	1460	1027	66.2	84.7	0.050	1.79	4.4	Valley
30	10364	16.19	59510	11.271	28796	5.454	4400	997	301.9	69.6	0.092	3.57	11.3	Mountain
31	1698	2.65	27495	5.207	15207	2.880	1430	1060	71.2	77.4	0.072	2.14	4.0	Valley
32	5597	8.74	38737	7.337	19128	3.623	2434	1125	178.4	76.7	0.074	2.31	8.1	Foothill
33	11814	18.46	40494	7.669	11596	2.196	2008	1178	108.2	77.2	0.046	1.33	9.0	Foothill
34	1312	2.05	26599	5.038	15730	2.979	1368	1007	71.6	84.3	0.049	1.46	4.7	Valley
35	2246	3.51												
Total	475206	746.02							Sub-Basin Min:	69.2	0.046	0.411		
									Sub-Basin Max:	84.7	0.111	8.080		
									Sub-Basin Mean:	76.8	0.076	3.213		
									Basin Mean:	75.1				

Source: Phillip Williams and Associates (1998) Total: 19.5

Table 3-2. USGS Flow Gage Data Summary

USGS Station Number	Station Name	County	Peak Flows Data Span*	Daily Flows Data Span**	Coordinate Latitude (N)	Coordinate Longitude (W)
11042400	Temecula C Nr Aguanga Ca	Riverside	58-98	8/1/57 - 9/30/98	033 27 33	116 55 22
11042430	Coahuila C Trib A Anza Ca	Riverside	61-72	No Daily Flow Data		
11042490	Wilson C Ab Vail Lk Nr Radec Ca	Riverside	92-94	10/1/89 - 9/30/94	033 29 12	116 54 37
11042520	Temecula C A Nigger Cyn Nr Temecula Ca	Riverside	23-48	2/1/23 - 9/30/48	033 29 40	116 59 00
11042600	Temecula C Bl Vail Dam Ca	Riverside	No Peak Flow Data	10/1/77 - 9/30/78	033 29 42	116 58 42
11042631	Pechanga C Nr Temecula Ca	Riverside	88-98	10/1/87 - 9/30/98	033 28 06	117 07 40
11042800	Warm Springs C Nr Murrieta Ca	Riverside	88-97	6/11/92 - 9/30/97	033 31 56	117 10 34
11042900	Santa Gertrudis C Nr Temecula Ca	Riverside	88-97	10/1/92 - 9/30/97	033 31 28	117 09 50
11043000	Murrieta C A Temecula Ca	Riverside	31-98	10/1/30 - 9/30/98	033 28 47	117 08 35
11044000	Santa Margarita R Nr Temecula Ca	Riverside	23-98	2/1/23 - 9/30/98	033 28 26	117 08 29
11044250	Rainbow C Nr Fallbrook Ca	San Diego	92-98	11/1/89 - 9/30/98	033 24 27	117 12 00
11044300	Santa Margarita R A Fpud Sump Nr Fallbrook Ca	San Diego	90-98	10/1/89 - 9/30/98	033 24 49	117 14 25
11044350	Sandia C Nr Fallbrook Ca	San Diego	90-98	10/1/89 - 9/30/98	033 25 28	117 14 54
11044500	Santa Margarita R Nr Fallbrook, Calif	San Diego	25-80	10/1/24 - 9/30/80	033 23 54	117 15 44
11044600	Santa Margarita R Trib Nr Fallbrook Ca	San Diego	62-73	10/1/61 - 9/30/65	033 24 39	117 16 45
11044800	De Luz C Nr De Luz Ca	San Diego	93-98	10/1/92 - 9/30/98	033 25 11	117 19 15
11044900	De Luz C Nr Fallbrook Ca	San Diego	52-67	10/1/51 - 9/30/67 10/1/89 - 9/30/90	033 22 12	117 19 15
11045000	Santa Margarita R Nr De Luz Sta Ca	San Diego	26-26	10/1/24 - 9/30/26	033 21 10	117 19 30
11045300	Fallbrook C Nr Fallbrook Ca	San Diego	94-98	10/1/93 - 9/30/98	033 20 49	117 19 01
11046000	Santa Margarita R A Ysidora Ca	San Diego	23-98	10/1/30 - 9/30/98	033 14 13	117 23 14
11046025	Plant 2 Discharge To Pond 2 Ca	San Diego	No Peak Flow Data	10/1/93 - 9/30/98	033 16 20	117 20 33
11046050	Santa Margarita R A Mo Nr Oceanside Ca	San Diego	92-96	No Daily Flow Data	033 14 08	117 24 27

*Peak flows are reported for water years beginning October 1 and ending September 30
**Daily flows are reported as average over the day.

Latitude and Longitude are in Deg Min Sec format

Table 3-3. Contributing Area to Selected USGS Gages

HEC-1 Node #	Gage Name (Gage ID)	Contributing Area (mi^2)		Drainage Area Controlled by Reservoirs (mi^2)
		USGS Reported	HEC-1 Model	
30	Pechanga C Nr Temecula Ca (11042631)	13.80	16.19	0.00
75	Warm Springs C Nr Murrieta Ca (11042800)	55.40	63.38	0.00
70	Santa Gertrudis C Nr Temecula Ca (11042900)	90.16	91.34	50.52
74	Murrieta C A Temecula Ca (11043000)	222.00	225.27	50.52
41	Santa Margarita R Nr Temecula Ca (11044000)	588.00	589.32	367.14
39	Santa Margarita R A Fpud Sump Nr Fallbrook Ca (11044300)	620.00	643.75	367.14
21	Sandia C Nr Fallbrook Ca (11044350)	21.14	21.59	0.00
19	De Luz C Nr De Luz Ca (11044800)	33.03	47.79	0.00
35	Santa Margarita R A Ysidora Ca (11046000)	740.00	746.00	367.14

Table 3-4: List of 30-Minute Interval Flow Gages

USGS Station Number	Station Name	JAN93	JAN95	FEB98	DSS Path
11042400	Temecula C Nr Aguanga Ca	✓	✓	✓	/SANTA MARGARITA/ TEMECULA C NR AGUANGA /FLOW//30MIN/OBS/
11042631	Pechanga C Nr Temecula Ca	✓	✓	✓	/SANTA MARGARITA/ PECHANGA C NR TEMECULA /FLOW//30MIN/OBS/
11042800	Warm Springs C Nr Murrieta Ca	✓	✓	✓	/SANTA MARGARITA/ WARM SPRINGS C NR MURRIETA /FLOW//30MIN/OBS/
11042900	Santa Gertrudic C Nr Temecula Ca	✓	✓	✓	/SANTA MARGARITA/ SANTA GERTRUDIC C NR TEMECULA /FLOW//30MIN/OBS/
11043000	Murrieta C A Temecula Ca	✓	✓	✓	/SANTA MARGARITA/ MURRIETA C A TEMECULA /FLOW//30MIN/OBS/
11044000	Santa Margarita R Nr Temecula Ca	✓	✓	✓	/SANTA MARGARITA/ SANTA MARGARITA R NR TEMECULA /FLOW//30MIN/OBS/
11044250	Rainbow C Nr Fallbrook Ca	✓	✓	✓	/SANTA MARGARITA/ RAINBOW C NR FALLBROOK /FLOW//30MIN/OBS/
11044300	Santa Margarita R A Fpud Sump Nr Fallbrook Ca	✓	✓	✓	/SANTA MARGARITA/ SANTA MARGARITA R A FPUD SUMP NR FALLBROOK /FLOW//30MIN/OBS/
11044350	Sandia C Nr Fallbrook Ca	✓	✓	✓	/SANTA MARGARITA/ SANDIA C NR FALLBROOK /FLOW//30MIN/OBS/
11044800	De Luz C Nr De Luz Ca	✓	✓	✓	/SANTA MARGARITA/ DE LUZ C NR DE LUZ /FLOW/ /30MIN/OBS/
11045300	Fallbrook C Nr Fallbrook Ca		✓	✓	/SANTA MARGARITA/ FALLBROOK C NR FALLBROOK /FLOW//30MIN/OBS/
11046000	Santa Margarita R A Ysidora Ca	✓	✓	✓	/SANTA MARGARITA/ SANTA MARGARITA R A YSIDORA /FLOW//30MIN/OBS/

Note: Gages where USGS flow data are available are noted by the symbol (✓). All above data obtained from USGS on special request. Some data within the period of record may be zero or missing.

Table 3-5. Precipitation Gage Data Summary

Gage Name	Source	DSS Path	Latitude	Longitude	HEC-1 Name	Elevation	Comments
Murrieta 128	Riverside County	/SANTA MARGARITA/MURRIETA 128/PRECIP//30MIN/COMPOUND/	33 33 17	117 13 55	SMURRI		See Comment 1
Temecula 217	Riverside County	/SANTA MARGARITA/TEMECULA 217/PRECIP//30MIN/COMPOUND/	33 29 48	117 8 57	STEMEC		See Comment 1
Wildomar 274	Riverside County	/SANTA MARGARITA/WILDOMAR 274/PRECIP//30MIN/COMPOUND/	33 35 30	117 18 30	SWILDO		See Comment 1
Winchester 248	Riverside County	/SANTA MARGARITA/WINCHESTER 248/PRECIP//30MIN/COMPOUND/	33 42 25	117 5 24	SWINCH		See Comment 1
Aguanga 002	Riverside County	/SANTA MARGARITA/AGUANGA 002/PRECIP//30MIN/COMPOUND/	33 26 40	116 52 47	SAGUAN	1920	See Comment 1
Lake Skinner 205	Riverside County	/SANTA MARGARITA/SKINNER LK 205/PRECIP//**1DAY**/OBSERVED/	33 34 58	117 4 30	DLKSKI		Daily Observed
Wildomar 246	Riverside County	/SANTA MARGARITA/**WILDOMAR 246**/PRECIP//1DAY/OBSERVED/	33 36 15	117 16 41	DWILDO		Daily Observed
Aguanga 001	Riverside County	/SANTA MARGARITA/AGUANGA 001/PRECIP//1DAY/OBSERVED/	33 29 20	116 47 40	DAGUAN	3800	Daily Observed
Anza 005	Riverside County	/SANTA MARGARITA/ANZA 005/PRECIP//1DAY/OBSERVED/	33 33 18	116 40 22	DANZA	3915	Daily Observed
El Cariso 062	Riverside County	/SANTA MARGARITA/EL CARISO 062/PRECIP//**15MIN**/OBSERVED/	33 39	117 24 43	SELCRS	-999	See Comment 6
El Cariso 062	Riverside County	/SANTA MARGARITA/EL CARISO 062/PRECIP//**30MIN/COMPOUND**/			AELCRS		
Elsinore 067	Riverside County	/SANTA MARGARITA/ELSINORE 067/PRECIP//**15MIN/OBSERVED**/	33 40 07	117 19 50	SELSIN	-999	See Comment 6
Red Mountain 171	Riverside County	/SANTA MARGARITA/RED MTN 171/PRECIP//15MIN/OBSERVED/	33 38 00	116 50 25	SREDMT	-999	See Comment 6
RR Canyon 163	Riverside County	/SANTA MARGARITA/RR CANYON 163/PRECIP//15MIN/OBSERVED/	33 40 28	117 16 26	SRRCYN	-999	See Comment 6
RR Canyon 163	Riverside County	/SANTA MARGARITA/RR CANYON 163/PRECIP//**30MIN/COMPOUND**/	33 40 28	117 16 26	ARRCYN	-999	See Comment 6
Sun City 212	Riverside County	/SANTA MARGARITA/SUN CITY 212/PRECIP//15MIN/OBSERVED/	33 42 55	117 11 25	SSUN	-999	
St. Rosa Ranch 191	Riverside County	/SANTA MARGARITA/ST Rosa R 191/PRECIP//15MIN/OBSERVED/	33 30 42	117 16 05	SSROSR	-999	
St. Rosa Plateau 199	Riverside County	/SANTA MARGARITA/ST Rosa P 199/PRECIP//15MIN/OBSERVED/	33 30 17	117 17 15	SSROSP	-999	
Temecula	San Diego County	/SANTA MARGARITA/**TEMECULA**/PRECIP//**1HOUR**/OBSERVED/	33 30	117 09	HTEMEC	-999	See Comment 2
Oak Grove	San Diego County	/SANTA MARGARITA/OAKGROVE/PRECIP//1HOUR/OBSERVED/	33 23	116 47	HOAKGR	2751	See Comment 2
Palomar Mountain	San Diego County	/SANTA MARGARITA/PALOMAR MTN/PRECIP//1HOUR/OBSERVED/	33 21 30	116 51 41	HPALMR	5560	See Comment 2
Palomar Mountain	San Diego County	/SANTA MARGARITA/PALOMAR MTN/PRECIP//**30MIN/COMPOUND**/	33 21 30	116 51 41	APALMR	5560	See Comment 4
Fallbrook FD	San Diego County	/SANTA MARGARITA/FALLBROOK FD/PRECIP//**1DAY**/OBSERVED/	33 23 0	117 14 53	DFLBRK	604	See Comment 2
De Luz	San Diego County	/SANTA MARGARITA/**DE LUZ**/PRECIP//1DAY/OBSERVED/	33 27	117 19	DDELUZ	-999	See Comment 2
Oceanside	San Diego County	/SANTA MARGARITA/**OCEANSIDE**/PRECIP//**30MIN/COMPOUND**/	33 13 0	117 21 00	AOCEAN	30	See Comment 5
Rincon Springs	San Diego County	/SANTA MARGARITA/**RINCOLN SPRINGS**/PRECIP//30MIN/COMPOUND/	33 17 17	116 57 41	ARINCO	970	See Comment 5
Oceanside NWS	San Diego County	/SANTA MARGARITA/**OCEANSIDE NWS**/PRECIP//**1HOUR/OBS**/	33 13 0	117 21 00	HOCEAN	30	See Comment 5
Oak Grove	Stetson Engnrs/ NWS	/SANTA MARGARITA/OAK_GROVE/PRECIP//1HOUR/OBS/	33 30	117 09	HOAKG2	-999	See Comment 7
SDSU Field	SDSU Field Station	/SANTA MARGARITA/SDSU Field/PRECIP//1HOUR/OBS/	33 27 29	117 10 12	HSDSUF	-999	
Case Springs	CDEC	/SANTA MARGARITA/CASE SPRINGS/PRECIP//1HOUR/COMP/	33 26 42	117 25 4.8	HCSPRI	2320	See Comment 3
Las Flores	CDEC	/SANTA MARGARITA/LAS FLORES/PRECIP//**1HOUR**/COMP/	33 17 20	117 26 20	HLASFL	100	See Comment 3
Target Range	CDEC	/SANTA MARGARITA/**TARGET RANGE**/PRECIP//1HOUR/COMP/	33 22 19	117 21 32	HTARGR	918	See Comment 3

Notes

1 HEC-1 name follows following convention:
First character of the gage name is either A, S , D or H
where A is for Alert Gage, S for Short duration, D for Daily duration and H for Hourly duration data.
The gage name is no more than six characters long.

2 Elevation of -999 means missing elevation.

3 Bold text in DSS pathname indicates difference from the previous DSS path.

Comments

1 Computed from 5 minute interval data except Aguanga 002, which was computed from 15 minute data interval.
All missing data flagged as zero by the data source - therefore these data may have been under-estimated.

2 Data obtained only for appreciable amount of precip events. Missing data periods include zero or very small precipitation.

3 Only 1995 and later events could be obtained from the web site. Incremental precipitation was calculated from the cumulative precipitation.

4 Palomar Mountain data for 1998 event obtained from alert dialin site. Data was alert and not at constant frequency.
Used DSSMath to compute data at equal time spacing.

5 Oceanside and Rincon Springs Gages are outside the Santa Margarita Watershed but close enough
that they can be used for interpolation. Oceanside NWS gage is about 10 feet away from Oceanside gage.
The Oceanside NWS gage is maintained by the National Weather Service.

6 15 minute data provided by RCFCD as computed from 5 minute data. However, 1998 data set for RR Canyon was
supplied in raw format (irregular time series) which was converted to regular time series data with a 30 minute time step.
Red Mountain gage was non-operational in Feb and March of 1998.

7 This data obtained from Stetson Engineers. According to Stetson Engineers this data was obtained from San Diego County.
We confirmed the total depth of 1993 event precipitation at this gage with the other gage data provided by San Diego county
to us and they match well.

Table 3-6. Total Gage Precipitation for Events

Gage Name	HEC-1 Name	Total Precipitation (inches) for Storm Events		
		Feb-98	Jan-95	Jan-93
Murrieta 128	SMURRI	3.02	2.87	8.46
Temecula 217	STEMEC	3.27	2.43	7.23
Wildomar 274	SWILDO	3.65	2.21	6.27
Winchester 248	SWINCH	1.82	1.34	3.63
Aguanga 002	SAGUAN	1.59	1.08	3.32
Lake Skinner 205	DLKSKI	2.62	2.23	6.64
Wildomar 246	DWILDO	3.66	2.14	5.52
Aguanga 001	DAGUAN	1.56	1.57	4.05
Anza 005	DANZA	1.37	1.94	3.42
El Cariso 062	SELCRS	-999	3.55	7.82
El Cariso 062	AELCRS	3.04	-999	-999
Elsinore 067	SELSIN	3.20	1.85	2.78
Red Mountain 171	SREDMT	-999	2.35	3.47
RR Canyon 163	SRRCYN	-999	1.88	2.21
RR Canyon 163	ARRCYN	2.87	-999	-999
Sun City 212	SSUN	2.45	1.47	4.84
St. Rosa Ranch 191	SSROSR	4.56	4.98	-999
St. Rosa Plateau 199	SSROSP	4.99	5.74	14.05
Temecula	HTEMEC	-999	-999	7.80
Oak Grove	HOAKGR	-999	-999	5.30
Palomar Mountain	HPALMR	-999	-999	9.10
Palomar Mountain	APALMR	3.08	5.18	-999
Fallbrook FD	DFLBRK	-999	2.50	7.37
De Luz	DDELUZ	-999	5.75	12.02
Oceanside	AOCEAN	2.01	1.16	-999
Rincon Springs	ARINCO	2.03	1.20	3.12
Oceanside NWS	HOCEAN	-999	-999	4.80
Oak Grove	HOAKG2	-999	1.60	5.20
SDSU Field	HSDSUF	-999	2.73	7.90
Case Springs	HCSPRI	4.00	-999	-999
Las Flores	HLASFL	-999	0.88	3.30
Target Range	HTARGR	1.80	1.53	-999

Notes

1 Precipitation of -999 means there is missing precipitation for the gage for the event.

2 Storm Event Dates are as follows

Storm Event Name	Start Date and Time	End Date and Time
Feb-98	23FEB98 0030	24FEB98 1800
Jan-95	10JAN95 0800	11JAN95 1000
Jan-93	15JAN93 0100	17JAN93 2400

Table 3-7. Summary of Sub-Basin Mean Precipitation (Inches) and Temporal Gages

	Jan-93		Jan-95		Feb-98	
SUB-BASIN	MEAN PRECIP	Temporal Gage	MEAN PRECIP	Temporal Gage	MEAN PRECIP	Temporal Gage
1	5.54	SWINCH	1.82	SWINCH	2.32	SWINCH
2	7.27	HTEMEC	2.24	HOAKG2	2.69	STEMEC
3	6.01	SWINCH	2.03	SWINCH	2.39	SWINCH
4	8.01	HTEMEC	2.30	HOAKG2	2.72	STEMEC
5	7.89	SMURRI	2.56	SMURRI	2.95	SMURRI
6	5.58	HTEMEC	1.97	HOAKG2	2.39	STEMEC
7	3.52	SREDMT	1.94	SREDMT	1.13	SAGUAN
8	3.58	SREDMT	1.80	SREDMT	1.42	SAGUAN
9	8.78	HTEMEC	2.43	HOAKG2	2.93	STEMEC
10	9.47	HTEMEC	2.79	HOAKG2	3.20	STEMEC
11	5.89	STEMEC	2.27	STEMEC	3.40	STEMEC
12	3.12	SAGUAN	1.29	SAGUAN	1.38	SAGUAN
13	7.90	HTEMEC	2.53	HOAKG2	3.26	STEMEC
14	3.39	SAGUAN	1.51	SAGUAN	2.02	SAGUAN
15	3.16	SAGUAN	1.24	SAGUAN	1.80	SAGUAN
16	7.47	HSDSUF	2.61	HSDSUF	3.66	STEMEC
17	5.01	SAGUAN	2.43	SAGUAN	2.11	SAGUAN
18	3.93	SAGUAN	1.29	SAGUAN	1.77	SAGUAN
19	11.62	SSROSP	4.89	SSROSP	4.05	SSROSP
20	4.94	HOAKGR	1.80	APALMR	2.24	APALMR
21	11.05	HSDSUF	4.10	HSDSUF	4.02	SSROSR
22	4.12	HOAKGR	0.97	APALMR	2.42	APALMR
23	8.58	SSROSP	3.09	HTARGR	2.97	HTARGR
24	5.61	HOAKGR	1.83	APALMR	2.94	APALMR
25	5.63	HLASFL	1.12	HTARGR	1.78	HTARGR
26	4.37	SREDMT	2.01	SREDMT	1.71	SWINCH
27	3.78	SWINCH	1.68	SWINCH	1.70	SWINCH
28	4.68	STEMEC	1.77	STEMEC	2.59	STEMEC
29	7.01	SWINCH	2.20	SWINCH	2.97	SWINCH
30	4.22	STEMEC	1.69	STEMEC	2.84	STEMEC
31	7.59	HTEMEC	2.24	HOAKG2	2.92	STEMEC
32	11.21	SSROSP	4.23	SSROSR	4.18	SSROSR
33	6.63	SWILDO	2.49	SWILDO	3.57	SWILDO
34	6.70	STEMEC	2.22	STEMEC	3.08	STEMEC

Maximum	11.62	4.89	4.18
Minimum	3.12	0.97	1.13
Average	6.27	2.22	2.63
Watershed Average	5.66	2.14	2.38

Table 3-8. Modifications to Vail Lake Storage-Discharge Relationship for January 1993 Storm Event

PWA Model		WEST Modified Model	
Storage (ac-ft)	Discharge (cfs)	Storage (ac-ft)	Discharge (cfs)
0	0	0	0
22284	0.1	22284	0.1
23921	0.2	23921	0.2
25559	0.3	25559	0.3
27331	0.4	27331	0.4
29104	0.5	29104	0.5
30949	0.6	30949	0.6
32866	0.7	32866	0.7
34783	0.8	34783	0.8
43800	1.2	43800	1.2
44072	65	44072	3
44616	365	44616	4
45160	820	45160	5
45568	1250	45568	6
45840	1495	45840	7
46520	2250	46520	8
47900	4400	47900	10
49300	7125	49300	7125
50667	10250	50667	10250
52000	13750	52000	13750

Table 3-9. Comparison of Computed Hydrograph with Observed Hydrograph

		MURRIETA C A TEMECULA	WARM SPRINGS C NR MURRIETA	SANTA GERTRUDIS C NR TEMECULA	SANTA MARGARITA R NR TEMECULA	SANTA MARGARITA R A FPUD SUMP	SANTA MARGARITA R A YSIDORA	PECHANGA C NR TEMECULA	SANDIA C NR FALLBROOK	DE LUZ C NR DE LUZ
Event January 1993		**Node 74**	**Node 75**	**Node 70**	**Node 41**	**Node 39**	**Node 35**	**Node 30**	**Node 21**	**Node 19**
Observed	Qp	25000	5556	7200	31000	34000	44000	3120	5100	9110
	Tp	23-47	48.5	23-47	23-47	23-47	23-47	23-47	23-47	40.5
	Depth	-	2.41	-		-	-	-	-	4.25
Computed	Qp	27934	10098	4027	30602	32185	46191	1074	5842	11515
	Tp	42	41.5	41.5	42.5	42.5	43.5	44	54.5	42.5
	Depth	-	3.15	-	-	-	-	-	-	6.97
Difference	% Qp	12%	82%	-44%	-1%	-5%	5%	-66%	15%	26%
	Tp	-	-7.0	-	-	-	-	-	-	2.0
	% Depth	-	31%	-	-	-	-	-	-	64%
Notes		1		1	1	1	1	1	1	

Event January 1995		**Node 74**	**Node 75**	**Node 70**	**Node 41**	**Node 39**	**Node 35**	**Node 30**	**Node 21**	**Node 19**
Observed	Qp	8431	1810	1587	8330	8749	15021	230	2002	3726
	Tp	11.0	0-16	10.5	11.0	14.0	13.5	12.0	10.5	10.0
	Depth	0.36	-	0.15	0.16	0.11	0.28	0.12	1.22	0.90
Computed	Qp	8321	2670	2532	8802	10352	12302	141	2421	4937
	Tp	12.5	12.5	13.0	12.5	13.0	15.0	12.5	7.5	10.5
	Depth	0.48	-	0.37	0.20	0.28	0.29	0.10	1.93	1.39
Difference	% Qp	-1%	48%	60%	6%	18%	-18%	-39%	21%	33%
	Tp	1.5	-	2.5	1.5	-1	1.5	0.5	-3	0.5
	% Depth	34%	-	142%	26%	145%	4%	-19%	58%	55%
Notes			1							

Event January 1998		**Node 74**	**Node 75**	**Node 70**	**Node 41**	**Node 39**	**Node 35**	**Node 30**	**Node 21**	**Node 19**
Observed	Qp	16721	3286	3741	17921	-	16344	315	2500	6513
	Tp	23.5	24.5	22.5	23.5	-	23.0	26.0	23.0	22.0
	Depth	1.14	0.92	0.45	0.20	-	0.23	0.33	1.87	2.02
Computed	Qp	9590	2795	1461	10908	14801	19077	584	2519	4356
	Tp	25.0	27.0	22.5	24.5	24	26.0	20.5	23.5	24.5
	Depth	0.73	0.62	0.29	0.33	-	0.46	0.56	2.01	1.40
Difference	% Qp	-43%	-15%	-61%	-39%	-	17%	85%	1%	-33%
	Tp	1.5	2.5	0	1	-	3	-5.5	0.5	2.5
	% Depth	-36%	-33%	-36%	64%	-	104%	67%	7%	-31%
Notes						2				

Legend and Units

Tp	Time to peak in hours
Qp	Peak Flow in cfs
Depth	Flow depth in inches

Positive difference in blue color
Negative difference in pink color

Notes	Description
1	No observed hydrograph available for this gage. Observed peak flow and peak time is taken from annual peak record.
2	No observed hydrograph or annual peak data available for this gage and event.

Event Date and Time

Event Name	Start Date and Time	End Date and Time
Jan-93	15JAN93 0100	17JAN93 2400
Jan-95	10JAN95 0800	11JAN95 1000
Feb-98	23FEB98 0030	24FEB98 1800

All Computed Hydrographs Used SCS Loss Rate Method.

Table 3-10. Sub-basin Scale SCS Curve Number for Various Antecedent Moisture Conditions (AMC)

SUB-BASIN	AMC II	AMC I	AMC III
1	77.7	59.7	89.7
2	77.6	59.6	89.6
3	78.9	61.8	90.9
4	78.7	61.4	90.7
5	79.3	62.3	91.0
6	75.1	57.1	88.1
7	77.6	59.6	89.6
8	72.4	53.4	86.4
9	75.5	57.5	88.5
10	77.8	59.8	89.8
11	80.8	63.8	91.8
12	74.4	55.8	88.0
13	82.6	66.6	92.6
14	69.2	50.2	84.2
15	80.4	63.4	91.4
16	78.3	60.6	90.3
17	71.7	52.7	86.0
18	76.4	58.4	89.0
19	75.0	57.0	88.0
20	74.5	56.0	88.0
21	83.9	67.9	93.0
22	75.2	57.2	88.2
23	69.2	50.2	84.2
24	73.9	54.9	87.9
25	74.7	56.4	88.0
26	76.4	58.4	89.0
27	81.9	65.8	92.0
28	73.0	54.0	87.0
29	84.7	69.4	93.7
30	69.6	50.6	84.6
31	77.4	59.4	89.4
32	76.7	58.7	89.0
33	77.2	59.2	89.2
34	84.3	68.6	93.3

Table 3-11. Sensitivity Analysis with Antecedent Moisture Condition (AMC)

		MURRIETA C A TEMECULA	WARM SPRINGS C NR MURRIETA	SANTA GERTRUDIS C NR TEMECULA	SANTA MARGARITA R NR TEMECULA	SANTA MARGARITA R A FPUD SUMP	SANTA MARGARITA R A YSIDORA	PECHANGA C NR TEMECULA	SANDIA C NR FALLBROOK	DE LUZ C NR DE LUZ
Event January 1995		**Node 74**	**Node 75**	**Node 70**	**Node 41**	**Node 39**	**Node 35**	**Node 30**	**Node 21**	**Node 19**
Observed	Qp	8431	1810	1587	8330	8749	15021	230	2002	3726
	Tp	11.0	0-16	10.5	11.0	14.0	13.5	12.0	10.5	10.0
	Depth	0.36	-	0.15	0.16	0.11	0.28	0.12	1.22	0.90
Computed AMC II	Qp	8321	2670	2532	8802	10352	12302	141	2421	4937
	Tp	12.5	12.5	13.0	12.5	13.0	15.0	12.5	7.5	10.5
	Depth	0.48	-	0.37	0.20	0.28	0.29	0.10	1.93	1.39
Computed AMC III	Qp	18046	5956	1770	19776	22799	26934	620	3800	7777
	Tp	11.5	12.0	13.5	11.5	12.0	13.5	12.0	7.5	10.5
	Depth	0.97	-	0.36	0.42	0.54	0.58	0.44	2.65	2.27
Computed AMC I	Qp	1720	5956	127	1766	3424	3390	0	991	1743
	Tp	11.0	12.0	25.5	11.0	11.5	16.0	11.0	11.0	10.5
	Depth	0.11	-	0.01	0.04	0.08	0.07	0.00	0.96	0.52
Difference AMC II	% Qp	-1%	-	60%	6%	18%	-18%	-39%	21%	33%
	Tp	1.5	-	2.5	1.5	-1	1.5	0.5	-3	0.5
	% Depth	34%	-	142%	26%	145%	4%	-19%	58%	55%
Difference AMC III	% Qp	114%	-	12%	137%	161%	79%	170%	90%	109%
	Tp	0.5	-	3	0.5	-2	0	0	-3	0.5
	% Depth	168%	-	137%	166%	376%	108%	256%	118%	154%
Difference AMC I	% Qp	-80%	-	-92%	-79%	-61%	-77%	-100%	-50%	-53%
	Tp	0.0	-	15	0	-2.5	2.5	-1	0.5	0.5
	% Depth	-69%	-	-92%	-73%	-31%	-74%	-100%	-21%	-42%
Notes			1							

Legend and Units

Tp	Time to peak in hours
Qp	Peak Flow in cfs
Depth	Flow depth in inches

Positive difference in blue color
Negative difference in pink color

Notes	Description
1	No observed hydrograph available for this gage. Observed peak flow and peak time is taken from annual peak record.
2	No observed hydrograph or annual peak data available for this gage and event.

Event Date and Time

Event Name	Start Date and Time	End Date and Time
Jan-93	15JAN93 0100	17JAN93 2400
Jan-95	10JAN95 0800	11JAN95 1000
Feb-98	23FEB98 0030	24FEB98 1800

All Computed Hydrographs Used SCS Loss Rate Method.

Table 3-12. FFA Program Results for Station 11046000 – Santa Margarita R A Ysidora

COMPUTED CURVE FLOW IN CFS	EXPECTED PROBABILITY FLOW IN CFS	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS 0.05 FLOW IN CFS	CONFIDENCE LIMITS 0.95 FLOW IN CFS
120000	142000	0.2	397000	48500
87000	100000	0.5	273000	36600
65000	73700	1.0	194000	28200
46000	50900	2.0	130000	20700
25700	27700	5.0	65900	12300
14300	15100	10.0	33700	7220
6490	6680	20.0	13700	3460
1070	1070	50.0	1940	601
119	113	80.0	220	57
32	29	90.0	65	13
10	8	95.0	23	3
1	1	99.0	3	0

SYNTHETIC STATISTICS			
LOG TRANSFORM: FLOW, CFS		NUMBER OF EVENTS	
MEAN	2.9080	HISTORIC EVENTS	0
STANDARD DEV	1.0548	HIGH OUTLIERS	1
COMPUTED SKEW	-0.8723	LOW OUTLIERS	3
REGIONAL SKEW	-0.1800	ZERO OR MISSING	18
ADOPTED SKEW	-0.7000	SYSTEMATIC EVENTS	48
		HISTORIC PERIOD	83

Table 3-13. Peak Flow Frequency for Station 11046000 – Santa Margarita R A Ysidora

Event	Percent Chance Exceedance	Flow (cfs)
5-year	20	8,000
10-year	10	17,000
20-year	5	26,000
50-year	2	37,500
100-year	1	46,000

Table 3-14. 100-Year Peak Discharge Values at the Ysidora gage from Different Investigators

Agency or Firm (Year)	100-Year Discharge (cfs)	Comments
WEST Consultants (This report)	46,000	Graphic analysis. Used median plotting positions for 48 years of systematic record and 83 years of historic record.
Corps of Engineers (1994)	57,000 "Present" 64,000 "Future"	Graphic analysis. Used median plotting positions for 45 years of systematic record and 78 years of historical record from 1916.
Leedshill-Herkenhoff (1987)	100,000	
Simons, Li and Assoc. (1987)	83,000	

Table 3-15. Peak Flow Frequency for Station 11044500 – Santa Margarita R A Fallbrook

Event	Percent Chance Exceedance	Flow (cfs)
5-year	20	8,000
10-year	10	17,000
20-year	5	26,000
50-year	2	36,000
100-year	1	44,000

Table 3-16. FFA Program Results for Station 11044500 – Santa Margarita R A Fallbrook

COMPUTED CURVE	EXPECTED PROBABILITY	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS 0.05	0.95
FLOW IN CFS			FLOW IN CFS	
223000	311000	0.2	874000	83800
139000	180000	0.5	494000	55600
93000	115000	1.0	305000	39100
59100	69500	2.0	177000	26200
29100	32400	5.0	76400	14000
15100	16200	10.0	35300	7770
6560	6810	20.0	13600	3620
1200	1200	50.0	2110	686
188	179	80.0	340	92
67	61	90.0	132	28
28	24	95.0	60	10
5	3	99.0	13	1

SYNTHETIC STATISTICS			
LOG TRANSFORM: FLOW, CFS		NUMBER OF EVENTS	
MEAN	3.0322	HISTORIC EVENTS	0
STANDARD DEV	0.9203	HIGH OUTLIERS	1
COMPUTED SKEW	-0.3236	LOW OUTLIERS	0
REGIONAL SKEW	-0.1200	ZERO OR MISSING	0
ADOPTED SKEW	-0.3000	SYSTEMATIC EVENTS	40
		HISTORIC PERIOD	83

Table 3-17. Peak Flow Frequency for Station 11044000 – Santa Margarita R Nr Temecula

Event	Percent Chance Exceedance	Flow (cfs)
5-year	20	7,200
10-year	10	14,000
20-year	5	21,000
50-year	2	29,000
100-year	1	35,000

Table 3-18. FFA Program Results for Station 11044000 – Santa Margarita R A Temecula

COMPUTED CURVE FLOW IN CFS	EXPECTED PROBABILITY FLOW IN CFS	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS 0.05 FLOW IN CFS	CONFIDENCE LIMITS 0.95 FLOW IN CFS
138000	176000	0.2	413000	61400
90100	109000	0.5	249000	42100
62500	72900	1.0	162000	30500
41400	46600	2.0	100000	21100
21800	23600	5.0	47300	11900
12000	12600	10.0	23800	6930
5640	5800	20.0	10100	3450
1200	1200	50.0	1910	764
225	217	80.0	366	126
88	83	90.0	154	44
40	36	95.0	75	17
8	6	99.0	19	3

SYNTHETIC STATISTICS			
LOG TRANSFORM: FLOW, CFS		NUMBER OF EVENTS	
MEAN	3.0392	HISTORIC EVENTS	0
STANDARD DEV	0.8349	HIGH OUTLIERS	1
COMPUTED SKEW	-0.3033	LOW OUTLIERS	0
REGIONAL SKEW	-0.0600	ZERO OR MISSING	0
ADOPTED SKEW	-0.3000	SYSTEMATIC EVENTS	49
		HISTORIC PERIOD	83

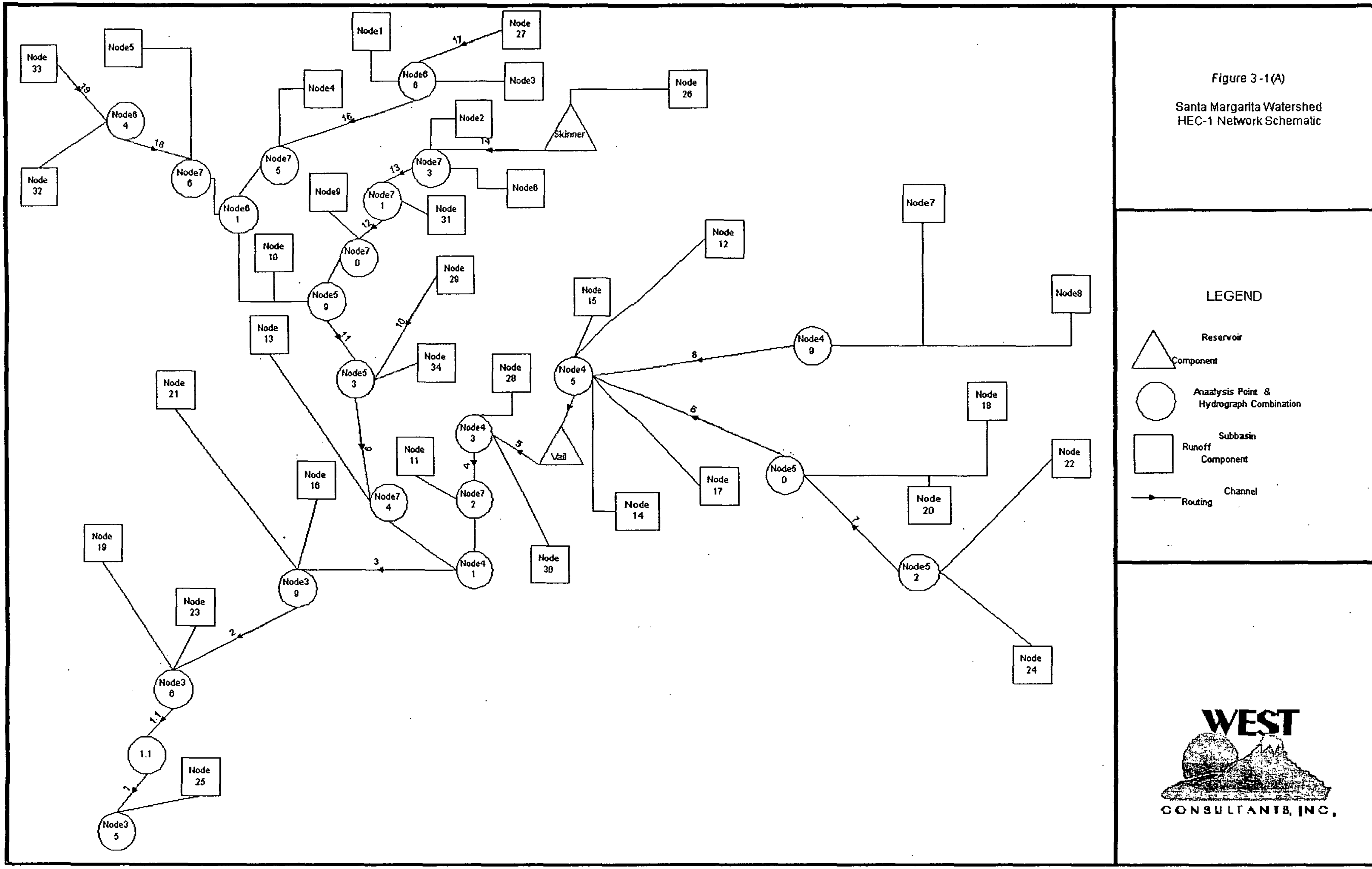

Figure 3-1(A)

Santa Margarita Watershed
HEC-1 Network Schematic

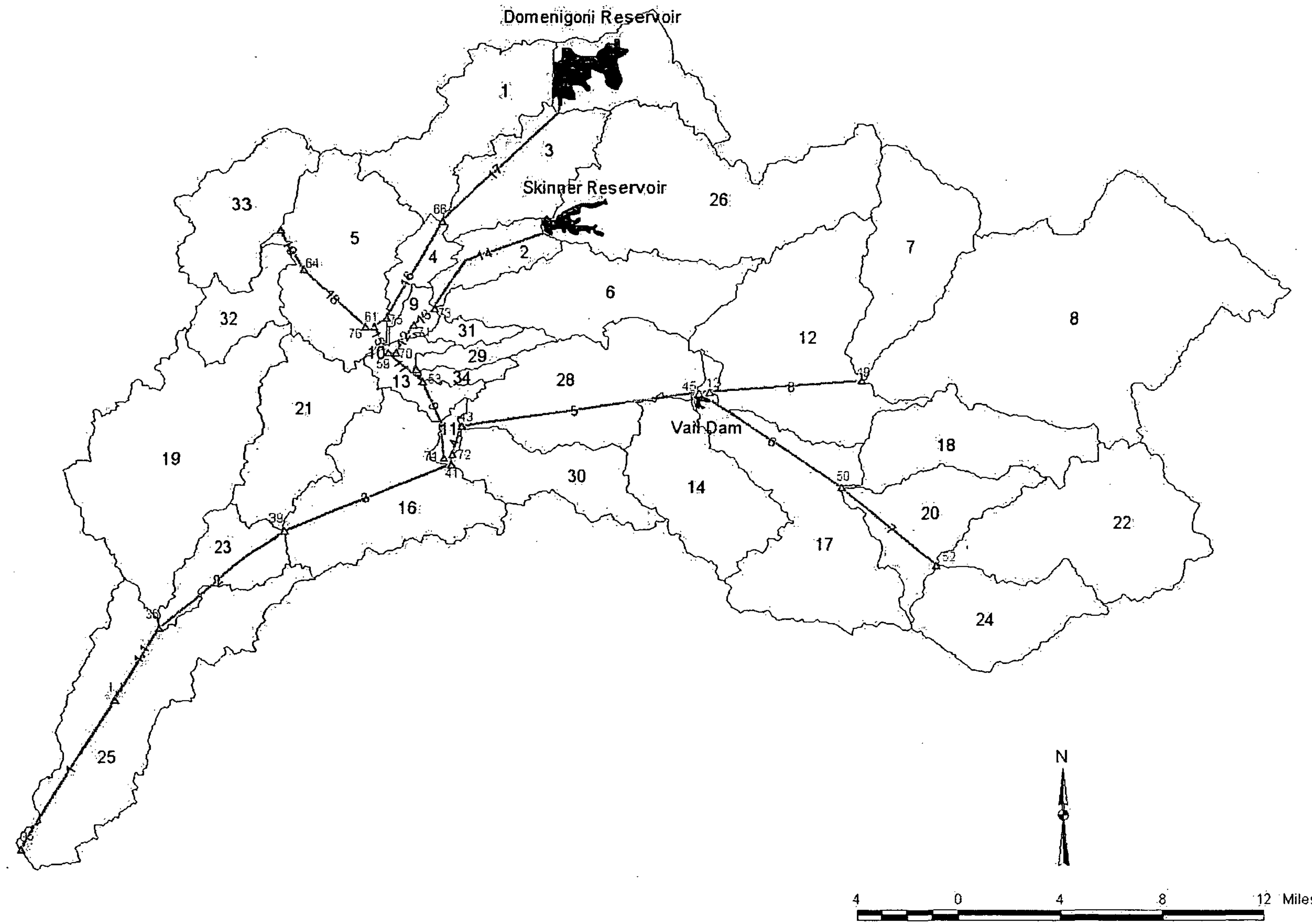

Figure 3-1(B)
Watershed Subbasin
Boundaries and
HEC-1 Schematic

LEGEND

- Combination Node
- Routing Reach
- Subbasin Boundary

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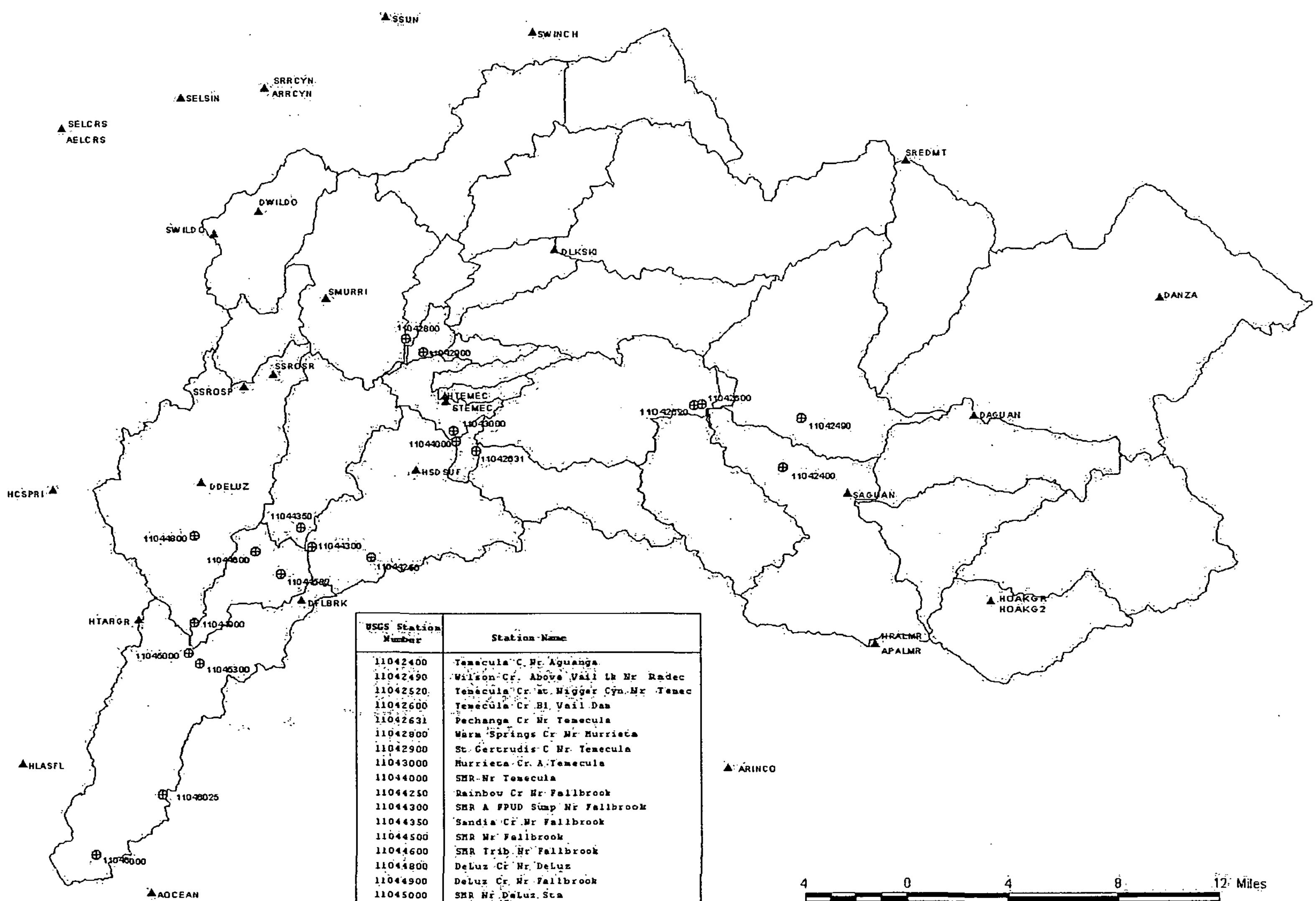
Figure 3-2
Location of Flow and Precipitation Gages for Santa Margarita Watershed



USGS Station Number	Station Name
11042400	Temecula C Nr Aguanga
11042490	Wilson Cr. Above Vail Lk Nr Radec
11042520	Temecula Cr at Nigger Cyn Nr Temec
11042600	Temecula Cr Bl Vail Dam
11042631	Pechanga Cr Nr Temecula
11042800	Warm Springs Cr Nr Murrieta
11042900	St Gertrudis C Nr Temecula
11043000	Murrieta Cr A Temecula
11044000	SMR Nr Temecula
11044250	Rainbow Cr Nr Fallbrook
11044300	SMR A FPUD Sump Nr Fallbrook
11044350	Sandia Cr Nr Fallbrook
11044500	SMR Nr Fallbrook
11044600	SMR Trib Nr Fallbrook
11044800	DeLuz Cr Nr DeLuz
11044900	DeLuz Cr Nr Fallbrook
11045000	SMR Nr DeLuz Sta
11045300	Fallbrook C Nr Fallbrook
11046000	SMR at Ysidora.
11046025	Plant 2 to Pond 2

Flow Gages (USGS Station Number)

Precipitation Gages (HEC-1 Name, See Table 3-5 for details)

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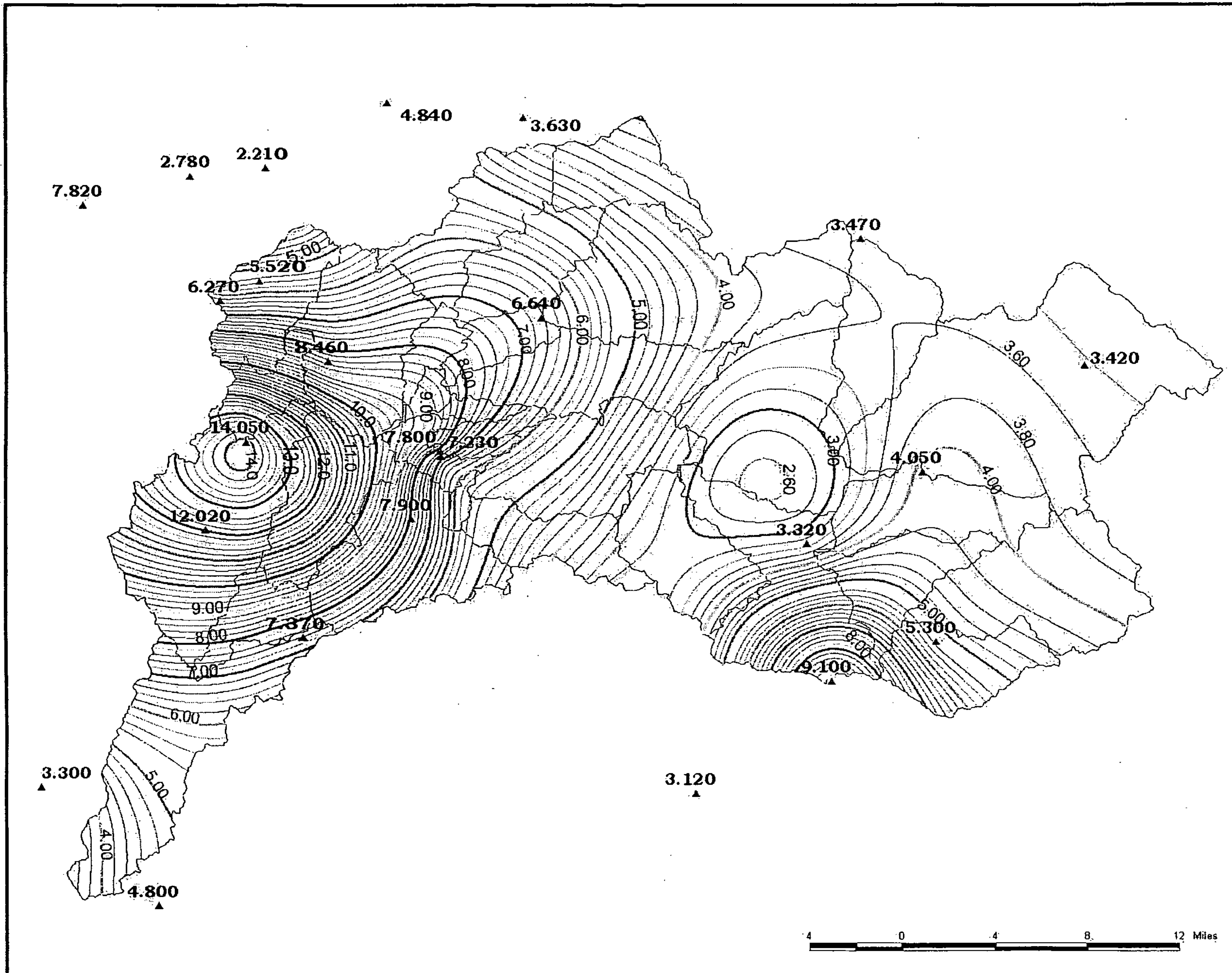

Figure 3-3
Precipitation Contours and Gage Totals (Inches) Over Santa Margarita Watershed for the January 1993 Storm Event

3.120 ▲ Precipitation Gage Locations and Totals (Typical)

N

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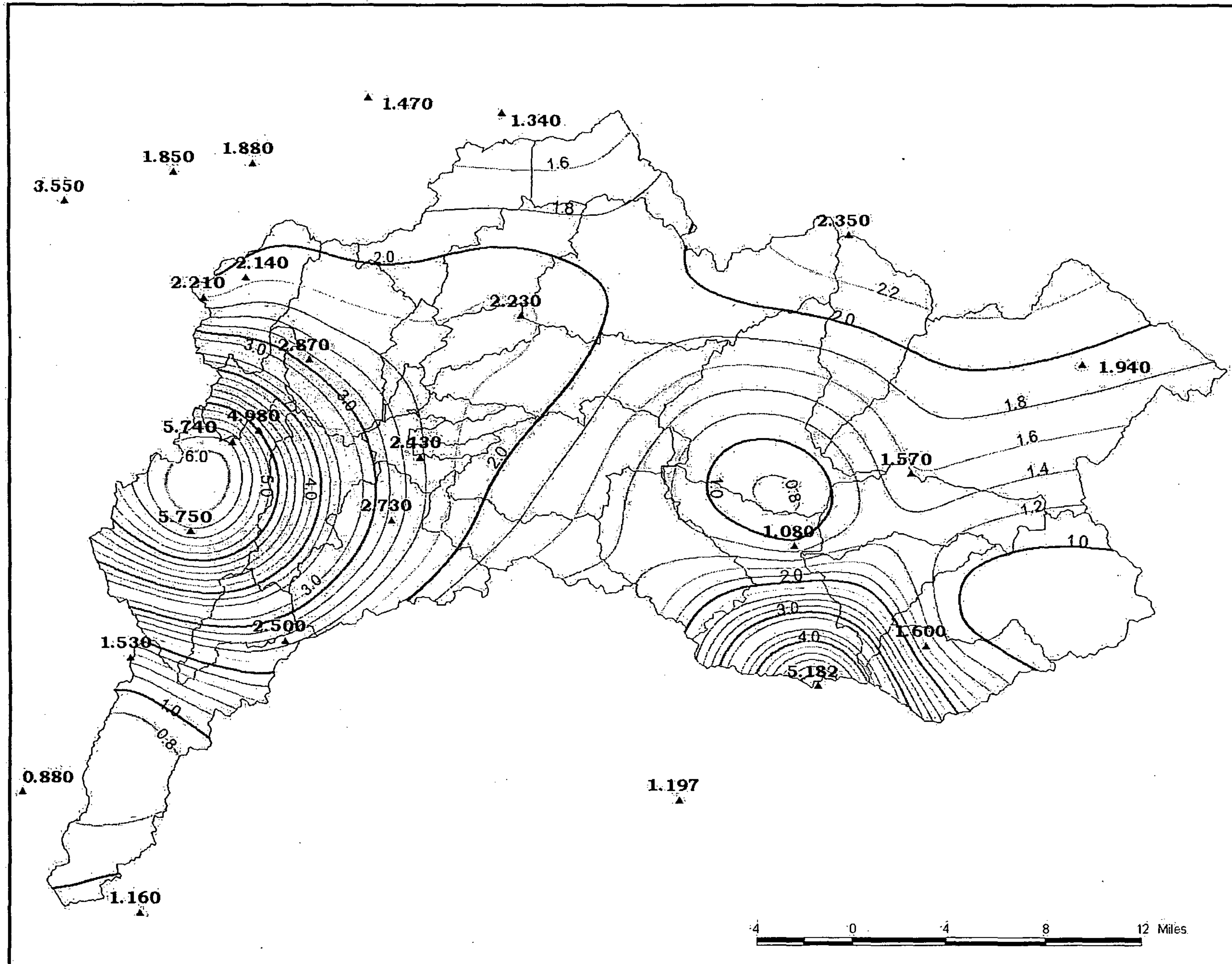

Figure 3-4
Precipitation Contours and Gage Totals (Inches) Over Santa Margarita Watershed for the January 1995 Storm Event

WEST CONSULTANTS, INC.

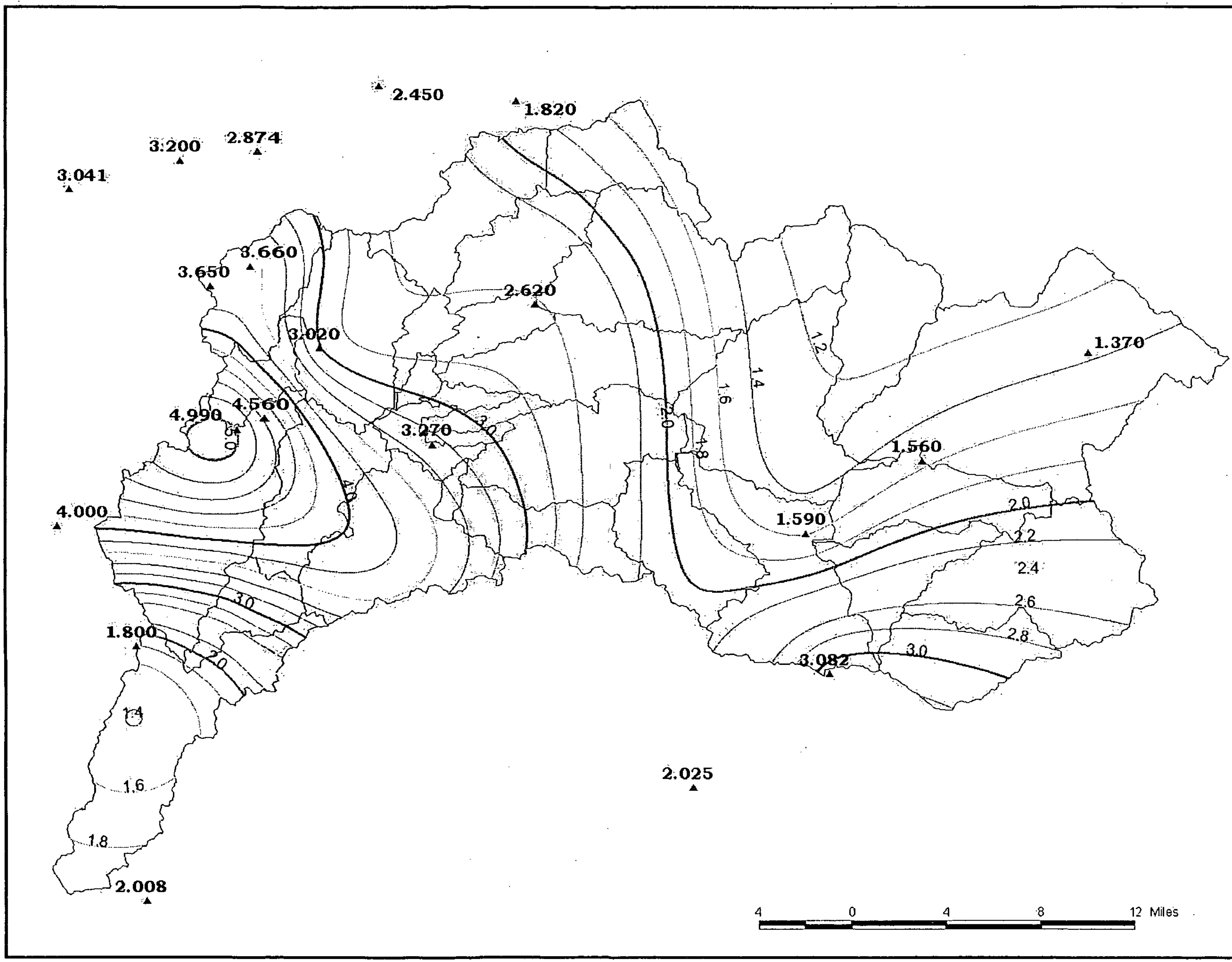

Figure 3-5
Precipitation Contours and Gage Totals (Inches) Over Santa Margarita Watershed for the February 1998 Storm Event

2.025 ▲ Precipitation Gage Locations and Totals (Typical)

N

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Figure 3-6

Ysidora Gage Flow Frequency Curves

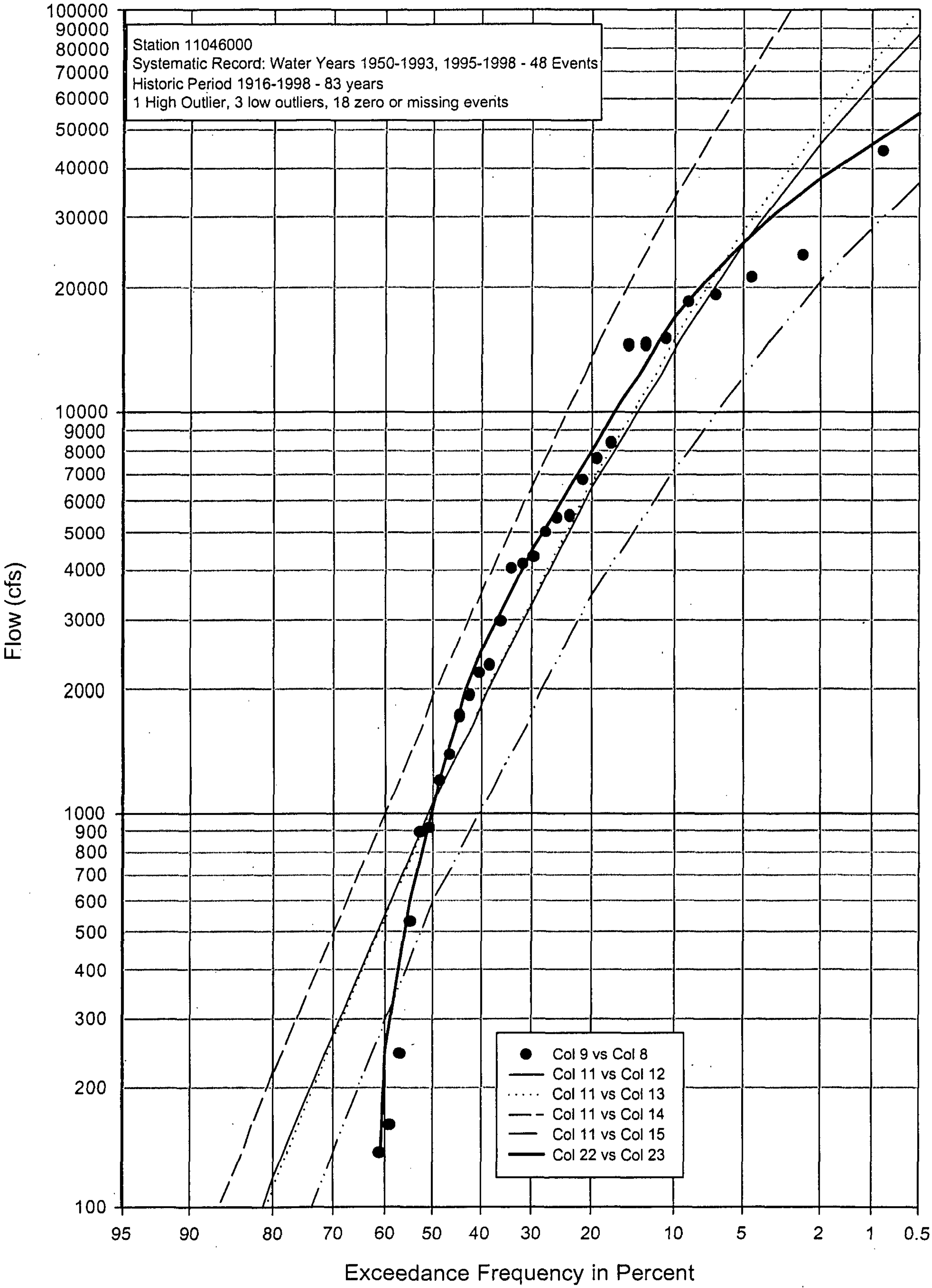


Figure 3-7

Fallbrook Gage Flow Frequency Curves

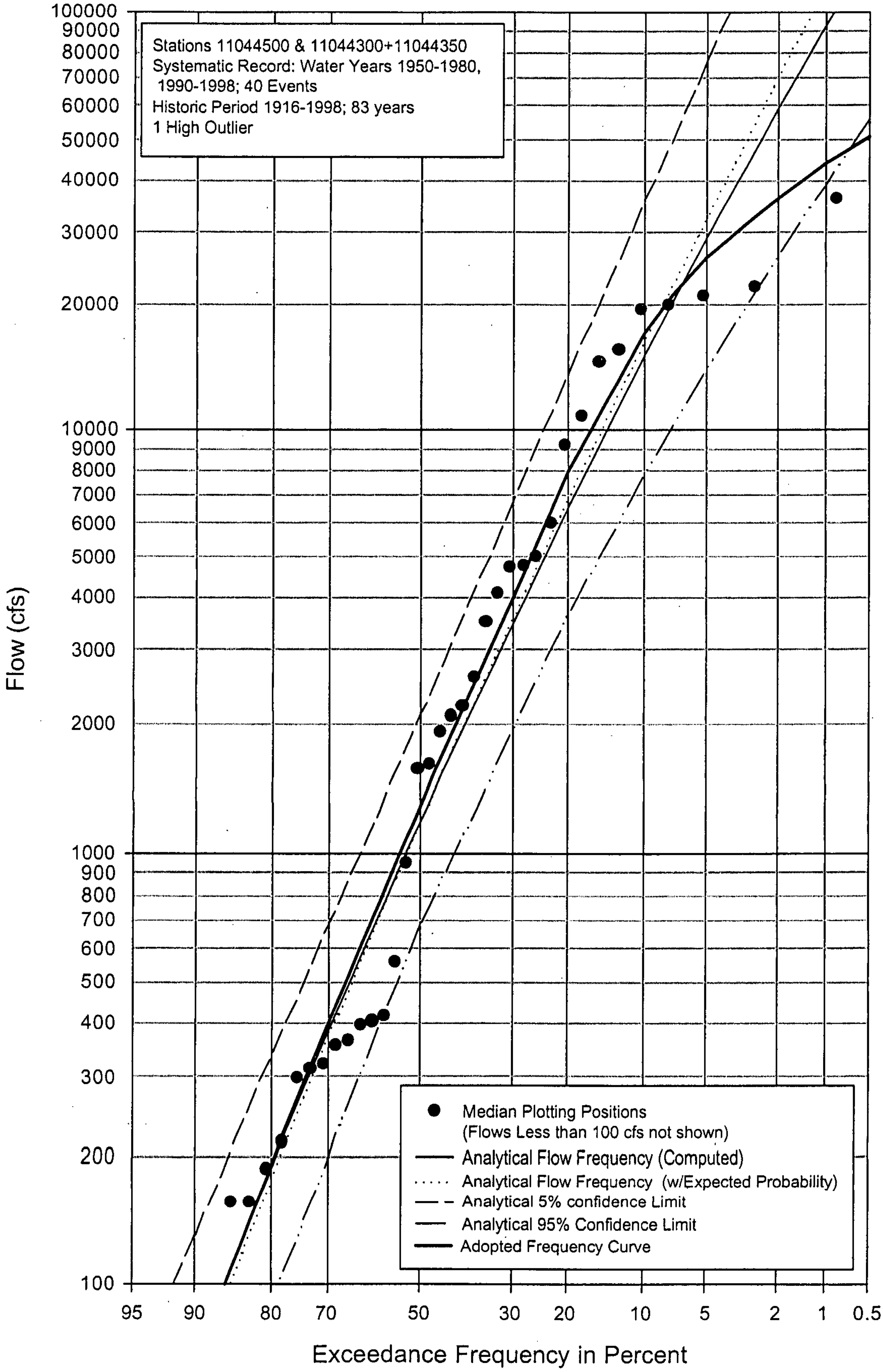


Figure 3-8

Temecula Gage Flow Frequency Curves

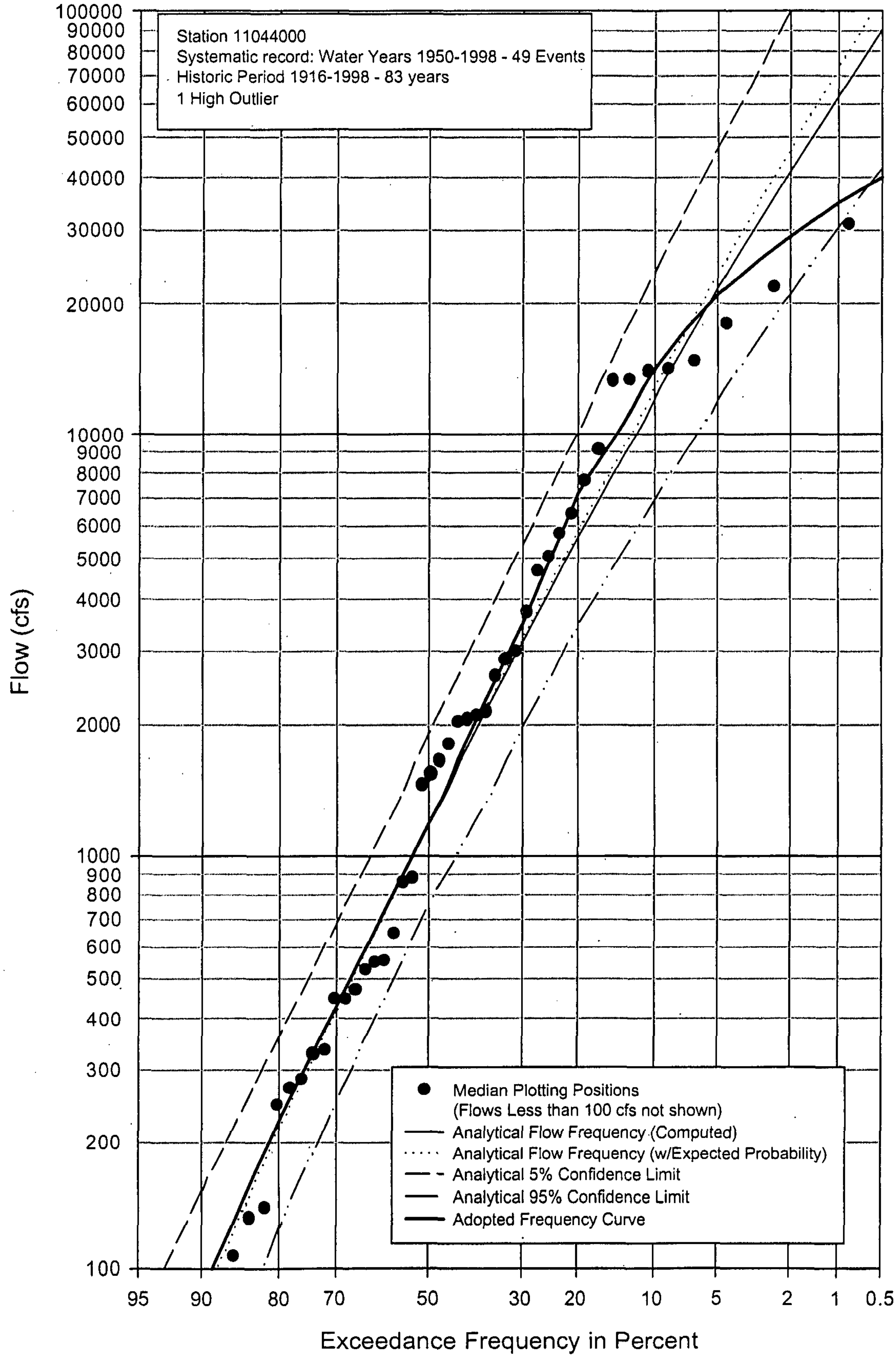


Figure 3-9

Ysidora Gage Volume Frequency Curves

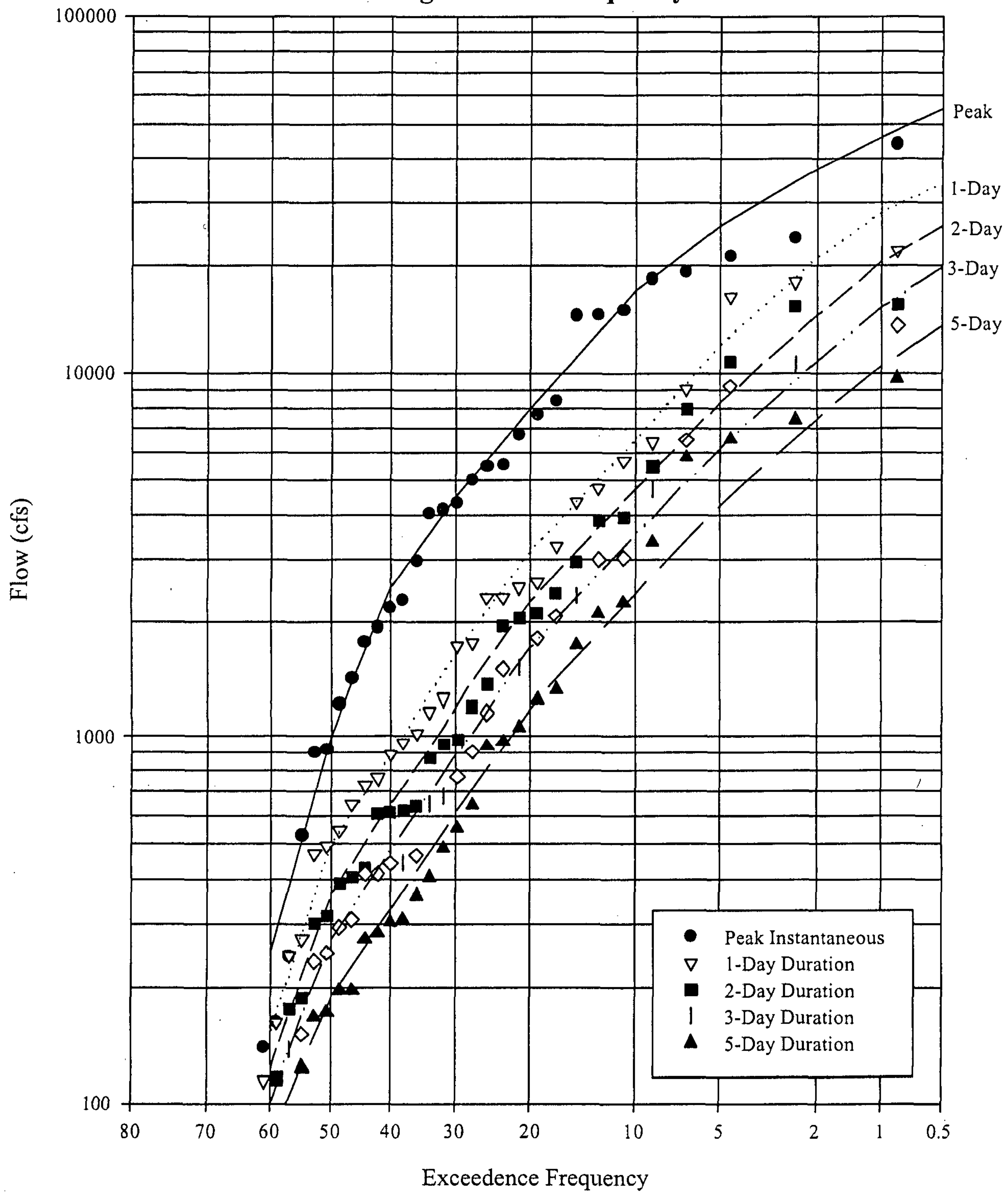
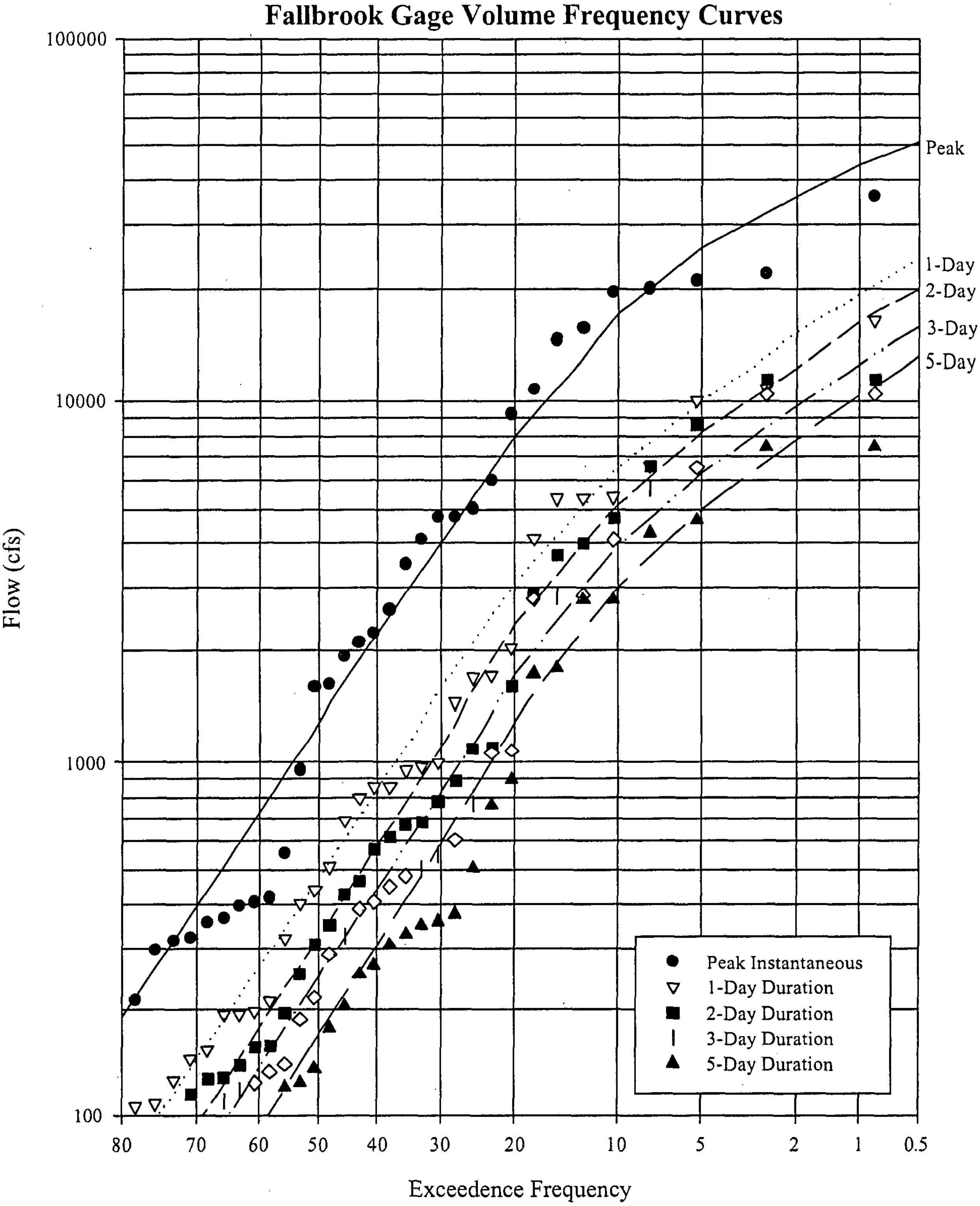
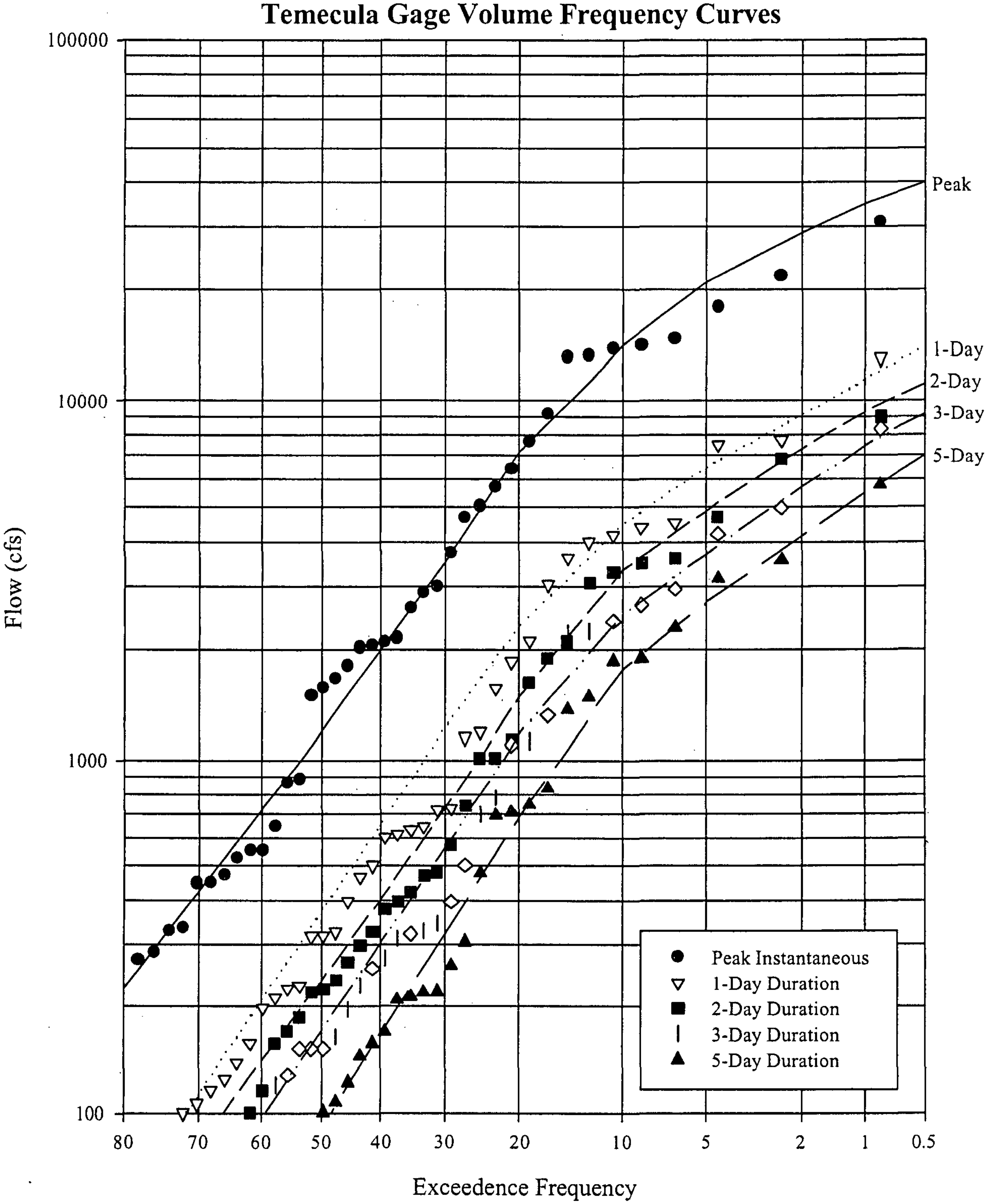


Figure 3-10



Fallbrook Gage Volume Frequency Curves
100000
10000
1000
100
Flow (cfs)
80
70
60
50
40
30
20
10
5
2
1
0.5
Exceedence Frequency
Peak
1-Day
2-Day
3-Day
5-Day
Peak Instantaneous
1-Day Duration
2-Day Duration
3-Day Duration
5-Day Duration

Figure 3-11



Temecula Gage Volume Frequency Curves
100000
10000
1000
100
Flow (cfs)
80
70
60
50
40
30
20
10
5
2
1
0.5
Exceedence Frequency
Peak
1-Day
2-Day
3-Day
5-Day
Peak Instantaneous
1-Day Duration
2-Day Duration
3-Day Duration
5-Day Duration

Figure 3-12. Ysidora Gage Balanced Hydrographs

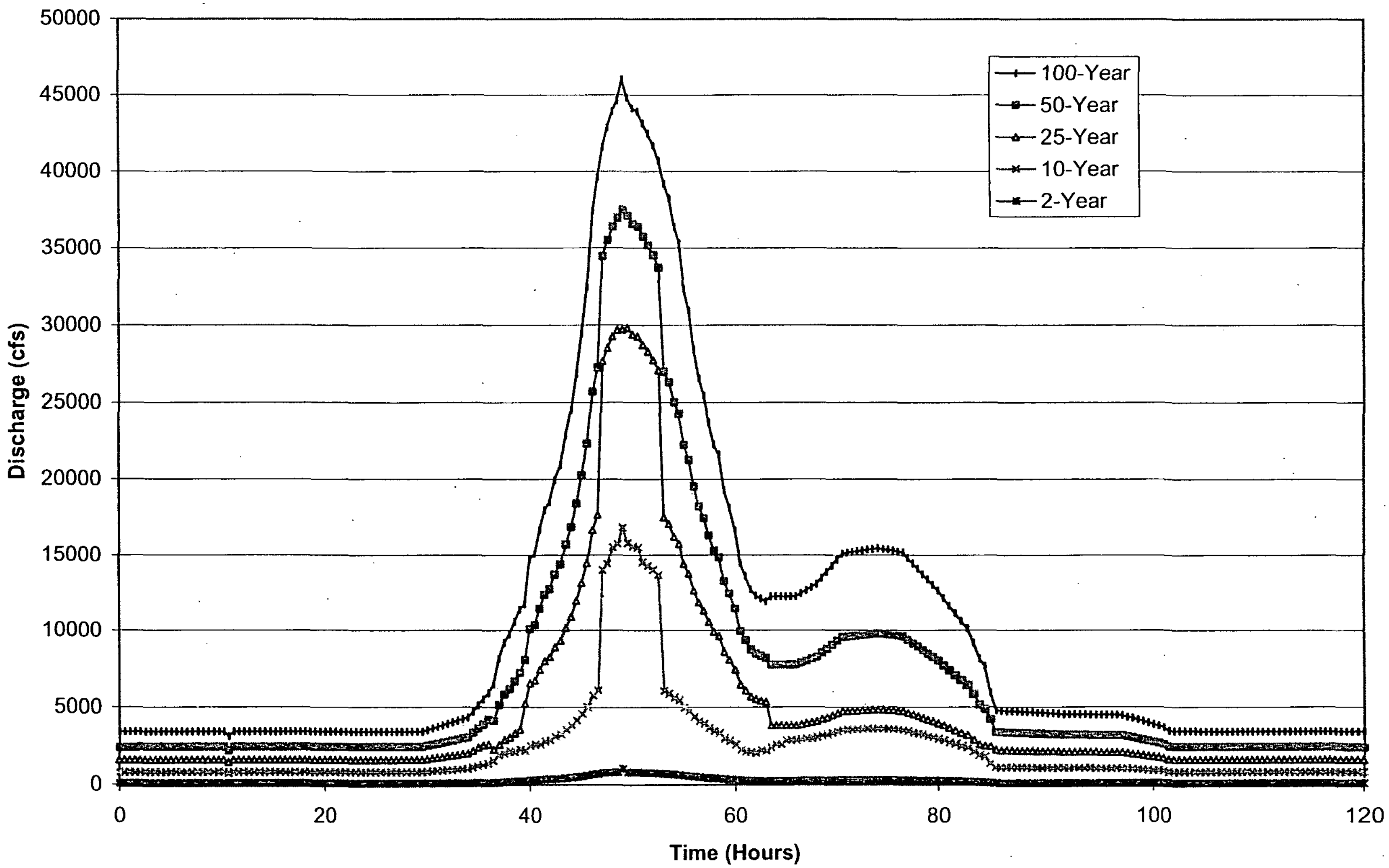


Figure 3-13. Fallbrook Gage Balanced Hydrographs

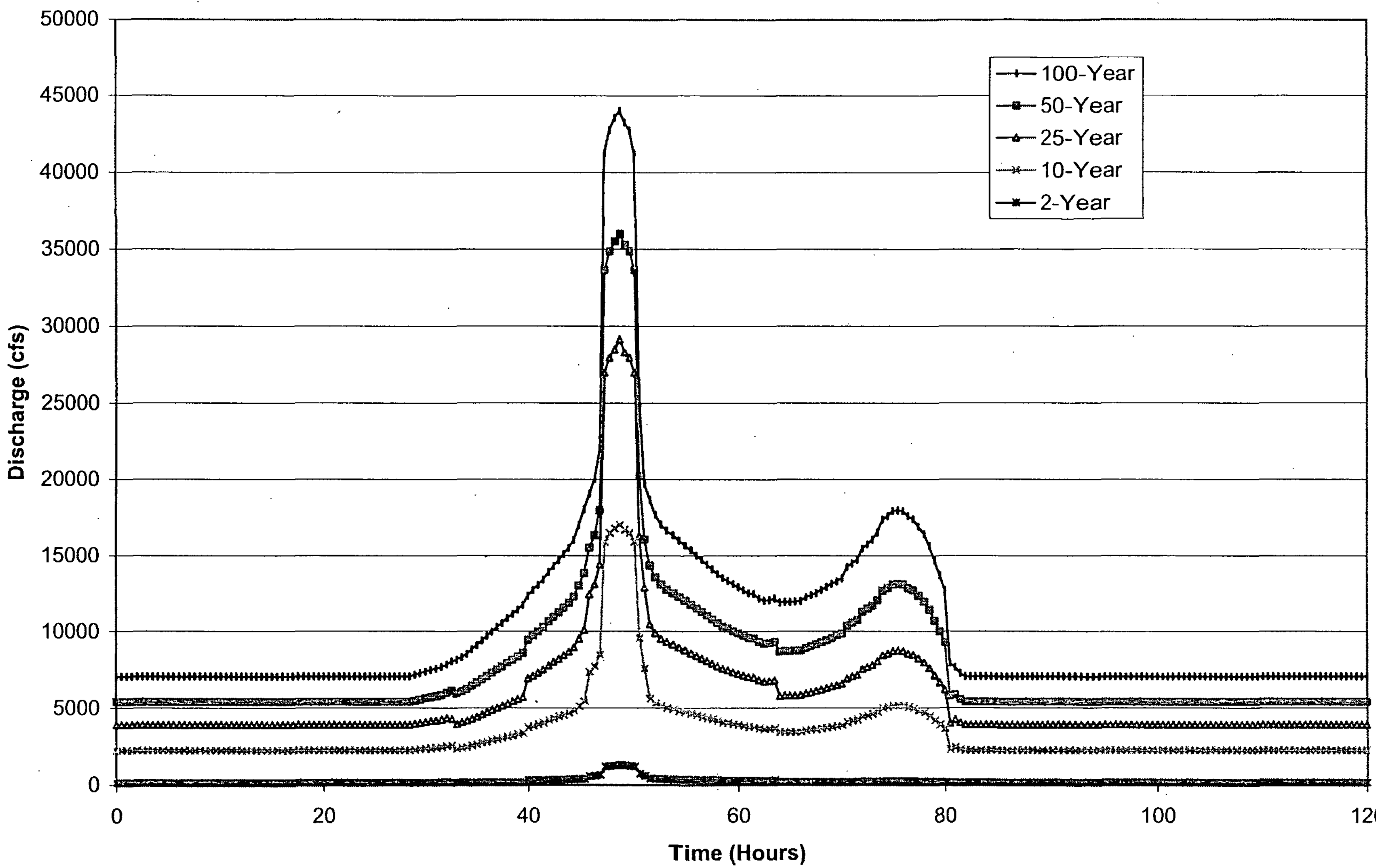
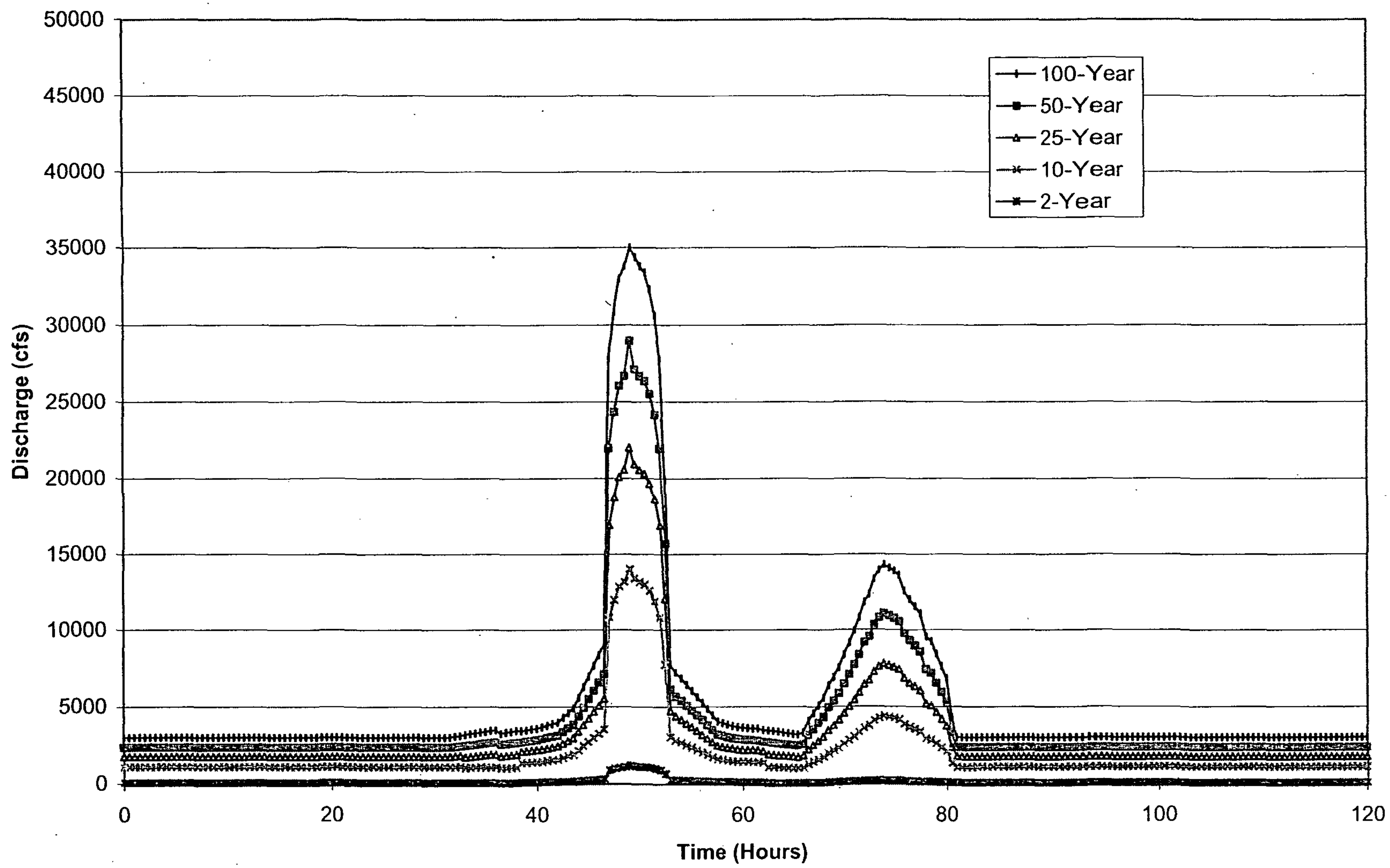


Figure 3-14. Temecula Gage Balanced Hydrographs



4 Hydraulics

4.1 Introduction

4.1.1 Purpose

WEST prepared a hydraulic model of the Santa Margarita River extending from the Pacific Ocean upstream to the confluence of Murrieta and Temecula Creeks. The hydraulic model is intended as a working tool to analyze various scenarios for the River and is a necessary precursor for the sediment transport model.

4.1.2 Previous Studies

Previous hydraulic studies or studies which include a hydraulic component include those by Leedshill-Herkenhoff (L-H, 1987), Simons, Li & Associates (SLA, 1995), and Northwest Hydraulic Consultants (NHC, 1997a, 1997b). These reports were reviewed and are summarized in the annotated bibliography.

4.1.3 Study Reach Description

The Santa Margarita River is modeled in its entirety from its birth at the confluence of Murrieta and Temecula Creeks to its outlet at the Pacific Ocean. The reach below the confluence of Temecula and Murrieta Creeks through Temecula Canyon consists of a steep, narrow, and rocky channel. From this point downstream, the canyon widens but continues fairly steep and narrow to the confluence with De Luz Creek. Below this point, the reduced slope and wider floodplain results in alluvial deposition and a densely vegetated overbank area. Downstream from the Stuart Mesa Bridge to the Pacific Ocean, the river progresses into a lightly vegetated coastal area.

4.2 HEC-RAS Model Development

The hydraulic model of the Santa Margarita was developed to analyze the 10-, 50-, and 100-year flood frequency events. The hydraulic model HEC-RAS, Version 2.2 (USACE, 1998b) was used for this study. New cross section geometry, as well sections from two previous models, were melded together to represent the river channel and overbank areas. New features were added and modifications were made to data from the previous models to simulate the existing conditions of the Santa Margarita River.

4.2.1 Geometric Data

WEST generated the model using new cross sections and cross-sectional geometry developed previously by SLA and NHC. Figure 4-1 shows the source of the geometric data used in the model for different portions of the river.

The SLA hydraulic model was prepared with computer generated contour files prepared by Hunsaker & Associates (referenced in SLA, 1995) and provided by the U.S. Army Corps of Engineers. The topographic map, dated February 10, 1994, provides contour intervals of 5-feet. The hydraulic model was originally analyzed using the U.S. Army Corps of Engineers Water Surface Profiles HEC-2 computer program. SLA's cross-sectional data covers the lower Santa Margarita River starting from the Pacific Ocean to cross section 54830 near the O'Neill Diversion Weir (Figure 4-1). SLA modeled Southbound Interstate 5 (I-5), Northbound I-5, and Stuart Mesa Road Bridges, which are located at cross sections 3050, 3632.5, and 6945, respectively. After importing the HEC-2 data into HEC-RAS, the bridge deck and pier geometry data was corrected to model the existing conditions.

The NHC HEC-RAS model was created for Winzler & Kelly in their design of a new levee and a new Basilone Bridge. The HEC-RAS model provided to WEST was used by NHC for sensitivity analysis purposes. Channel geometry for the model was determined from laser topography created following the 1998 storm event. NHC's cross-sectional data covers the lower Santa Margarita River from cross sections 20646 through 48145 (Figure 4-1). This model incorporates structures which are currently under construction: a new levee and floodwall around the airfield, the new Basilone Bridge crossing located at cross section 42448, and a guide vane upstream of the bridge. WEST made slight modifications to the bridge in the NHC model after checking all of the mentioned structures against the current project plans (with revisions dated January through March 1998) provided by the Camp Pendleton Public Works Department.

WEST Consultants generated new geometry for cross sections 55583 to 154453 (Figure 4-1). From cross sections 55583 to 93227 cross section geometry was obtained from Camp Pendleton Public Works Department topographic maps. The digital topographic maps provide 5-feet contour intervals. Cross-sectional data was obtained by "cutting" cross sections from the computer-generated contours using BOSS RiverCAD, an AutoCAD-based computer program.

From cross sections 94068 through 128383 topographic data was obtained from the San Diego County Department of Public Works (SDCPW). The topographic maps, dated August 25, 1986, provide 5-foot contour intervals. It must be noted that the vertical control is based on the National Geodetic Vertical Datum of 1929 (NGVD29).

Using Corpscon for Windows (USACE, 1997) the datum was corrected to the North American Vertical Datum of 1988 (NAVD88). Corpscon is a program created by the U.S. Army Corps of Engineers that can convert orthometric heights between NGVD29 and NAVD88. To adjust elevations from the NGVD29 datum to the NAVD88 datum 2.25 feet were added to the elevation values.

From cross sections 128883 through 154453 topographic data was obtained from United States Geology Survey (USGS) 7.5-minute quadrangle maps. The topographic maps, dated 1968, provide a contour interval of 20-feet based upon NGVD29 datum. Cross sections generated with these maps were not adjusted to NAVD88. Adjustment to the 1988 datum for these sections was not performed. This was because the 2.25-foot adjustment would be unnoticeable given the accuracy of ground points obtained from a 20-foot contour interval map.

WEST added the De Luz Road and Sandia Creek Drive crossings to the HEC-RAS model. The De Luz Road bridge dimensions were obtained from plans, dated March 1993, provided by the County of San Diego Department of Public Works. This wooden bridge was constructed under emergency conditions after the previous dip crossing was destroyed during the 1993 floods. The crossing, located at cross section 95687.44 was modeled with a skew angle of 45-degrees to represent the high water flow angle of attack to the upstream bridge face. Dimensions for the Sandia Creek Drive crossing, located at cross section 106612, were obtained from as-built plans, dated July 1980, provided by the County of San Diego Department of Transportation. This crossing consists of ten box culverts with the roadway designed to be overtopped during larger flood events.

After merging the SLA and NHC geometry data with new WEST sections, the final cross-sectional layout is as shown on the maps provided in Appendix E. The source of the cross section data, shown graphically in Figure 4-1, is repeated in Table 4-1.

The cross section numbering corresponds roughly to the distance in feet along the main channel upstream from the mouth of the river at the Pacific Ocean (cross section 0). Because the original cross numbering scheme from the SLA study was maintained for consistency between the studies, actual distance can vary by up to 2,000 feet from the cross section number. NHC cross sections were re-numbered to conform to the SLA cross section numbering. WEST cross section numbers increase from the SLA cross section number at the diversion weir (54830) by the measured channel distance (in feet) between cross sections.

4.2.2 Manning's "n" Values

Manning's "n" values representing the roughness of the channel and the overbanks were determined based upon field observations and reference to pertinent publications such as Chow (1959) and Barnes (1967). In addition, Manning's "n" values were computed using Jarrett's equation (Jarrett, 1984), which relates the roughness coefficients with cross-sectional hydraulic parameters. This equation was developed for high gradient streams with large particle sizes and was deemed applicable to the upper reaches of the river. No historical water surface profiles or reliable gage data from previous flood events were available to calibrate "n" values.

The upstream portion of the study reach consists of a steep, narrow, and rocky channel. Based on the results from Jarrett's equation, as well as experience and the cited references, we selected roughness values of 0.053 for the main channel and 0.055 for the overbanks for the range of flows modeled. Further downstream, the channel widens and continues through a steep and narrow section to the De Luz Creek confluence. This section can contain dense vegetation and noticeable sand bars. Manning's "n" values of 0.045 for the channel and 0.07 to 0.1 for the overbanks were selected this reach. From De Luz Creek to Stuart Mesa Road (the majority of the river located inside MCB Camp Pendleton) the channel has a sand bed and is often flanked by very dense vegetation. Channel roughness values were set at 0.035 to 0.045 and overbank values at 0.07 to 0.1. The reach section from Stuart Mesa Bridge to the Pacific Ocean is a lightly vegetated coastal zone. The "n" values are 0.025 to 0.035 for the channel and 0.04 to 0.07 for the overbanks. A summary of Manning's n values for the study reach is given in Table 4-2.

4.2.2.1 Comparison with Previous Studies

Different Manning's n values were used in previous studies. The L-H (1987) study roughness values are shown in Table 4-3. These were determined:

> "...based on recommendations made in the San Diego County Flood Control Manual (Jan. 1985), and on field observations. The roughness coefficient of 0.025 was used where there is a smooth, sandy, well-defined channel. A coefficient of .045 was used where there is a heavy, vegetative cover. The channel overbank roughness varies from .025 to .050. The roughness for the lagoon overbank is between .025 and .030. Upstream overbank varies from .030 in smooth, sandy reaches to .050 in well-vegetated reaches."

The SLA model using 1994 topography modified the L-H values "based upon field evaluation of current roughness conditions." These are shown in Table 4-4. It should be noted that SLA also performed a sensitivity analysis for their selected project alternative (new levee construction around the airfield) where "n" values were raised to 0.08 "in portions of the floodplain." Review of the SLA model output indicates that roughness values for the channel and both overbanks were raised to 0.08 along the length of the proposed levee from near the wastewater treatment plant (section 28235) to above the Basilone Road Bridge and Ranch House (section 46075). Comparisons made by SLA between their existing conditions model (values shown in Table 4-4) and with-project high roughness model ("n" = 0.08 in project reach) showed increases in computed water surface elevations of up to 9 feet for the study's 100-year flow (64,000 cfs). Associated decreases in velocity were up to 8 ft/s.

The NHC base hydraulic model (1997a) contained two roughness scenarios: "normal", with a channel roughness of 0.025 and overbank roughness of 0.06 for the entire study reach, and "high" with a roughness coefficient of 0.08 for both the channel and overbanks (Tables 4-5). The "normal" scenario was chosen to represent "current vegetation conditions in the river," although no additional details were given as to how the particular values were chosen. Using a 100-year discharge of 64,000 cfs, NHC found flow depths were up to 4 feet higher and velocities up to 3 ft/s lower when the high roughness scenario results were compared with the "normal" roughness scenario results.

It should be noted that, due to limited gage data (especially during large events) and the effects of bridges and levee failures, no hydraulic roughness calibration has been performed, to our knowledge, on the Santa Margarita River.

4.2.3 Ineffective Flow Areas

Throughout the model, ineffective flow areas were defined at cross sections to separate areas of active conveyance from areas where ponding occurs. Modifications were made to both the SLA and NHC ineffective flow areas. Additionally, some areas modeled as blocked obstructions were changed to ineffective flow areas to better represent the hydraulics of the Santa Margarita River. This was done because, in HEC-RAS, blocked obstructions add wetted perimeter to the cross section (i.e., increased flow resistance) while ineffective flow boundaries do not add wetted perimeter. Blocked obstructions, in general, should be used where physical barriers exist while ineffective flow boundaries should separate active conveyance and ponding areas. The levee along the airfield (currently under construction) was modeled using blocked obstructions.

4.2.4 Model Discharges

Frequency analysis was used to determine discharge rates at three gauging stations located along the Santa Margarita River (see Chapter 3). Frequency flows obtained from the Ysidora gage analysis were applied to the reach between the Pacific Ocean and De Luz Creek. Flows from the Fallbrook gage analysis were applied to the reach between De Luz Creek and Rainbow Creek. Upstream of Rainbow Creek, to the confluence of Murrieta and Temecula Creeks, flow results from the Temecula gage were applied. Table 4-6 shows the flow change locations and the discharge rates for the different storm events modeled.

4.3 Model Results

Water surface profiles developed from the 10-, 50-, and 100-year flows are shown in Appendix F. Calculated water surface elevations, and velocities, along with other hydraulic parameters, are presented in tabular format in Appendix G. To obtain greater accuracy in the computed profiles, interpolated cross sections were used when the channel cross section spacing exceeded 1500 feet. Interpolated cross sections are indicated with an asterisk in both the profile plots and tabular output. From the water surface profile plots, the effect of the bridges on the water surface profiles may be noted. While the 50- and 100-year storm events overtopped Stuart Mesa Road, all storm events overtopped Sandia Creek Drive and De Luz Road. Significant backwater effect occurs at the De Luz Road Bridge and the weir section at cross section 55583.35 (O'Neill Diversion Weir). The other structures in the model do not create significant backwater.

Plots of the model cross sections are located in Appendix H. From these plots one can see the ineffective and blocked flow areas, structures, and computed water surface elevations for the three modeled events.

4.4 Floodplain Delineation

Lateral limits of the 10-, 50-, and 100-year floodplains are plotted on the cross section location maps presented in Appendix E. Floodplain limits were delineated by applying the computed water surface elevations from the HEC-RAS model to the 1994 Camp Pendleton topography, from the ocean to the eastern edge of the base (near cross section 96818). It is important to note that some of the cross sections were developed from different topographic data as previously discussed. Water surface elevations between cross sections were interpolated between the values at the bounding cross sections.

4.5 Discussion

The accuracy of the water surface profiles depends principally on two factors: the cross section geometry and estimated roughness coefficients. Because of lack of data for calibration, the Manning's "n" values were estimated as described above and are reasonably conservative for determining water surface elevations for flood inundation purposes. There is concern, however, regarding the accuracy of the survey data.

The Winzler & Kelly (W&K) aerial survey was prompted by discovery of important deficiencies in the survey data used in the SLA (1995) study. Because of the limited extent of the W&K aerial surveys, WEST used SLA data both upstream and downstream of the NHC model limits (developed using W&K survey data). The Camp Pendleton topographic data is also from 1994 surveys, and appears very similar to the topography used by SLA in spot checks performed by WEST. Information provided by the Base is not sufficient to determine if the topography is the same as that used by SLA or was obtained from a different surveyor. In any case, the SLA model cross sections have widely spaced ground points in many instances, and for some cross sections a constant elevation across an overbank area appears to represent the top of vegetation. Use of five-foot contour data in much of the model will also limit the accuracy of computed water surface profiles. In the upper river reach where cross sections were obtained from the USGS topographic maps, the results should be considered approximate. Therefore, for a more accurate estimation of water surface profile elevations, consideration should be given to new surveys in the study reach.

Table 4-1. Cross Section Data Sources

Cross-Sections	Creator	Topography
0-20620	Simons, Li & Associates	USACE, 1994
20646-48145	Northwest Hydraulic Consultants	Winzler & Kelly, 1998
49580-54830	Simons, Li & Associates	USACE, 1994
55583-93227	WEST Consultants, Inc.	Camp Pendleton, 1994
94068-128383	WEST Consultants, Inc.	SDCPW, 1986
128883-154453	WEST Consultants, Inc.	USGS, 1968

Table 4-2. Manning's "n" Values, Present Study

Cross-Section(s)	LOB	CHANNEL	ROB
0-3585	0.040	0.025	0.040
3680-6930	0.060	0.035	0.060
6960-24948	0.070	0.035	0.070
25422-36912	0.100	0.035	0.100
37324-42425	0.070	0.035	0.070
42471-56240.52	0.100	0.045	0.100
56780.57	0.070	0.045	0.100
57470.75	0.070	0.045	0.100
58918.76	0.100	0.045	0.070
59981	0.100	0.045	0.085
61043.39	0.100	0.045	0.100
61803.02	0.070	0.045	0.100
62602.5	0.080	0.045	0.100
63402.09	0.100	0.045	0.100
64421.6	0.085	0.045	0.100
65441.11	0.070	0.045	0.100
66215.1	0.070	0.045	0.085
66989.14-67901.5	0.070	0.045	0.070
69275.12-69979.46	0.070	0.045	0.100
70966.85-74195.95	0.070	0.045	0.070
74615.51-84060.79	0.100	0.045	0.100
84866	0.100	0.045	0.085
85671.33	0.100	0.045	0.070
86547.69	0.070	0.045	0.100
87513.7	0.085	0.045	0.100
88479.84-94068.04	0.100	0.045	0.100
94468.04-123483	0.055	0.045	0.055
125583-154453	0.055	0.053	0.055

Table 4-3. Manning's "n" Values used by L-H (1987)

Cross-Section(s)	LOB	CHANNEL	ROB
0-6085	0.03	0.025	0.025
6440-8230	0.03	0.035	0.03
8910	0.035	0.035	0.035
9600-14640	0.045	0.04	0.045
14920-19820	0.03	0.045	0.045
20590-21930	0.05	0.045	0.045
22610-29185	0.05	0.035	0.05
30125-41905	0.03	0.035	0.045
42305-46075	0.035	0.045	0.05
46705-54830	0.045	0.035	0.035

Table 4-4. Manning's "n" Values used by SLA (1994)

Cross-Section(s)	LOB	CHANNEL	ROB
0-3585	0.04	0.025	0.04
3680-29185	0.06	0.035	0.06
30125-33610	0.05	0.035	0.06
34810-54830	0.05	0.035	0.05

Table 4-5. Manning's "n" Values used by NHC (1997a)

Cross-Section(s)	LOB	CHANNEL	ROB
20646-48145 "base conditions"	0.06	0.025	0.06
20646-48145 sensitivity analysis	0.08	0.08	0.08

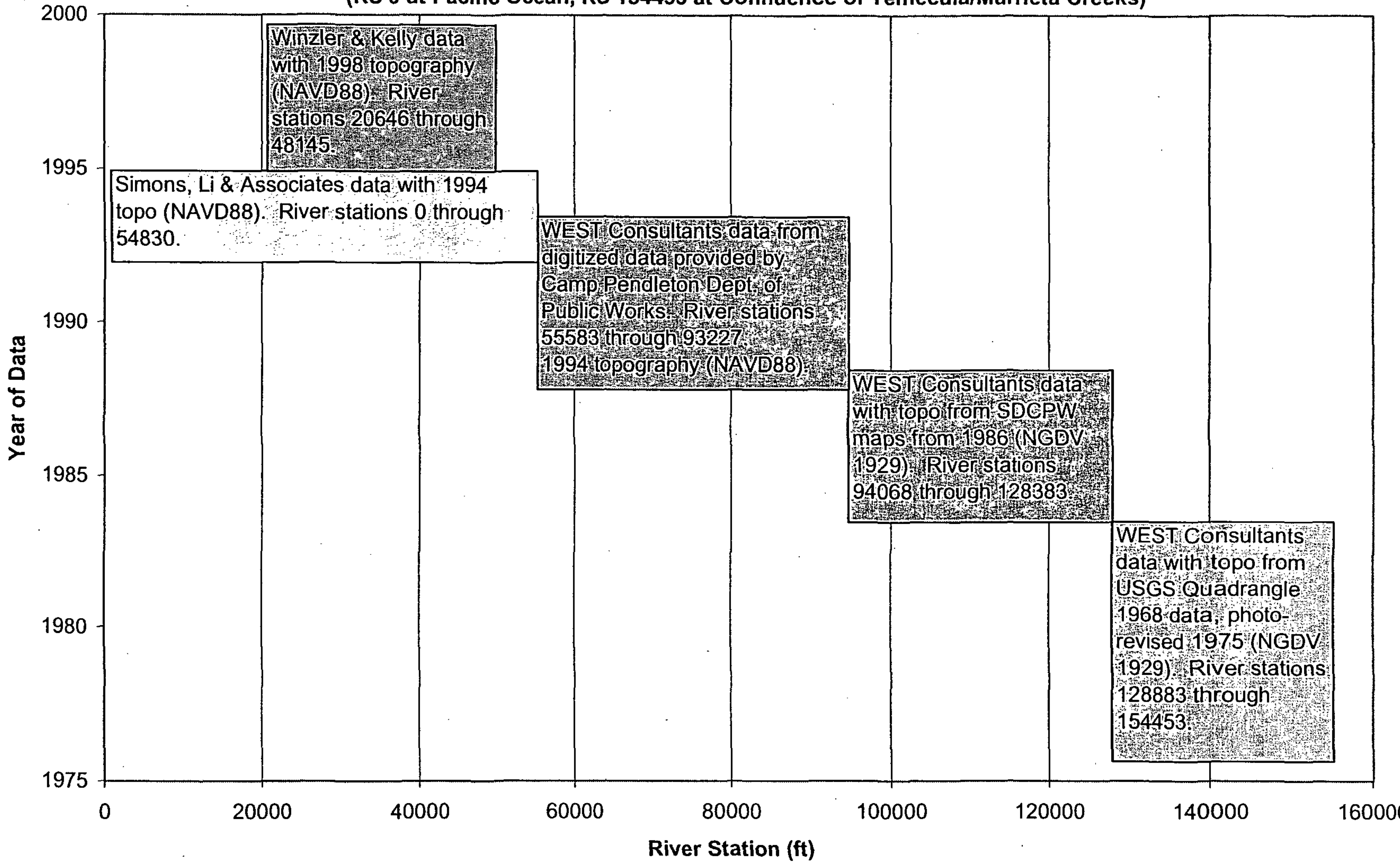
Table 4-6. Model Discharges

River Reach (River Stations)	10-Year Discharge (cfs)	50-Year Dischrage (cfs)	100-Year Discharge (cfs)
119033 - 154453	14,000	29,000	35,000
65441 - 116033	17,000	36,000	44,000
0 - 63402	17,000	37,500	46,000

Figure 4-1

Channel Geometry Data Sources for the Santa Margarita River

(RS 0 at Pacific Ocean, RS 154453 at Confluence of Temecula/Murrieta Creeks)



5 Sediment Yield

5.1 Introduction

As a part of this study, a qualitative assessment of sediment yield is to be performed for the upper and lower subbasins. The scope of work specifically states that average annual sediment yield should be computed using regional methods such as the Pacific Southwest Interagency Committee (PSIAC) method. The scope of work also requires application of the Los Angeles District Corps of Engineers Debris Method on five balanced-hydrograph floods to estimate average annual sediment production.

Of the many methods available to estimate sediment production, some give average annual sediment yield, while others provide estimates of sediment yield for a given storm hydrograph. It was decided to use average annual sediment yield to make a qualitative assessment of the sediment yield for each subbasin. For the methods that estimate sediment production or yield for a given storm, the sediment yield was computed for six frequency floods (2-, 5-, 10-, 25-, 50-, and 100-years) and then was integrated over a probability graph to get the average annual sediment yield. The flood peak and volume for 2-, 10-, and 100-year frequency storms were taken from PWA's (1998) HEC-1 model corresponding to a 6-hour subbasin scale storm duration and assuming historic mean storage for Vail and Skinner reservoirs. The peak flow and volume were plotted on a log-probability graph to interpolate the corresponding values for 5-, 25-, and 50-year floods. Appendix I contains the peak flow and volume plots and Table 5-1 shows the peak flow and volume values interpolated from these plots.

The results from various methods are in different units such as acre-ft, cubic yards (yd^3) and tons. For comparison purposes, sediment yield for all methods are converted into units of acre-ft/mi^2. The dry unit weight of the sediment used in this conversion was estimated (Vanoni, 1977) as 93 pounds/ft^3.

The following methods were used in estimating sediment yield:

1. Pacific Southwest Inter-Agency Committee (PSIAC)
2. U.S. Army Corps of Engineers, Los Angeles District (LA Corps)
3. Modified Universal Soil Loss Equation (MUSLE)
4. Dendy and Bolton
5. Brownlie and Taylor
6. Taylor
7. SCS Sediment Yield Map

A description of each method follows.

5.2 PSIAC method

5.2.1 Background

The Pacific Southwest Inter-Agency Committee (PSIAC) method for computation of watershed sediment yield is a regional method intended for use in the Pacific Southwest of the United States (PSIAC, 1968.) It was developed with regard to the geologic, climatic, and hydrologic conditions found in this area. The method was developed primarily for planning purposes, and results in a range of expected annual sediment yield values. It is meant for use with relatively large areas, generally no smaller than 10 square miles. The PSIAC method has been found to correlate well with measured data in Southwestern United States (Shown, 1970; Renard, 1980).

5.2.2 Computation

The PSIAC method divides sediment yields in the Pacific Southwest into five classes based on average annual yield in acre-feet per square mile (shown in Table 5-2). Each of these classes is associated with a PSIAC yield rating that is calculated by summing nine coefficients describing the characteristics of the watershed. The nine coefficients are associated with the following factors: surface geology, soils, climate, runoff, topography, ground cover, land use, upland erosion, and channel erosion and sediment transport. A description of each factor and the values assigned to it in this study is given below. Rating values for each of the subbasins are shown in Table 5-3.

5.2.3 Surface Geology

The surface geology coefficient describes the influence of the types of rock found in outcrops and other areas devoid of soil. Weaker and softer rocks are more readily erodible and therefore contribute more to sediment yield than types that are more resistant. The coefficient ranges from 0 to 10 and is based on the hardness and weathered condition of rocks in the area.

Information about the surface geology of each of the 34 subbasins in the current study was taken from Soil Conservation Service (SCS) soil surveys of Riverside County (SCS, 1971) and San Diego County (SCS, 1973). These surveys provided information on the content of bed material and depth of surface soils. Different rock types were assigned coefficients based on their relative hardness and on the amount of exposed material. The degree to which the rock within an area is exposed is important as soil protects the rock from weathering. Since no information was available on the amount of exposed formations, areas with shallow soil depths and high elevations were assumed to have more exposed rock and were assigned higher coefficients.

Coefficients assigned to each soil classification found in the watershed are shown in Table 5-4. Each subbasin was assigned an average surface geology coefficient by weighting the coefficients for each soil classification by area. The size of subbasins 10 and 34 made it difficult to determine the distribution of soil classes within them. Therefore, values assigned to these two subbasins are the averages of values assigned to subbasins surrounding them. The calculation of the basin average coefficients is shown in Table 5-5.

5.2.4 Soils

The soil factor describes the resistance of soil against erosion. This is a function of the soil binding material, climate, type of vegetation growth on soil, and accumulation of rock fragments/calcareous material (caliche) on soil. The soil factor varies between 0 and 10, with a value of 0 assigned to soil with a high percentage of rock fragments and a value of 10 assigned to fine textured soils. For lack of any detailed information that relates to the soil coefficients, soil coefficient values were related to hydrologic soil group, which is indirectly related to soil texture. Soil coefficient values assigned to each hydrologic soil group are shown in Table 5-6. Figure 5-1 shows the variation of hydrologic soil group. The average soil factor over each subbasin was computed and is reported in Table 5-3.

5.2.5 Climate

The climate coefficient describes the influence of the intensity and frequency of rainfall events as well as other factors such as temperature, winds and snow. It has values ranging from 0 to 10.

The climate coefficient was assumed constant throughout the entire watershed because the factors mentioned above can generally be considered homogeneous in the region. A value of 2 was assigned to the watershed to reflect the mild climate and very low frequency, low intensity rainfall typical of Southern California.

5.2.6 Runoff

The runoff coefficient reflects the relative amount of runoff per unit area experienced by a subbasin and its effect on soil erosion. Values can range between 0 and 10, with a value of 10 assigned to an area with high runoff and volume per unit area, and a value of 0 assigned to an area with rare runoff events.

Coefficients were assigned to each basin based on runoff values calculated by WEST HEC-1 for the 1993 extreme storm event. Values were assumed to be between 2 and 7, reflecting relatively moderate peak flows and volumes per unit area. Based on this assumption, coefficients were calculated by applying a liner interpolation to the data. Calculations of subbasin runoff coefficients are shown in Table 5-7.

5.2.7 Topography

The topography coefficient quantifies the effect of watershed slope, floodplain development, drainage patterns and size on sediment yield. It has values ranging from 0 to 20.

Coefficients were assigned to each subbasin based on average slopes calculated for the MUSLE method. The full range of values was used to describe the wide variation in slope encountered in the mountainous and coastal areas within the watershed. The average subbasin slopes and their respective topography coefficients are shown in Table 5-8.

5.2.8 Ground Cover

The ground cover coefficient describes how well soils are protected from precipitation by items such as vegetation, litter, and rock fragments. It has values ranging from –10 to 10. A value of –10 is assigned to areas completely protected by vegetation, rock fragments and/or litter, such that there is little opportunity for rainfall to reach erodible material. A value of 10 is assigned to areas with ground cover not exceeding 20 percent, sparse vegetation, little or no litter, and no rock in surface soils.

Vegetation was used as the main factor in determining values for this coefficient. The large size of the watershed and limited accessibility to remote areas as well as low detail in topographic maps prevent accurate estimates of quantities of litter and rock. Each of the different types of ground cover found in the watershed was assigned a coefficient based on the degree of protection it provides from the impact of rainfall and erosion caused by runoff. Important factors include density, canopy coverage, surface coverage, and root system. The values associated with each ground cover classification are shown in Table 5-9. GIS was used to calculate an area weighted average coefficient for each subbasin based on these values. The distribution of vegetation coverage throughout the watershed is shown in Figure 5-2. The distribution of ground cover coefficients throughout the watershed is shown in Figure 5-3.

5.2.9 Land Use

The land use coefficient reflects the impact that the alteration of the land from its natural state has on sediment yield. Cultivation, high intensity grazing, fires, logging, and construction activities work to increase erosion. Urban development may decrease sediment yields locally but may have negative impacts on surrounding areas due to increased runoff. The land use coefficient has values ranging from –10 to 10.

Weighted average coefficients for each subbasin were determined in a manner similar to that used for ground cover. Different classifications of land use were assigned values and average coefficients were calculated using GIS. Values associated with the land use classifications are shown in Table 5-10 and their distribution throughout the watershed is shown in Figure 5-4.

5.2.10 Upland Erosion

The upland erosion coefficient describes the overall tendency for soils beyond the limits of valleys to erode. It is characterized by the development of rills and gullies and is associated with several factors mentioned above. It has values ranging from 0 to 25.

Qualitative information about the watershed was not available due to limited land accessibility and resolution of aerial photography. Therefore, values for this coefficient were related to the soil erodibility factors calculated for each subbasin for the MUSLE method. Extreme (high and low) values of the MUSLE soil erodibility factor were taken from Maidment (1992) and assigned to the extreme values for the PSIAC upland erosion coefficient to relate the soil erodibility factor with the upland erosion coefficient. Coefficients for each subbasin were then calculated by applying a linear interpolation between these values. Calculation of these coefficients is shown in Table 5-11.

5.2.11 Channel Erosion and Sediment Transport

The channel erosion and sediment transport coefficient quantifies the contribution of bank and streambed erosion to the sediment yield of an area. Important factors to consider are observed channel conditions, flow depth and duration, channel slope, cross section, and material. The coefficient has values ranging from 0 to 25.

Values were assigned to each subbasin based on observations and consideration of channel material and slope. The full range of values was used to characterize natural and constructed channels of varying slope. Coefficients for each subbasin are shown in Table 5-3.

5.3 U.S. Army Corps of Engineers, Los Angeles District Method (LA Corps)

5.3.1 Background

This method (USACE, 1992a) was developed to estimate unit debris yield values for "n-year" flood events for the design and analysis of debris-catching structures in coastal Southern California watersheds, considering the coincident frequency of wildfire and flood magnitude. This method is intended for coastal-draining, mountainous, Southern California watersheds. Outside of the area from which the data were collected and used to develop the method (San Gabriel Mountains), the Adjustment and Transposition (A-T) Factor must be carefully applied. The method is applicable to watersheds of area 0.1 to 200 mi^2, and is intended for watersheds with a high proportion of their total area in steep, mountainous terrain. The storm frequency has to be more than 5 years for good accuracy and the method should not be used to estimate debris yield resulting from runoff events of less than 3 cfs/mi^2. Best results will be obtained for watersheds that have undergone significant antecedent rainfall. In most cases, this antecedent rainfall condition will be satisfied when the watershed has received at least 2 inches of prior rainfall in approximately 48 hours.

The following equations are used in estimating the sediment yield. The equations in this method were obtained after performing multiple regression analysis on the available data.

Equation 1: Valid for watersheds from 0.1 mi^2 to 3.0 mi^2 in area.
$$\text{LOG } Dy = 0.65 (\text{LOG } P) + 0.62 (\text{LOG } RR) + 0.18 (\text{LOG } A) + 0.12 (FF)$$

Equation 2: Valid for watersheds from 3 mi^2 to 10 mi^2 in area.
$$\text{LOG } Dy = 0.85 (\text{LOG } Q) + 0.53 (\text{LOG } RR) + 0.04 (\text{LOG } A) + 0.22 (FF)$$

Equation 3: Valid for watersheds from 10 mi^2 to 25 mi^2 in area.
$$\text{LOG } Dy = 0.88 (\text{LOG } Q) + 0.48 (\text{LOG } RR) + 0.06 (\text{LOG } A) + 0.20 (FF)$$

Equation 4: Valid for watersheds from 25 mi^2 to 50 mi^2 in area.
$$\text{LOG } Dy = 0.94 (\text{LOG } Q) + 0.32 (\text{LOG } RR) + 0.14 (\text{LOG } A) + 0.17 (FF)$$

Equation 5: Valid for watersheds from 50 mi^2 to 200 mi^2 in area.
LOG Dy = 1.02 (LOG Q) + 0.23 (LOG RR) + 0.16 (LOG A) + 0.13 (FF)

The variables used in the above equations are:
Dy = Unit Debris Yield (yd^3/mi^2)
P = Maximum 1-Hour Precipitation (inches, rounded to two places after decimal point, multiplied by 100)
RR = Relief Ratio (ft/mi)
A = Drainage Area (ac)
FF = Non-Dimensional Fire Factor
Q = Unit Peak Runoff (cfs/mi^2).

This method was applied to each subbasin of the Santa Margarita River Watershed for flows with return frequencies of 100, 50, 25, and 10, and 5 years. The method was not applied to 2-year frequency flows because this method is limited to frequency flows greater than or equal to 5 years. Yields associated with the 2-year event or from subbasins having unit discharge less than 2 cfs/mi^2 flows were not directly computed. Debris yields for such cases were extrapolated from calculated values. Appendix J shows the sediment yield plotted on a normal probability scale. The fitted lines on these plots were used to extrapolate the sediment yield. Extrapolation sometimes resulted in negative values, in which case a value of zero was assumed.

The average annual sediment yield was computed from the frequency the sediment yields by integrating the latter with probability of occurrence. Finally, the average annual sediment yield was multiplied by A-T the factor to account for the change in location from the watershed upon which the model is based. Tables 5-12 through 5-16 show the computations for each frequency. Table 5-17 shows the average annual sediment yield calculated by integration of frequency sediment yields with respect to probability.

The following sections describe the parameter estimation procedures used for this method.

5.3.2 Maximum 1-Hour Precipitation "P"

Maximum 1-hour precipitation "P" for a return period is assumed to be equal to the 1-hour precipitation obtained from the Riverside County Flood Control District Hydrology Manual (1978.) The 2-year and 100-year precipitation values were read from plates D-4.2 and D-4.3, respectively, for each subbasin. Plate D-4.5 was used in computing the precipitation for other frequencies between 2 and 100-years.

This data is used for subbasins with area smaller than 3.0 mi^2. The precipitation is rounded to 2 decimal places and multiplied by 100 when using in Equation 1.

5.3.3 Relief Ratio "RR"

Relief ratio "RR" is defined as the difference in elevation between highest and lowest points on the longest watercourse divided by the length of the longest watercourse. The

RR is computed in units of ft/mile. The longest watercourse in each subbasin was defined from flow accumulation grids obtained from a digital elevation model in ArcView GIS. The longest watercourse was defined along the grids having flow accumulation values greater than 5,000 cells. Figure 5-5 shows the watercourse defined in this manner. Table 5-18 shows the computed relief ratio for each watercourse.

5.3.4 Non-Dimensional Fire Factor "FF"

The non-dimensional fire factor "FF" accounts for the increase in debris yield due to fire in the watershed. This factor varies between 3.0 and 6.5, with a higher factor indicating a more recent fire and higher debris yield. The factor is 3.0 (lowest) after 10 years without fire in a small watershed (basin area < 3.0 mi^2), and after 15 years without fire in relatively large watershed (basin area ≥ 3.0 mi^2.) This factor is also 3.0 for desert watersheds where the effect of wildfire is minimal. A graph of FF with drainage area and years after fire is provided (USACE, 1992a.) In this study the FF factor was determined assuming 5 years without occurrence of fire.

5.3.5 Unit Peak Runoff "Q"

Unit peak runoff "Q" is defined as peak runoff per unit area of the watershed, in units of cfs/mi^2. The peak unit runoff for each subbasin was computed by dividing the peak flow (Table 5-1) by the area of each subbasin.

5.3.6 Adjustment and Transposition "A-T" Factor

The adjustment and transposition "A-T" factor is applied to transpose the debris yield from the San Gabriel Mountains (from which the data were taken to develop the regression equations) to the current watershed. The debris yield obtained using the regression equations is multiplied by the A-T factor to get the adjusted debris yield for the watershed.

Four techniques are provided (USACE, 1992a) to estimate this factor. They are described below:

Technique 1: This technique is applicable if the sediment/debris record for the subject watershed contains single event debris yield values. The A-T factor is the ratio of the subject watershed observed debris yield to the unadjusted regression equation debris yield. There is no observed event debris yield available for the Santa Margarita River Watershed. Therefore this technique could not be used.

Technique 2: This technique is applicable if the sediment/debris record for the subject watershed contains periodic survey results only. The ratio of average annual sediment yield (AASY) and average annual precipitation (AAP) is computed for the given watershed. A corresponding AASY/AAP ratio is estimated for an equivalent size watershed in San Gabriel Mountains, from a regression curve provided. The A-T Factor is the ratio of AASY/AAP for the watershed to the equivalent watershed in San Gabriel Mountains. The available sediment data for the Santa Margarita River Watershed was measured at the Ysidora gage, which covers a watershed of area about 746 mi^2. The curve provided (USACE, 1992a) to estimate AASY/AAP, for an equivalent sized watershed located in San Gabriel Mountains is only valid for watersheds smaller than 200 mi^2. Therefore this method could not be applied to compute A-T factor.

Technique 3: This technique is applicable if no sediment/ debris record is available for the subject watershed but nearby watersheds have periodic survey results. A local regression curve fit of AASY/AAP versus area would be created so a comparison could be made to a similar curve generated for the San Gabriel Mountains. Data from at least three nearby watershed should be available to generate a local regression curve of AASY/AAP versus area. Because such data were not available, this method could not be applied.

Technique 4: This technique is used when no records are available for the subject watershed or nearby watersheds. A detailed field analysis is made to get an approximate A-T factor using a given A-T factor table, based on the PSIAC method for Southern California watersheds. An estimate of the A-T factor using this technique is least accurate of all because of its highly subjective nature.

Since Techniques 1,2 and 3 did not specifically apply and Technique 4 was the least accurate, a hybrid approach was adopted. Brownlie and Taylor (1981) estimate an average annual sediment yield of 0.39 ac-ft/mi^2 for this watershed. The estimated average annual sediment yield using the LA Corps method (Table 5-17) is 0.82 ac-ft/mi^2. Assuming that A-T factor estimation Technique 1 can be applied to average annual (as it is to single event) sediment yield, the A-T factor was estimated for the entire watershed to be equal to 0.47.

5.4 Modified Universal Soil Loss Equation (MUSLE)

5.4.1 Background

This method is based on the Universal Soil Loss Equation (USLE). The U.S. Department of Agriculture (USDA) Agricultural Research Service in cooperation with USDA Soil Conservation Services (SCS) developed the USLE method (SCS, 1972.) The USLE method is based on data obtained from the Central and Eastern United States and estimates the average annual soil loss due to sheet-and-rill erosion on a relatively small agricultural plot. The sediment yield ratio needs to be estimated to get the average annual sediment delivery. The USLE method relates the annual soil loss to the product of six factors describing rainfall energy, soil erodibility, cropping and management, supplemental erosion control practices such as contouring and terracing, and a topographic factor involving the steepness and length of the overland slope.

The modified USLE (MUSLE) method (Williams and Berndt, 1972) was developed to estimate the sediment yield from a single storm. The modified equation applicable to the Southwestern United States (Resource Consultants, 1994) was used in estimating the sediment yield for each subbasin for six different return frequencies (2-, 5-, 10-, 25-, 50-, and 100-year.) The average annual sediment yield was computed by integrating the frequency sediment yield with respect to probability of occurrence.

The MUSLE yield is given by:

$Y_s = R_w \, K \, LS \, C \, P$

where
Y_s = sediment yield in tons for the storm event,
R_w = storm runoff energy factor,
K = soil erodibility factor,
LS = topographic factor representing the combination of slope length and basin slope,
C = cover and management factor, and
P = the erosion control practice factor.

The following sections describe the parameter estimation methods for the MUSLE method.

5.4.2 Storm Runoff Energy Factor "R_w"

The Rw factor is given by the equation:

$R_w = \text{Alpha}\,(V\,q_p)^{\text{Beta}}$,

where
V = the storm event runoff volume in acre-feet,
q_p = the storm peak flow rate in cfs, and
Alpha and Beta are coefficients.

The values of the Alpha and Beta parameters recommended for the Albuquerque area (Resource Consultants, 1994) are 285 and 0.56 respectively. The Alpha value is about three times the standard value, with no change in Beta. These values were estimated based on limited data indicating that fine sediments in the Albuquerque area were about three times that estimated by using standard coefficient values.

Because no estimates of these values for Southern California were found in the literature, the Albuquerque values for the Alpha and Beta coefficients were adopted for our study area. The peak discharge q_p and hydrograph runoff volume V for each subbasin were taken from Table 5-1.

5.4.3 Soil Erodibility Factor "K"

The soil erodibility factor "K" is a function of the soil texture and gravel content in the topsoil layer. For lack of any detailed information over the subbasins for soil texture and gravel content, the hydrologic soil group was related to soil texture and K values were assigned to each hydrologic soil group. Table 5-6 shows the K values corresponding to each hydrologic soil group. Figure 5-6 shows the hydrologic soil group over the subbasins on a 30-meter square grid. An average of the K values over each subbasin was computed and applied as the K factor for the subbasin.

5.4.4 Topographic Factor "LS"

This factor represents the effect of the combination of slope length and basin slope.

Slope length is defined (Resource Consultants, 1994) as the distance from the point of overland flow origin to the point where either the slope decreases to the extent that deposition begins or runoff water enters a well-defined channel. The U.S. Army Corps of Engineers (1995b) provides the Williams and Berndt (1976) equation for estimating this length as:

$$L_{of} = 0.5\ A/L_t$$

Here, L_{of} is the slope length, A is the basin drainage area and L_t is the total length of all major channels. This method was used in estimating the slope length. The total length of the main channel was estimated by assuming that a main channel is defined by a minimum flow of 0.5 cfs for a 10-year flood. The 10-year flood peak unit flow over the watershed was estimated as 24 cfs/mi^2, using peak flow data at the Fallbrook, Temecula and Ysidora gages. This results in a flow accumulation value of approximately 60 cells, corresponding to an accumulated flow of 0.5 cfs in a 10-year frequency flood. The total number of grids in each subbasin having a flow accumulation value greater than or equal to 60 was counted using ArcView GIS. Total channel length L_t was computed as total number of such grids times the width of the grid (30 meters.) Substituting subbasin area A and total length L_t into the Williams and Berndt equation, slope length was computed.

Basin slope was computed from a digital elevation model at each node of a 30 meter square grid in the ArcView GIS computer program. An average of grid slope over each subbasin area was computed and used as basin slope in this study. Figure 5-6 shows the variation of ground slope over the watershed.

The topographic factor LS was computed by interpolation from an LS lookup table as a function of basin slope and slope length. The lookup table is provided in SCS New Mexico Technical Note 28 and reproduced in Resource Consultants (1994) report.

5.4.5 Cover and Management Factor "C"

The cover and management factor "C" is a function of vegetative canopy type and height, percent canopy coverage, soil surface coverage type (weed or grass) and percent soil coverage. Due to unavailability of detailed data, vegetative coverage type was used with assumptions on percent canopy coverage, soil percent coverage and type. A suitable value of the cover and management factor C was assigned to each vegetation coverage. Figure 5-2 shows the vegetation coverage over the watershed. Table 5-19 shows the assumptions made on canopy coverage, percent cover, weed cover and type in arriving at C values for each vegetation type. Figure 5-7 shows the assigned C values for each vegetation and the variation over the basin. An average of C values over each subbasin was computed and used in this method.

5.4.6 Erosion Control Practice Factor "P"

The erosion control practice factor "P" accounts for the effect of conservation practices such as contouring, strip cropping, and terracing on erosion. Terracing is generally the most effective conservation practice for decreasing soil erosion. This factor has no significance for range and wild-land areas and was set to 1.0.

Tables 5-20 through 5-25 show the sediment yield calculations for various return periods using this method. Table 5-26 shows the average annual sediment yield by the MUSLE method.

5.5 Dendy and Bolton

Dendy and Bolton (1976) studied sedimentation data from 505 reservoirs having mean annual runoff data. Annual sediment yield per unit area was shown to increase sharply as mean annual runoff increased from 0 to 2 in. Thereafter, for mean annual runoff from 2 to 50 inches, annual sediment yield per unit area decreased exponentially. Assuming reference mean annual runoff of 2 inches (Ponce, 1989), reference mean annual sediment yield of 1645 tons/mi^2, and a reference area of 1 mi^2, the mean annual sediment yield equations are given as:

$$S=1280\, Q^{0.46}\, (1.43-0.26 \log A) \text{ for } Q < 2 \text{ inches, and}$$
$$S=1965\, e^{-0.055Q}\, (1.43-0.26 \log A) \text{ for } Q >=2 \text{ inches}$$

where
S = annual sediment yield in tons/ mi^2,
Q = mean annual runoff in inches, and
A = basin area in square miles.

For the present study, watershed mean annual runoff is estimated by averaging the annual amounts for water years 1924 to 1975, as reported by Brownlie and Taylor (1981). These amounts are from "natural" storm-water runoff, computed by summing recorded flows at the Ysidora gage, flows diverted to the O'Neill Ditch, and natural flows recorded above Vail Dam. The mean annual runoff volume is computed as 25.778 million cubic meters, which is equivalent to 0.52 inches over a watershed area of 746 mi^2. Since the runoff varies from one subbasin to the next, the average basin runoff depth (0.52 inches) is scaled for each subbasin proportional to the relative magnitude of subbasin storm runoff from the January 1993 flood. Table 5-27 shows the average annual sediment yield for each subbasin.

5.6 Brownlie and Taylor (1981)

Brownlie and Taylor (1981) performed regression on data for watersheds in Southern California to predict annual sediment delivery rate and instantaneous suspended sediment discharge as a function of annual storm flow and water discharge respectively. One particular regression was performed on sediment and flow data recorded by the USGS at the Ysidora gage on the Santa Margarita River. Average annual "natural" sediment delivery at Ysidora between water year 1931 and 1975 was estimated at 43,500 million metric tonnes per year. The "natural" sediment delivery is sediment delivery corresponding to "natural" flow, which is the sum of flows at the Ysidora gage, diversions to the O'Neill Ditch, and the natural flow recorded above Vail Dam.

Taylor (1981) reports that the ratio of shoreline sediment delivery estimates to upland erosion estimates is 0.1 for Santa Margarita River Basin. Therefore, it was concluded that the upland erosion or sediment yield for Santa Margarita River Watershed is 43,500/0.1 = 435,000 million metric tonnes per year. Using a sediment dry density of 93 lb/ft^3 (Vanoni, 1977) and watershed area of 746 mi^2, the sediment yield for this basin is 0.39 ac-ft/mi^2.

5.7 Taylor (1981)

Taylor (1981) derived a regression equation for predicting sediment yield in Southern California Basins. The regression was performed on long-term sediment delivery data for upland drainage areas. The data include debris accumulation measurements in 36 water conservation reservoirs, flood control reservoirs, and smaller debris basins. The drainage areas range from 1 km^2 to more than 1100 km^2 with record periods ranging from 11 to 54 years long. A multiple regression analysis resulted in following equation:

$$DR= Alpha\ (L^{Beta})\ (A^{Gamma})$$

where
DR= average annual catchment denudation rate in units of mm/year
L= land type, values of 1.0, 2.0 and 2.7 assigned for plains, hills and mountains respectively,
A= erosional catchment area in km^2, and
Alpha, Beta and Gamma = Regression Constants.

Values of 0.0936, 3.11 and –0.141 were estimated, respectively, for the constants using all available data. The multiple correlation coefficient for this equation fit is R=0.86.

By performing another regression using regional data, while keeping Beta and Gamma as constants, Alpha values were refined for individual regions. The refined Alpha value for the Peninsular Ranges, which includes the Santa Margarita River Watershed, is 0.075.

Land type "L" in the equation is a function of the topography. A land type is defined as mountainous if it has topographic features with vertical relief on the order of thousands of meters. Hill areas have more mature features with relief on the order of hundreds of meters, and plains are essentially smooth with characteristic relief on the order of meters per kilometer. Based on this, Taylor defined subbasins in the Santa Margarita River Watershed with one of the above land type characteristics. Comparing the WEST subbasin boundaries with subbasin boundaries defined by Taylor, we classified each of our subbasins into one of the land types defined above. Applying the equation for average annual catchment denudation-rate, we came up with estimates of average annual sediment yield for each subbasin. Table 5-28 shows the computed sediment yield for each subbasin.

5.8 SCS Sediment Yield Map (1974)

The Soil Conservation Service developed a sediment yield map (SCS, 1974) for the Western United States as a part of a study to assess erosion, sediment and related salt problems. Sediment yield classes were determined using the PSIAC method. The sediment yield rate map shows a yield class rate of 0.5 to 1.0 ac-ft/mi^2/year for the Santa Margarita River Watershed.

5.9 Classification of Subbasins in the Santa Margarita Watershed

Table 5-29 summarizes the sediment yield obtained by using the various methods presented in this report. Figure 5-8 shows the comparison of results between the methods. An average sediment yield value for each subbasin was computed by weighting the results from the different methods. We assigned a weight of 1.0 to sediment yield by the Dendy and Bolton method and a weight of 2.0 to all other methods. This was done because the Dendy and Bolton method is derived from data all over the United States, while all other methods are either derived from local data or are modified to be applicable to watersheds in southern California.

The mean (μ) and standard deviation (σ) of the sediment yield over the entire watershed were computed by using a 30 meter square grid in ArcView GIS. The subbasins were divided into one of the three categories, High, Normal or Low sediment producing areas. Subbasins with average annual sediment yield less than μ-σ were categorized as Low sediment yield producing areas. Subbasins with average annual sediment yield more than μ+σ were categorized as High sediment yield producing areas. Subbasins with average annual sediment yield between μ-σ and μ+σ were categorized as Normal sediment yield producing areas. Figure 5-8 shows the basin classification assigned using these criteria.

Subbasins 2, 6, 9, 13, 29, 31, and 34 are classified as low sediment producing areas. Currently, there is a significant amount of construction activity taking place in these subbasin areas. The land use information used in computing the average annual sediment yield does not reflect these construction activities. Usually there is a higher potential of sediment production in these areas during construction activities. After construction is complete, the sediment yield will usually decrease because increases in impermeable areas and vegetation will decrease upland sediment erosion. However, increased runoff produced by the same land use changes also has the potential to increase sediment yield by channel erosion.

5.10 Recommendations for Future Studies

The sediment yield estimates obtained by the different methods are based on many assumptions made in estimating input parameters for the methods. Many of these assumptions were necessary because of insufficient data available to estimate the parameters. The sediment yield estimates could be improved by collecting more data to achieve better input parameter estimates. The following paragraphs describe the assumptions made in estimating the parameters for the different methods.

Estimation of input parameters for the PSIAC method entailed many. First, the soil factors were related to hydrologic soil group. The estimates of this factor could be improved by obtaining more information about soil structure and type of vegetation growth on soil, and accumulation of rock fragments/calcareous material (caliche) on soil. Second, the ground cover factors were estimated from vegetation coverage. This factor could be better estimated by studying in more detail the rock or litter cover, and type of topsoil. Third, the PSIAC land use factor is estimated from vegetation coverage. This factor could be better estimated by more detailed information regarding logging activity, fire history, and land development activity in the watershed. Fourth, upland erosion factors were related to the MUSLE soil erodibility factor. The factor could be better estimated if more detailed aerial photographs showing drainage patterns were made available. Fifth, channel erosion coefficients were estimated based on channel side slope and channel material. This factor could be better estimated by more detailed field inspection of the watershed's main channels.

The results obtained using the LA Corps method are highly dependent on the A-T factor. This factor could be better estimated if sediment delivery for at least one storm were recorded. The fire factor was computed based on the assumption of no fire in the last 5 years. The estimates presented in this study could be improved by more accurate estimation of the A-T factor and fire frequency in the watershed.

For the MUSLE method, the soil erodibility factor was estimated by relating it to hydrologic soil group. This factor could be better estimated if soil texture and sediment gravel content were known. Also, the cover and management factor was estimated by assigning values of percent canopy coverage, soil surface coverage type, and percent soil surface coverage to vegetation type. Information on the coverage of these parameters, rather than basing their values on vegetation, could lead to refined estimates of the cover and management factor. Finally the storm runoff energy factor is based on parameters estimated for the Albuquerque area. These parameters should be estimated for local conditions based on measurements.

Sediment yield by the Dendy and Bolton method was computed by estimating subbasin mean annual runoff proportional to 1993 extreme event storm runoff generated by HEC-1 model. The results can be improved by estimating subbasin mean annual runoff by simulation of the long-term hydrology of the subbasins.

Brownlie and Taylor used sediment data at the Ysidora gage to generate regression equation expressing sediment delivery as a function of flow rate. Using the regression equation with a long term observed hydrograph, they estimated the average annual sediment delivery at the gage. The sediment delivery ratio (0.1) was computed by dividing their average annual sediment yield by the one estimated by Taylor (1981). One should check the accuracy of this method by collecting more sediment data in the watershed.

Taylor estimated sediment yield as a function of area and topography. The yield equation is based on local watershed data. Variability of the sediment yield inside watershed is described by variability of topography. One should check the accuracy of this method by collecting more sediment data in the watershed.

5.11 Summary of Results

Following is a summary of results obtained from the sediment yield analysis:

1. In general, estimated sediment yields are highest by the MUSLE method, followed in order by the Taylor, Dendy and Bolton, PSIAC, and LA Corps methods.

2. The subbasins defined as high sediment yield areas are usually steeper, with average basin slope greater than 19 percent, and the subbasins defined as low sediment yield areas are usually flatter, with average basin slope less than 13 percent. While average annual slope is not the only factor in estimating the sediment yield, this factor is a good indicator of yield.

3. The high sediment yield producing areas (subbasins 7, 17, 22, and 24) are upstream of Vail dam. The dam intercepts most of the sediment delivered by these subbasins; therefore the effect of these areas on downstream areas is negligible.

4. Lake Skinner intercepts the sediment from subbasin 26; therefore effect of subbasin 26 sediment on downstream areas will be negligible.

5. The sediment yield in this study was estimated to perform a qualitative assessment of subbasins with respect to each other. Use of these results for any other scenarios should take into consideration the assumptions made in this study.

Table 5-1. Subbasin Scale Peak Flow and Volume for Various Return Periods

Sub-Basin	Area	Peak Flow (cfs)						Volume (acre-ft)					
Name	(mi^2)	2-year	5-year	10-year	25-year	50-year	100-year	2-year	5-year	10-year	25-year	50-year	100-year
1	22.37	222	520	926	1400	1800	2257	74	180	315	480	620	826
2	8.1	88	190	305	410	500	612	34	75	128	140	210	261
3	18.4	348	710	1184	1600	2100	2617	79	180	295	420	550	703
4	5.69	105	220	360	480	580	696	30	65	113	160	190	231
5	30.47	935	1800	2774	3800	4600	5750	256	520	865	1400	1600	1962
6	27.55	127	290	508	710	920	1186	84	190	344	500	650	821
7	24.6	695	1300	1739	2400	3000	3651	300	540	797	1100	1700	1741
8	88.44	928	2200	3830	5600	7100	9059	369	890	1593	2400	3000	4017
9	2.52	34	80	142	190	240	284	10	21	34	47	59	74
10	0.18	10	19	30	39	47	56	0	5	5	5	5	5
11	1.88	126	210	289	370	440	514	20	25	49	62	74	89
12	42.32	864	1700	2516	3700	4800	6034	221	450	713	1100	1500	1883
13	6.71	293	500	735	900	1100	1205	59	110	162	200	240	280
14	23.58	386	800	1328	1900	2500	3190	123	280	457	680	900	1151
15	1	88	150	193	260	320	392	10	17	25	36	46	59
16	32.84	576	1000	1532	2100	2600	3123	236	430	679	910	1200	1426
17	38.5	590	1300	1977	2800	3600	4416	246	510	890	1030	1200	2105
18	22.18	790	1500	2082	2800	3500	4240	221	320	659	920	1300	1431
19	47.79	416	940	1657	2500	3200	4142	226	530	969	990	1900	2572
20	18.04	414	820	1320	1800	2200	2668	143	300	492	690	860	1062
21	21.59	487	810	1194	1600	1900	2336	256	450	664	900	1200	1362
22	38.15	964	1800	2593	3600	4500	5635	418	790	1200	1800	2200	2773
23	10.58	23	80	183	290	400	524	10	32	74	130	170	216
24	19.81	539	1200	1873	2500	3100	3739	152	330	575	800	1000	1224
25	43.88	276	550	888	1400	1800	2335	128	280	462	700	960	1279
26	50.52	913	1700	2547	3600	4500	5636	280	550	870	1300	1600	2105
27	16.93	573	980	1397	1800	2100	2585	157	290	428	580	700	851
28	29.36	340	700	1137	1600	2100	2606	98	220	374	560	720	949
29	3.94	182	300	431	510	590	658	44	78	113	140	160	177
30	16.19	220	440	693	1000	1600	1783	89	180	290	450	600	782
31	2.65	42	88	144	190	210	252	10	22	39	51	62	74
32	8.74	443	820	1280	1800	2300	2710	98	200	325	470	600	757
33	18.46	1367	2700	3996	5400	6600	8070	216	450	728	1000	1400	1613
34	2.05	107	180	246	290	330	370	25	41	59	72	82	93

Notes

1 Values for 2-, 10-, and 100-year frequency obtained from PWA HEC-1 Model corresponding to a subbasin scale 6-hour duration storm and historic mean starting storage for Vail and Skinner reservoirs.

2 Values for 5-year return frequency obtained from interpolation between 2- and 10-year return frequencies plotted on log-probability graph.

3 Values for 25- and 50- year return frequencies obtained from interpolation between 10- and 100-year return frequencies plotted on log-probability graph.

Table 5-2. PSIAC Sediment Yield Classifications

PSIAC classification	PSIAC yield rating	Sediment yield (acre-ft/mi^2)
1	> 100	3.0
2	75 - 100	1.0 -3.0
3	50 - 75	0.5 - 1.0
4	25 - 50	0.2 - 0.5
5	0 - 25	< 0.2

Table 5-3. Calculation of Subbasin PSIAC Ratings and Average Annual Sediment Yield

Subbasin	Area (mi^2)	PSIAC Coefficients: Surface Geology	Soils	Climate	Runoff	Topography	Ground Cover	Land use	Upland erosion	Channel erosion and Sediment Transport	Sum of PSIAC Coefficients (PSIAC Rating)	Subbasin Sed. Yield Range (ac-ft/mi^2)	Subbasin Sediment Yield (ac-ft/mi^2)
1	22.4	3.60	5	2	3	5	1	-4	6	10	31	0.2-0.5	0.28
2	8.1	4.80	7	2	3	5	-3	-3	11	10	37	0.2-0.5	0.35
3	18.4	4.80	8	2	4	8	1	-4	12	3	39	0.2-0.5	0.36
4	5.7	4.00	7	2	4	5	0	-5	10	10	36	0.2-0.5	0.34
5	30.5	4.30	7	2	3	8	0	-5	11	10	40	0.2-0.5	0.38
6	27.6	4.30	6	2	2	5	-2	-2	10	5	31	0.2-0.5	0.27
7	24.6	2.00	7	2	2	15	5	-2	11	7	49	0.2-0.5	0.49
8	88.4	4.50	7	2	2	8	4	-4	9	10	43	0.2-0.5	0.42
9	2.5	9.40	5	2	4	5	-5	-4	8	10	35	0.2-0.5	0.33
10	0.2	5.78	6	2	7	5	-5	-7	10	0	24	<0.2	0.19
11	1.9	7.20	8	2	4	10	2	-4	11	10	51	0.5-1.0	0.51
12	42.3	1.85	7	2	3	8	6	-5	11	10	44	0.2-0.5	0.43
13	6.7	8.20	7	2	4	8	0	-7	10	1	34	0.2-0.5	0.31
14	23.6	1.20	6	2	2	20	7	-5	9	3	46	0.2-0.5	0.45
15	1.0	0.00	8	2	4	10	5	-5	12	1	37	0.2-0.5	0.34
16	32.8	2.20	8	2	3	15	4	-3	12	4	47	0.2-0.5	0.47
17	38.5	4.00	7	2	3	20	6	-5	10	10	58	0.5-1.0	0.65
18	22.2	3.05	8	2	3	10	7	-5	11	6	46	0.2-0.5	0.45
19	47.8	2.30	6	2	4	20	3	0	9	10	57	0.5-1.0	0.63
20	18.0	2.35	8	2	2	10	7	-5	11	10	47	0.2-0.5	0.47
21	21.6	3.00	8	2	4	15	0	2	12	8	54	0.5-1.0	0.57
22	38.2	2.70	7	2	2	10	6	-4	11	9	46	0.2-0.5	0.45
23	10.6	2.40	6	2	3	15	5	2	9	4	49	0.2-0.5	0.49
24	19.8	1.80	6	2	3	15	5	-3	10	3	43	0.2-0.5	0.41
25	43.9	6.55	7	2	2	8	-1	3	10	2	40	0.2-0.5	0.38
26	50.5	1.90	6	2	3	8	5	-5	10	8	39	0.2-0.5	0.37
27	16.9	6.10	5	2	3	10	-2	2	8	0	34	0.2-0.5	0.30
28	29.4	8.00	6	2	2	8	-1	-4	9	10	41	0.2-0.5	0.39
29	3.9	9.50	5	2	5	5	-2	-6	9	0	27	0.2-0.5	0.23
30	16.2	0.50	7	2	2	15	4	-4	10	4	41	0.2-0.5	0.39
31	2.7	7.24	5	2	4	5	-4	-7	9	0	21	<0.2	0.15
32	8.7	0.60	8	2	6	8	1	-6	12	0	31	0.2-0.5	0.27
33	18.5	5.00	7	2	3	10	2	-6	10	0	34	0.2-0.5	0.31
34	2.1	8.57	6	2	4	5	-1	-8	9	0	26	0.2-0.5	0.21
Total Area	746.0												
										Max	**58**		**0.65**
										Min	**21**		**0.15**
												Basin Average	**0.43**

Notes

1 PSIAC method specifies sediment yield range for a PSIAC rating.
However in this study, sediment yield values have been linearly interpolated, in order to assign a single sediment yield value to a subbasin.

2 Soil factor for subbasin 27 taken as average of nearby subbasin soil factors.

Table 5-4. PSIAC Surface Geology Coefficients Associated With Various Soil Classifications

Soil Association	Description	Assigned PSIAC Coefficient
	From Western Riverside Area Soil Survey by the Soil Conservation Service	
	Soils of the Southern California Coastal Plains	
1	Cajalco-Temescal- Las Posas association: Well-drained, undulating to steep, moderately deep to shallow soils that have a surface layer of fine sandy loam; on gabbro and latiteporphyry	0
2	Friant-Lodo-Escondido Association: Well-dained and somewhat excessively drained, undulationg to steep, shallow to deep soils that hve a surface layer of fine sandy loam and gravelly loam, on metamorphosed sandstone and mica-schist	6
3	Cieneba-Rock land-Fallbrook association: Well-drained ansd somewhat excessively drained, undulation to steep, very shallow to moderately deep soils that have a surface layer of samdy loam and fine sandy loam; on granitic rock.	0
4	Bad land-San Timoteo- association: Well-drained, rolling to very steep, moderately deep calcareous loam, and very shallow soils, on inland sea sediment snd soft sandstone	7
5	Hanford -Tujunga-Greenfield association: Very deep , well-drained to excessively drained, nearly level to mederately steep soils that have a surface layer of sand to sandy loam; on alluvial fans and flood plains	10
6	Monserate-Arlington-Exeter association: Well-drained, nearly level to moderately steep soils that have a surface layer of sandy loam to loam and are shallow to deep to hardpan	8
7	San Emigdio-Grangeville-Metz association: Very deep, poorly drained to somewhat excessively drained, nearly level to strongly sloping soils that have a surface layer of calcareous loamy sand to loam; on alluvial fans and flood plains	10
8	Traver-Domino-Willows association: Moderately well drained to poorly drained, nearly level to gentlty sloping, saline-alkali soils that have a surface layer of loamy fine sand to silty caly and are moderately deep to very deep to a calcareous hardpan	8
	Soils of the Southern California Mountains	
9	Tollhouse-Sheephead-Crafton association: Excessively drained to well-drained, gently rolling to steep, shallow to mederately deep siols that have a surface layer of loam; on granitic rock	0
10	Mottsville-calpine-Oak Glen association: Excessively drained to well-drained, gently sloping to moderately sttep soils that have a surface layer of loamy sand to fine sandy loam; on alluvial fans and valley fill	10

Table 5-4 (Continued). PSIAC Surface Geology Coefficients Associated With Various Soil Classifications

Soil Association	Description	Assigned PSIAC Coefficient
	From San Diego Area Soil Survey by the Soil Conservation Service	
Group II	Excessively drained to well-drained, gently sloping to strongly sloping loamy coarse sands to sandy loams on alluvial fans and in basins in mountainous areas	
4'	Mottsville-Bull Trail association: Excessively drained to well drained loamy coarse sands and coarse sandy loams on alluvial fans; 2 to 9 percent slopes	10
Group III	Excessively drained to moderately well-drained, nearly level to moderately sloping loamy sands to calys on alluvial fans and alluvial plains in foothill and coastal plain areas	
7'	Visalia-Tujunga assocaition: Moderately well drained and excessively drained sandy loams to sand on alluvial fans and alluvial plains; 0 to 9 percent slopes	10
Group IV	Somewhat excessively drained to moderately well drained narly level to steep loamy coasrse sands to caly loams on terraces in foothill and coastal plain areas	
10'	Huerhuero-Stockpen association: Moderately well-drained loams to gravely caly loams that have a subsoil of caly or gravelly caly; 0 to 9 percent slopes	9
Group V	Excessively drained to well-drained, moderately slopin to very steep loamy coarse sands to loams on uplands in mountainous areas	
17	Tollhouse-La Posta-Rock land association, eroded: Excessively drained and somewhat excessively drained coarse sandy loams and loamy coarse sands over granitic rock, and areas of rock land; 9 to 65 percent slopes	0
18	Sheephead association, rocky: Well-drained cobbly fine sandy loams over fractured mica schist, 9 to 65 percent slopes	4
Group VI	Excessivley drained to moderately well-drained, gently slpping to very steep sandy loams to silt loams on uplands in foothill areas	
21	Fallbrook-Vista association, rocky: Well-drained sandy loams and coarse sandy loams that have a subsoil of sandy clay loam and clay loam over decomposed grandodiorite; 2 to 9 percent slopes	2
22	Las Posas association, stony: Well-drained stony fine sandy loams that have a clay subsoil over decomposed gabbro; 9 to 65 percent slopes	2
23	Cieneba-Fallbrook association, very rocky: Excessively drained to well-drained coarse sandy loams and sandy loams that have a sandy clay loam subsoil over decomposed granodiorite; 9 to 75 percent slopes	2
Group VII	Well-drained and moderately well drained, moderately sloping to very steep loamy fine sands to calys on uplands in caistal plain areas	
30	Las Flores-Huerhuero association, eroded: Moderately well-drained loamy fine sands to loams that have a subsoil of sandy clay or clay; 9 to 30 percent slopes	10
31	Gaviota-Hambright association, eroded: Well-drained fine sandy loams and gravelly clay loams over sandstone and breccia; 30 to 75 percent slopes	6
National Forest	No information available within national forest areas	5

Table 5-5. Calculation of Area Weighted PSIAC Surface Geology Coefficients for Subbasins

Subbasin	Soil Association	PSIAC Coefficient	Pecentage of Subbasin Area	Area Weighted Contribution	Subbasin Coefficient *
1	1	0	30	0	3.6
	3	0	25	0	
	6	8	25	2	
	8	8	20	1.6	
2	1	0	40	0	4.8
	6	8	60	4.8	
3	1	0	35	0	4.8
	2	6	20	1.2	
	6	8	45	3.6	
4	1	0	60	0	4
	5	10	40	4	
5	1	0	40	0	4.3
	3	0	15	0	
	5	10	35	3.5	
	6	8	10	0.8	
6	1	0	15	0	4.3
	2	6	30	1.8	
	3	0	30	0	
	5	10	25	2.5	
7	3	0	60	0	2
	National Forest	5	40	2	
8	9	0	45	0	4.5
	10	10	35	3.5	
	National Forest	5	20	1	
9	1	0	5	0	9.4
	5	10	90	9	
	6	8	5	0.4	
11	2	6	20	1.2	7.2
	3	0	10	0	
	5	10	20	2	
	6	8	50	4	
12	1	0	20	0	1.85
	2	6	25	1.5	
	3	0	50	0	
	4	7	5	0.35	
13	5	10	10	1	8.2
	6	8	90	7.2	
14	1	0	40	0	1.2
	22	2	20	0.4	
	23	2	40	0.8	
15	1	0	55	0	0
	3	0	45	0	

Table 5-5 (Continued). Calculation of Area Weighted PSIAC Surface Geology Coefficients for Subbasins

Subbasin	Soil Association	PSIAC Coefficient	Pecentage of Subbasin Area	Area Weighted Contribution	Subbasin Coefficient *
16	1	0	20	0	2.2
	2	6	30	1.8	
	3	0	30	0	
	21	2	5	0.1	
	22	2	5	0.1	
	23	2	10	0.2	
17	1	0	10	0	4
	4	7	40	2.8	
	18	4	10	0.4	
	23	2	40	0.8	
18	3	0	15	0	3.05
	4	7	15	1.05	
	9	0	50	0	
	10	10	20	2	
19	1	0	20	0	2.3
	2	6	15	0.9	
	3	0	15	0	
	7'	10	5	0.5	
	21	2	5	0.1	
	23	2	40	0.8	
20	3	0	40	0	2.35
	4	7	10	0.7	
	9	0	20	0	
	4'	10	5	0.5	
	18	4	10	0.4	
	34	5	15	0.75	
21	1	0	15	0	3
	2	6	45	2.7	
	3	0	25	0	
	23	2	15	0.3	
22	9	0	50	0	2.7
	10	10	10	1	
	18	4	30	1.2	
	34	5	10	0.5	
23	7'	10	5	0.5	2.4
	21	2	15	0.3	
	23	2	80	1.6	
24	4'	10	10	1	1.8
	17	0	70	0	
	18	4	20	0.8	

Table 5-5 (Continued). Calculation of Area Weighted PSIAC Surface Geology Coefficients for Subbasins

Subbasin	Soil Association	PSIAC Coefficient	Pecentage of Subbasin Area	Area Weighted Contribution	Subbasin Coefficient *
25	7'	10	5	0.5	6.55
	10'	9	25	2.25	
	21	2	10	0.2	
	22	2	5	0.1	
	23	2	20	0.4	
	30	10	25	2.5	
	31	6	10	0.6	
26	1	0	10	0	1.9
	2	6	25	1.5	
	3	0	60	0	
	6	8	5	0.4	
27	2	6	10	0.6	6.1
	3	0	25	0	
	5	10	15	1.5	
	6	8	35	2.8	
	8	8	15	1.2	
28	1	0	5	0	8
	3	0	15	0	
	5	10	80	8	
29	5	10	75	7.5	9.5
	6	8	25	2	
30	1	0	45	0	0.5
	3	0	50	0	
	5	10	5	0.5	
32	1	0	45	0	0.6
	2	6	10	0.6	
	3	0	45	0	
33	1	0	10	0	5
	3	0	30	0	
	5	10	40	4	
	National Forest	5	20	1	

Notes : * Calculated as the area weighted average of PSIAC coefficients within the subbasin. Values for subbasins 10 and 34 were calculated as the average of the coefficients associated with the subbasins surrounding them.

Table 5-6. Hydrologic Soil Group Related to MUSLE Erodibility Factor and PSIAC Soil Factor

Hydrologic Soil Group	*MUSLE Erodibility Factor*	*PSIAC Soil Factor*
A	0.15	2
B	0.25	5
C	0.30	7
D	0.32	10

Table 5-7. Calculation of PSIAC Runoff Coefficients

Sub-Basin	Area (mi^2)	Runoff Volume * (ac-ft)	Runoff Intensity (ac-ft/mi^2)	PSIAC Coefficient **
1	22.37	4208	188.11	5.39
2	8.1	1348	166.42	5.57
3	18.4	4718	256.41	4.80
4	5.69	1283	225.48	5.07
5	30.47	6043	198.33	5.30
6	27.55	2133	77.42	6.34
7	24.6	2364	96.10	6.18
8	88.44	7065	79.88	6.32
9	2.52	702	278.57	4.61
10	0.18	105	583.33	2.00
11	1.88	536	285.11	4.56
12	42.32	4720	111.53	6.04
13	6.71	2064	307.60	4.36
14	23.58	2292	97.20	6.17
15	1	239	239.00	4.95
16	32.84	6280	191.23	5.36
17	38.5	6874	178.55	5.47
18	22.18	4090	184.40	5.42
19	47.79	11515	240.95	4.93
20	18.04	1541	85.42	6.27
21	21.59	5842	270.59	4.68
22	38.15	2230	58.45	6.50
23	10.58	1997	188.75	5.38
24	19.81	2330	117.62	5.99
25	43.88	3606	82.18	6.30
26	50.52	7971	157.78	5.65
27	16.93	2098	123.92	5.94
28	29.36	2921	99.49	6.15
29	3.94	1487	377.41	3.77
30	16.19	1074	66.34	6.43
31	2.65	591	223.02	5.09
32	8.74	4284	490.16	2.80
33	18.46	3137	169.93	5.54
34	2.05	608	296.59	4.46
		minimum	58.45	
		maximum	583.33	

Notes:
- * Taken from HEC-1 runoff data based on January 1993 extreme storm event.
- ** Values from 2 to 7 assumed for Santa Margarita watershed. Calculated by interpolation with runoff intensity.

Table 5-8. PSIAC Topography Coefficients

Basin Number	Average Slope *	Topography Coefficient
1	7.5%	5
2	6.8%	5
3	10.2%	8
4	9.0%	5
5	10.9%	8
6	7.9%	5
7	21.7%	15
8	13.6%	8
9	6.3%	5
10	7.0%	5
11	18.5%	10
12	13.3%	8
13	10.8%	8
14	29.7%	20
15	18.8%	10
16	24.7%	15
17	29.2%	20
18	16.3%	10
19	26.0%	20
20	19.6%	10
21	21.0%	15
22	19.4%	10
23	23.1%	15
24	25.0%	15
25	12.6%	8
26	14.8%	8
27	17.4%	10
28	13.3%	8
29	7.9%	5
30	20.6%	15
31	7.4%	5
32	15.0%	8
33	16.4%	10
34	8.5%	5

Note: * Basin average slope from ArcView GIS slope grid.

Table 5-9. PSIAC Ground Cover Coefficients

Vegetation classification	*PSIAC coefficient*
No Data	0
Agriculture	-5
Dune	10
Coastal Scrub	7
Chaparral and Sage	7
Grassland	-10
Marsh	0
Developed	0
Riparian Forest	5
Riparian Woodland	5
Fan Scrub	5
Oak Woodland with Pinion & Juniper	7
Mixed Woodland & Pine	7
Row Crops	0
Pasture	-5
Beach and Alluvial Wash	10
Orchard	-5
Disturbed	10
Water	-10

Table 5-10. PSIAC Land Use Coefficients

Land use classification	*PSIAC coefficient*
Riparian Vegetation	-5
Mixed Forest	-5
Oak Forest	-5
Sage	-5
Grassland	-10
Altered Land	10
Military Impact	5
Military Maneuver	5
Orchard	5
Rural Residential	-5
Single Family Residential	-10
Multi Family Residential	-10
Commercial/Industrial	-10
Transportation	-10
Water	-10

Table 5-11. Calculation of PSIAC Upland Erosion Coefficients

Subbasin	MUSLE K Values	PSIAC Coefficient **
1	0.22	13.71
2	0.29	9.79
3	0.30	9.51
4	0.28	10.28
5	0.29	10.15
6	0.28	10.53
7	0.29	9.85
8	0.26	11.39
9	0.26	11.72
10	0.28	10.40
11	0.29	9.89
12	0.29	10.00
13	0.28	10.45
14	0.27	11.04
15	0.30	9.23
16	0.30	9.39
17	0.28	10.51
18	0.30	9.61
19	0.27	11.00
20	0.29	9.99
21	0.30	9.53
22	0.29	10.00
23	0.27	11.20
24	0.28	10.63
25	0.28	10.59
26	0.28	10.34
27	0.25	11.98
28	0.27	11.10
29	0.26	11.48
30	0.28	10.53
31	0.26	11.49
32	0.30	9.39
33	0.28	10.40
34	0.27	11.09

Notes:

** Calculated by linear interpolation between 2 and 7 related to MUSLE K Values of 0.14 and 0.48.

Table 5-12. Sediment Yield By LA Corps Method for 100-Year Return Period

Subbasin	Drainage Area A (mi^2)	Drainage Area A (acre)	1-hr Precipitation P (inches*100)	Relief Ratio RR (ft/mi)	Fire Factor FF	Unit Peak Flow Q, (cfs/mi^2)	Log (Dy) (0.1 - 3.0) mi^2	Log (Dy) (3 - 10) mi^2	Log (Dy) (10 - 25) mi^2	Log (Dy) (25 -50) mi^2	Log (Dy) (50 - 200) mi^2	Dy yd^3/mi^2	Sed. Vol. yd^3	Sed. Yield ac-ft/mi^2
1	22.37	14317	120	25.56	4.77	101	-	-	3.642	-	-	4389	98189	2.7
2	8.10	5184	120	63.85	4.62	76	-	3.755	-	-	-	5691	46098	3.5
3	18.40	11776	120	59.69	4.77	142	-	-	3.945	-	-	8817	162232	5.5
4	5.69	3642	120	42.22	4.55	122	-	-	3.741	-	-	5507	31334	3.4
5	30.47	19501	125	21.37	4.77	189	-	-	-	3.976	-	9469	288521	5.9
6	27.55	17632	120	33.46	4.77	43	-	-	-	3.429	-	2686	74011	1.7
7	24.60	15744	140	157.30	4.77	148	-	-	4.171	-	-	14831	364834	9.2
8	88.44	56602	140	130.73	4.77	102	-	-	-	-	3.918	8279	732167	5.1
9	2.52	1613	120	26.94	4.20	113	2.890	-	-	-	-	777	1958	0.5
10	0.18	115	120	56.75	4.20	311	2.885	-	-	-	-	767	138	0.5
11	1.88	1203	135	11.98	4.20	273	2.683	-	-	-	-	482	905	0.3
12	42.32	27085	135	99.78	4.77	143	-	-	-	4.096	-	12474	527885	7.7
13	6.71	4294	120	10.54	4.57	180	-	3.646	-	-	-	4422	29671	2.7
14	23.58	15091	145	51.03	4.77	135	-	-	3.900	-	-	7943	187292	4.9
15	1.00	640	130	197.13	4.20	392	3.377	-	-	-	-	2381	2381	1.5
16	32.84	21018	140	66.30	4.77	95	-	-	-	3.858	-	7218	237038	4.5
17	38.50	24640	145	67.92	4.77	115	-	-	-	3.948	-	8871	341519	5.5
18	22.18	14195	140	135.68	4.77	191	-	-	4.234	-	-	17154	380478	10.6
19	47.79	30586	135	41.18	4.77	87	-	-	-	3.777	-	5986	286087	3.7
20	18.04	11546	150	129.72	4.77	148	-	-	4.122	-	-	13230	238663	8.2
21	21.59	13818	135	32.31	4.77	108	-	-	3.717	-	-	5212	112532	3.2
22	38.15	24416	145	157.28	4.77	148	-	-	-	4.167	-	14701	560843	9.1
23	10.58	6771	130	37.61	4.70	50	-	-	3.417	-	-	2615	27664	1.6
24	19.81	12678	150	140.84	4.77	189	-	-	4.234	-	-	17153	339805	10.6
25	43.88	28083	130	10.54	4.77	53	-	-	-	3.383	-	2418	106094	1.5
26	50.52	32333	130	61.26	4.77	112	-	-	-	-	3.841	6937	350442	4.3
27	16.93	10835	120	48.77	4.77	153	-	-	3.928	-	-	8475	143487	5.3
28	29.36	18790	130	37.53	4.77	89	-	-	-	3.744	-	5551	162979	3.4
29	3.94	2522	120	56.22	4.39	167	-	3.954	-	-	-	8990	35420	5.6
30	16.19	10362	145	59.12	4.77	110	-	-	3.842	-	-	6954	112587	4.3
31	2.65	1696	120	68.14	4.20	95	3.144	-	-	-	-	1394	3694	0.9
32	8.74	5594	140	174.01	4.65	310	-	4.515	-	-	-	32761	286328	20.3
33	18.46	11814	145	35.60	4.77	437	-	-	4.267	-	-	18485	341225	11.5
34	2.05	1312	120	74.53	4.20	180	3.148	-	-	-	-	1407	2885	0.9
Total	746.01	477446									Total		6617383	
											Basin Average	8870		5.5

Table 5-13. Sediment Yield By LA Corps Method for 50-Year Return Period

Subbasin	Drainage Area A (mi^2)	Drainage Area A (acre)	1-hr Precipitation P (inches*100)	Relief Ratio RR (ft/mi)	Fire Factor FF	Unit Peak Flow Q, (cfs/mi^2)	Log (Dy) (0.1 - 3.0) mi^2	Log (Dy) (3 - 10) mi^2	Log (Dy) (10 - 25) mi^2	Log (Dy) (25 -50) mi^2	Log (Dy) (50 - 200) mi^2	Dy yd^3/mi^2	Sed. Vol. yd^3	Sed. Yield ac-ft/mi^2
1	22.37	14317	108	25.56	4.77	80	-	-	3.556	-	-	3597	80463	2.2
2	8.10	5184	108	63.85	4.62	62	-	3.681	-	-	-	4793	38821	3.0
3	18.40	11776	108	59.69	4.77	114	-	-	3.861	-	-	7264	133666	4.5
4	5.69	3642	108	42.22	4.55	102	-	-	3.671	-	-	4691	26689	2.9
5	30.47	19501	113	21.37	4.77	151	-	-	-	3.885	-	7677	233928	4.8
6	27.55	17632	108	33.46	4.77	33	-	-	-	3.325	-	2116	58293	1.3
7	24.60	15744	126	157.30	4.77	122	-	-	4.096	-	-	12477	306930	7.7
8	88.44	56602	126	130.73	4.77	80	-	-	-	-	3.810	6457	571047	4.0
9	2.52	1613	108	26.94	4.20	95	2.860	-	-	-	-	724	1824	0.4
10	0.18	115	108	56.75	4.20	261	2.854	-	-	-	-	714	129	0.4
11	1.88	1203	122	11.98	4.20	234	2.653	-	-	-	-	450	846	0.3
12	42.32	27085	121	99.78	4.77	113	-	-	-	4.003	-	10060	425732	6.2
13	6.71	4294	108	10.54	4.57	164	-	3.612	-	-	-	4092	27458	2.5
14	23.58	15091	130	51.03	4.77	106	-	-	3.807	-	-	6410	151137	4.0
15	1.00	640	117	197.13	4.20	320	3.346	-	-	-	-	2220	2220	1.4
16	32.84	21018	124	66.30	4.77	79	-	-	-	3.784	-	6076	199524	3.8
17	38.50	24640	131	67.92	4.77	94	-	-	-	3.865	-	7321	281846	4.5
18	22.18	14195	126	135.68	4.77	158	-	-	4.161	-	-	14490	321386	9.0
19	47.79	30586	121	41.18	4.77	67	-	-	-	3.672	-	4697	224471	2.9
20	18.04	11546	134	129.72	4.77	122	-	-	4.048	-	-	11164	201407	6.9
21	21.59	13818	121	32.31	4.77	88	-	-	3.638	-	-	4346	93826	2.7
22	38.15	24416	130	157.28	4.77	118	-	-	-	4.076	-	11899	453963	7.4
23	10.58	6771	117	37.61	4.70	38	-	-	3.314	-	-	2062	21813	1.3
24	19.81	12678	134	140.84	4.77	156	-	-	4.163	-	-	14545	288140	9.0
25	43.88	28083	117	10.54	4.77	41	-	-	-	3.277	-	1893	83072	1.2
26	50.52	32333	117	61.26	4.77	89	-	-	-	-	3.741	5514	278550	3.4
27	16.93	10835	108	48.77	4.77	124	-	-	3.849	-	-	7059	119509	4.4
28	29.36	18790	117	37.53	4.77	72	-	-	-	3.656	-	4532	133046	2.8
29	3.94	2522	103	56.22	4.39	150	-	3.913	-	-	-	8194	32284	5.1
30	16.19	10362	130	59.12	4.77	99	-	-	3.801	-	-	6322	102353	3.9
31	2.65	1696	108	68.14	4.20	79	3.113	-	-	-	-	1299	3441	0.8
32	8.74	5594	125	174.01	4.65	263	-	4.455	-	-	-	28497	249062	17.7
33	18.46	11814	130	35.60	4.77	358	-	-	4.190	-	-	15487	285885	9.6
34	2.05	1312	108	74.53	4.20	161	3.120	-	-	-	-	1318	2701	0.8
Total	746.01	477446									Total		5435463	
											Basin Average	7286		4.5

Table 5-14. Sediment Yield By LA Corps Method for 25-Year Return Period

Subbasin	Drainage Area A (mi^2)	Drainage Area A (acre)	1-hr Precipitation P (inches*100)	Relief Ratio RR (ft/mi)	Fire Factor FF	Unit Peak Flow Q, (cfs/mi^2)	Log (Dy) (0.1 - 3.0) mi^2	Log (Dy) (3 - 10) mi^2	Log (Dy) (10 - 25) mi^2	Log (Dy) (25 -50) mi^2	Log (Dy) (50 - 200) mi^2	Dy yd^3/mi^2	Sed. Vol. yd^3	Sed. Yield $ac\text{-}ft/mi^2$
1	22.37	14317	95	25.56	4.77	63	-	-	3.460	-	-	2883	64498	1.8
2	8.10	5184	95	63.85	4.62	51	-	3.607	-	-	-	4049	32795	2.5
3	18.40	11776	95	59.69	4.77	87	-	-	3.757	-	-	5718	105219	3.5
4	5.69	3642	95	42.22	4.55	84	-	-	3.599	-	-	3971	22595	2.5
5	30.47	19501	100	21.37	4.77	125	-	-	-	3.807	-	6415	195473	4.0
6	27.55	17632	95	33.46	4.77	26	-	-	-	3.220	-	1659	45692	1.0
7	24.60	15744	112	157.30	4.77	98	-	-	4.011	-	-	10252	252208	6.4
8	88.44	56602	112	130.73	4.77	63	-	-	-	-	3.705	5069	448271	3.1
9	2.52	1613	95	26.94	4.20	75	2.825	-	-	-	-	669	1685	0.4
10	0.18	115	95	56.75	4.20	217	2.819	-	-	-	-	660	119	0.4
11	1.88	1203	108	11.98	4.20	197	2.621	-	-	-	-	418	785	0.3
12	42.32	27085	107	99.78	4.77	87	-	-	-	3.896	-	7877	333334	4.9
13	6.71	4294	97	10.54	4.57	134	-	3.538	-	-	-	3450	23152	2.1
14	23.58	15091	115	51.03	4.77	81	-	-	3.702	-	-	5034	118710	3.1
15	1.00	640	103	197.13	4.20	260	3.312	-	-	-	-	2052	2052	1.3
16	32.84	21018	108	66.30	4.77	64	-	-	-	3.696	-	4971	163232	3.1
17	38.50	24640	117	67.92	4.77	73	-	-	-	3.762	-	5780	222544	3.6
18	22.18	14195	112	135.68	4.77	126	-	-	4.076	-	-	11907	264086	7.4
19	47.79	30586	107	41.18	4.77	52	-	-	-	3.571	-	3724	177985	2.3
20	18.04	11546	118	129.72	4.77	100	-	-	3.971	-	-	9357	168804	5.8
21	21.59	13818	107	32.31	4.77	74	-	-	3.572	-	-	3736	80657	2.3
22	38.15	24416	115	157.28	4.77	94	-	-	-	3.984	-	9648	368066	6.0
23	10.58	6771	103	37.61	4.70	27	-	-	3.191	-	-	1554	16436	1.0
24	19.81	12678	118	140.84	4.77	126	-	-	4.081	-	-	12037	238447	7.5
25	43.88	28083	103	10.54	4.77	32	-	-	-	3.175	-	1495	65593	0.9
26	50.52	32333	103	61.26	4.77	71	-	-	-	-	3.643	4391	221848	2.7
27	16.93	10835	97	48.77	4.77	106	-	-	3.790	-	-	6164	104348	3.8
28	29.36	18790	103	37.53	4.77	54	-	-	-	3.545	-	3509	103036	2.2
29	3.94	2522	86	56.22	4.39	129	-	3.860	-	-	-	7239	28523	4.5
30	16.19	10362	115	59.12	4.77	62	-	-	3.621	-	-	4180	67682	2.6
31	2.65	1696	95	68.14	4.20	72	3.079	-	-	-	-	1199	3178	0.7
32	8.74	5594	110	174.01	4.65	206	-	4.364	-	-	-	23137	202219	14.3
33	18.46	11814	115	35.60	4.77	293	-	-	4.113	-	-	12980	239607	8.0
34	2.05	1312	97	74.53	4.20	141	3.088	-	-	-	-	1225	2511	0.8
Total	746.01	477446									Total		4385390	
											Basin Average	5878		3.6

Table 5-15. Sediment Yield By LA Corps Method for 10-Year Return Period

Subbasin	Drainage Area A (mi^2)	Drainage Area A (acre)	1-hr Precipitation P (inches*100)	Relief Ratio RR (ft/mi)	Fire Factor FF	Unit Peak Flow Q, (cfs/mi^2)	Log (Dy) (0.1 - 3.0) mi^2	Log (Dy) (3 - 10) mi^2	Log (Dy) (10 - 25) mi^2	Log (Dy) (25 -50) mi^2	Log (Dy) (50 - 200) mi^2	Dy yd^3/mi^2	Sed. Vol. yd^3	Sed. Yield ac-ft/mi^2
1	22.37	14317	79	25.56	4.77	41	-	-	3.302	-	-	2004	44830	1.2
2	8.10	5184	79	63.85	4.62	38	-	3.498	-	-	-	3149	25504	2.0
3	18.40	11776	79	59.69	4.77	64	-	-	3.642	-	-	4387	80727	2.7
4	5.69	3642	79	42.22	4.55	63	-	-	3.489	-	-	3083	17541	1.9
5	30.47	19501	84	21.37	4.77	91	-	-	-	3.679	-	4772	145415	3.0
6	27.55	17632	79	33.46	4.77	18	-	-	-	3.083	-	1211	33355	0.8
7	24.60	15744	93	157.30	4.77	71	-	-	3.888	-	-	7721	189949	4.8
8	88.44	56602	93	130.73	4.77	43	-	-	-	-	3.537	3440	304264	2.1
9	2.52	1613	79	26.94	4.20	56	2.772	-	-	-	-	591	1490	0.4
10	0.18	115	79	56.75	4.20	167	2.766	-	-	-	-	584	105	0.4
11	1.88	1203	91	11.98	4.20	154	2.571	-	-	-	-	372	700	0.2
12	42.32	27085	88	99.78	4.77	59	-	-	-	3.739	-	5481	231973	3.4
13	6.71	4294	82	10.54	4.57	110	-	3.463	-	-	-	2905	19491	1.8
14	23.58	15091	95	51.03	4.77	56	-	-	3.565	-	-	3673	86616	2.3
15	1.00	640	86	197.13	4.20	193	3.260	-	-	-	-	1818	1818	1.1
16	32.84	21018	87	66.30	4.77	47	-	-	-	3.568	-	3695	121357	2.3
17	38.50	24640	98	67.92	4.77	51	-	-	-	3.620	-	4167	160448	2.6
18	22.18	14195	93	135.68	4.77	94	-	-	3.963	-	-	9174	203475	5.7
19	47.79	30586	88	41.18	4.77	35	-	-	-	3.403	-	2530	120916	1.6
20	18.04	11546	97	129.72	4.77	73	-	-	3.853	-	-	7122	128483	4.4
21	21.59	13818	88	32.31	4.77	55	-	-	3.461	-	-	2888	62342	1.8
22	38.15	24416	95	157.28	4.77	68	-	-	-	3.850	-	7087	270380	4.4
23	10.58	6771	86	37.61	4.70	17	-	-	3.015	-	-	1036	10961	0.6
24	19.81	12678	97	140.84	4.77	95	-	-	3.970	-	-	9336	184943	5.8
25	43.88	28083	86	10.54	4.77	20	-	-	-	2.989	-	974	42757	0.6
26	50.52	32333	86	61.26	4.77	50	-	-	-	-	3.489	3085	155875	1.9
27	16.93	10835	82	48.77	4.77	83	-	-	3.693	-	-	4931	83487	3.1
28	29.36	18790	86	37.53	4.77	39	-	-	-	3.4058	-	2546	74736	1.6
29	3.94	2522	64	56.22	4.39	109	-	3.798	-	-	-	6274	24721	3.9
30	16.19	10362	95	59.12	4.77	43	-	-	3.481	-	-	3027	49014	1.9
31	2.65	1696	79	68.14	4.20	54	3.026	-	-	-	-	1061	2811	0.7
32	8.74	5594	90	174.01	4.65	146	-	4.238	-	-	-	17316	151345	10.7
33	18.46	11814	95	35.60	4.77	216	-	-	3.998	-	-	9958	183833	6.2
34	2.05	1312	82	74.53	4.20	120	3.040	-	-	-	-	1096	2247	0.7
Total	746.01	477446									Total		3217910	
											Basin Average	4313		2.7

Table 5-16. Sediment Yield By LA Corps Method for 5-Year Return Period

Subbasin	Drainage Area A (mi^2)	Drainage Area A (acre)	1-hr Precipitation P (inches*100)	Relief Ratio RR (ft/mi)	Fire Factor FF	Unit Peak Flow Q, (cfs/mi^2)	Log (Dy) (0.1 - 3.0) mi^2	Log (Dy) (3 - 10) mi^2	Log (Dy) (10 - 25) mi^2	Log (Dy) (25 -50) mi^2	Log (Dy) (50 - 200) mi^2	Dy yd^3/mi^2	Sed. Vol. yd^3	Sed. Yield ac-ft/mi^2
1	22.37	14317	50	25.56	4.77	23	-	-	3.081	-	-	1206	26980	0.7
2	8.10	5184	50	63.85	4.62	23	-	3.323	-	-	-	2106	17056	1.3
3	18.40	11776	50	59.69	4.77	39	-	-	3.447	-	-	2797	51473	1.7
4	5.69	3642	50	42.22	4.55	39	-	-	3.301	-	-	1999	11372	1.2
5	30.47	19501	55	21.37	4.77	59	-	-	-	3.502	-	3178	96838	2.0
6	27.55	17632	50	33.46	4.77	11	-	-	-	2.854	-	715	19693	0.4
7	24.60	15744	60	157.30	4.77	53	-	-	3.777	-	-	5977	147042	3.7
8	88.44	56602	60	130.73	4.77	25	-	-	-	-	3.291	1954	172846	1.2
9	2.52	1613	50	26.94	4.20	32	2.643	-	-	-	-	440	1109	0.3
10	0.18	115	50	56.75	4.20	106	2.638	-	-	-	-	434	78	0.3
11	1.88	1203	60	11.98	4.20	112	2.454	-	-	-	-	284	534	0.2
12	42.32	27085	55	99.78	4.77	40	-	-	-	3.579	-	3792	160469	2.4
13	6.71	4294	55	10.54	4.57	75	-	3.321	-	-	-	2094	14048	1.3
14	23.58	15091	60	51.03	4.77	34	-	-	3.371	-	-	2352	55450	1.5
15	1.00	640	55	197.13	4.20	150	3.134	-	-	-	-	1361	1361	0.8
16	32.84	21018	50	66.30	4.77	30	-	-	-	3.394	-	2475	81268	1.5
17	38.50	24640	65	67.92	4.77	34	-	-	-	3.449	-	2810	108192	1.7
18	22.18	14195	60	135.68	4.77	68	-	-	3.837	-	-	6875	152478	4.3
19	47.79	30586	55	41.18	4.77	20	-	-	-	3.172	-	1485	70968	0.9
20	18.04	11546	60	129.72	4.77	45	-	-	3.671	-	-	4684	84508	2.9
21	21.59	13818	55	32.31	4.77	38	-	-	3.312	-	-	2052	44308	1.3
22	38.15	24416	60	157.28	4.77	47	-	-	-	3.7015	-	5029	191848	3.1
23	10.58	6771	55	37.61	4.70	8	-	-	2.699	-	-	500	5292	0.3
24	19.81	12678	60	140.84	4.77	61	-	-	3.800	-	-	6310	124993	3.9
25	43.88	28083	55	10.54	4.77	13	-	-	-	2.793	-	621	27255	0.4
26	50.52	32333	55	61.26	4.77	34	-	-	-	-	3.310	2043	103201	1.3
27	16.93	10835	55	48.77	4.77	58	-	-	3.557	-	-	3610	61112	2.2
28	29.36	18790	55	37.53	4.77	24	-	-	-	3.208	-	1613	47371	1.0
29	3.94	2522	25	56.22	4.39	76	-	3.664	-	-	-	4611	18168	2.9
30	16.19	10362	60	59.12	4.77	27	-	-	3.307	-	-	2030	32863	1.3
31	2.65	1696	50	68.14	4.20	33	2.897	-	-	-	-	789	2091	0.5
32	8.74	5594	55	174.01	4.65	94	-	4.074	-	-	-	11860	103653	7.4
33	18.46	11814	60	35.60	4.77	146	-	-	3.848	-	-	7053	130194	4.4
34	2.05	1312	55	74.53	4.20	88	2.928	-	-	-	-	847	1737	0.5
Total	746.01	477446									Total		2167850	
											Basin Average	2906		1.8

Table 5-17. Average Annual Sediment Yield By LA Corps Method

	Return Period	100 yr	50 yr	25 yr	10 yr	5 yr	Average Annual Sediment Yield (Cu. Yd.)	Average Annual Sediment Yield (ac-ft/mi^2)	Sed. Yield with A-T Factor Applied (ac-ft/mi^2)
	Probability	0.01	0.02	0.04	0.1	0.2			
Subbasin									
Number	Area (sq. mi.)	Sediment Yield (yd^3)							
1	22.37	98189	80463	64498	44830	17453	16700	0.46	0.2
2	8.10	46098	38821	32795	25504	11284	9704	0.74	0.4
3	18.40	162232	133666	105219	80727	21316	24698	0.83	0.4
4	5.69	31334	26689	22595	17541	4701	5293	0.58	0.3
5	30.47	288521	233928	195473	145415	24385	38262	0.78	0.4
6	27.55	74011	58293	45692	33355	25092	17772	0.40	0.2
7	24.60	364834	306930	252208	189949	46173	56139	1.41	0.7
8	88.44	732167	571047	448271	304264	87824	101341	0.71	0.3
9	2.52	1958	1824	1685	1490	1353	852	0.21	0.1
10	0.18	138	129	119	105	95	60	0.21	0.1
11	1.88	905	846	785	700	640	402	0.13	0.1
12	42.32	527885	425732	333334	231973	58064	72324	1.06	0.5
13	6.71	29671	27458	23152	19491	3480	4908	0.45	0.2
14	23.58	187292	151137	118710	86616	25717	28327	0.74	0.4
15	1.00	2381	2220	2052	1818	1653	1040	0.64	0.3
16	32.84	237038	199524	163232	121357	38152	39955	0.75	0.4
17	38.50	341519	281846	222544	160448	46090	51829	0.83	0.4
18	22.18	380478	321386	264086	203475	38538	54712	1.53	0.7
19	47.79	286087	224471	177985	120916	50243	47061	0.61	0.3
20	18.04	238663	201407	168804	128483	30299	37266	1.28	0.6
21	21.59	112532	93826	80657	62342	18809	19773	0.57	0.3
22	38.15	560843	453963	368066	270380	59674	78429	1.27	0.6
23	10.58	27664	21813	16436	10961	9197	6415	0.38	0.2
24	19.81	339805	288140	238447	184943	34807	49415	1.55	0.7
25	43.88	106094	83072	65593	42757	29472	22144	0.31	0.1
26	50.52	350442	278550	221848	155875	38531	48118	0.59	0.3
27	16.93	143487	119509	104348	83487	17712	22768	0.83	0.4
28	29.36	162979	133046	103036	74736	27989	27136	0.57	0.3
29	3.94	35420	32284	28523	24721	4417	6122	0.96	0.5
30	16.19	112587	102353	67682	49014	18528	18190	0.70	0.3
31	2.65	3694	3441	3178	2811	2552	1607	0.38	0.2
32	8.74	286328	249062	202219	151345	21106	37725	2.68	1.3
33	18.46	341225	285885	239607	183833	16691	41209	1.38	0.7
34	2.05	2885	2701	2511	2247	2059	1291	0.39	0.2
						Total	988984		
						Basin Average	1325.70	0.82	0.39

Average Annual Sediment Yield Computed from the following formula:

Yavg=0.01*Y100+0.005*(Y100+Q50)+0.01*(Y50+Y25)+0.03*(Y25+Y10)+0.05*(Y10+Y5)+0.4*Y5

where Yavg, Y100, Y50, Y25, Y10, and Y5 are average annual sediment yield, and sediment yield for return periods 100, 50, 25, 10, and 5 years respectively.

Adjustment Transposition (A-T) Factor=0.39/0.82= 0.47

Table 5-18. Computed Relief Ratio for Longest Subbasin Watercourse

Subbasin	Length (ft)	Slope (ft/ft)	Slope (ft/mi)
1	13633	0.005	25.56
2	9307	0.012	63.85
3	9046	0.011	59.69
4	8717	0.008	42.22
5	11351	0.004	21.37
6	4502	0.006	33.46
7	5536	0.030	157.30
8	20509	0.025	130.73
9	3755	0.005	26.94
10	846	0.011	56.75
11	1347	0.002	11.98
12	12669	0.019	99.78
13	6690	0.002	10.55
14	1969	0.010	51.03
15	2024	0.037	197.13
16	14523	0.013	66.30
17	12050	0.013	67.92
18	4802	0.026	135.68
19	9493	0.008	41.18
20	8105	0.025	129.72
21	1877	0.006	32.31
22	9612	0.030	157.28
23	10895	0.007	37.61
24	1508	0.027	140.84
25	20125	0.002	10.54
26	12571	0.012	61.26
27	11370	0.009	48.77
28	17164	0.007	37.53
29	8120	0.011	56.22
30	4862	0.011	59.12
31	6114	0.013	68.14
32	5923	0.033	174.01
33	5636	0.007	35.60
34	1169	0.014	74.53
Minimum	**846**		**10.54**
Maximum	**20509**		**197.13**

Table 5-19. MUSLE C Values Related to Vegetation Coverage

Vegetation Coverage	Assumption Made Related to Vegetation Coverage				Related C Values
	Vegetation Canopy	% Canopy Coverage	Ground Cover Type	% Ground Cover	
No Data	None	None	Weeds	0	0.000
Agri	No appreciable canopy	None	Weeds	40	0.150
Dune	No appreciable canopy	None	Weeds	0	0.450
Coastal Scrub	Tall weeds/ Short brush	75	Weeds	20	0.160
Chap. and Sage	Tall weeds/ Short brush	75	Weeds	20	0.160
Grassland	No appreciable canopy	None	Weeds	80	0.043
Marsh	No appreciable canopy	None	Weeds	60	0.091
Dev	No appreciable canopy	None	Weeds	80	0.043
Riparian Forest	Long brushes	75	Weeds	60	0.078
Riparian Woodland	Trees	50	Weeds	40	0.140
Fan Scrub	Tall weeds/ Short brush	75	Weeds	20	0.160
Oak Woodland with Pinon & J	Long brush	25	Weeds	20	0.220
Mixed Woodland & Pine	Trees	50	Weeds	20	0.210
Row Crops	No appreciable canopy	None	Weeds	40	0.150
Pasture	No appreciable canopy	None	Weeds	80	0.043
Beach and Alluvial Wash	No appreciable canopy	None	Weeds	0	0.450
Orchard	Long brush	75	Weeds	20	0.170
Disturbed	No appreciable canopy	None	Weeds	0	0.450
Water	No appreciable canopy	None	Weeds	0	0.011

Table 5-20. Sediment Yield by MUSLE Method for 100-Year Return Period

1	2	3	4	5	6	7	8	9	10	11	12	
Subbasin Name	Area (mi2)	Discharge (cfs)	Runoff Volume (ac-ft)	Rw	K	Overflow Length (ft)	Slope	LS	C	P	Ys (tons)	Ys (ac-ft/mi²)
1	22.37	2257	826	925477	0.22	915	7.5%	2.77	0.08	1	43669	0.96
2	8.10	612	261	233555	0.29	1217	6.8%	2.84	0.11	1	21957	1.34
3	18.40	2617	703	918698	0.30	1017	10.2%	4.48	0.10	1	123799	3.32
4	5.69	696	231	234666	0.28	1031	9.0%	3.79	0.10	1	24094	2.09
5	30.47	5750	1962	2536141	0.29	858	10.9%	4.58	0.09	1	308573	5.00
6	27.55	1186	821	643314	0.28	944	7.9%	2.99	0.10	1	53688	0.96
7	24.60	3651	1741	1839107	0.29	867	21.7%	13.82	0.16	1	1169525	23.47
8	88.44	9059	4017	4886792	0.26	897	13.6%	6.69	0.15	1	1261205	7.04
9	2.52	284	74	74935	0.26	1430	6.3%	2.76	0.09	1	4834	0.95
10	0.18	56	5	6625	0.28	429	7.0%	1.74	0.06	1	184	0.50
11	1.88	514	89	115693	0.29	874	18.5%	10.41	0.11	1	37558	9.86
12	42.32	6034	1883	2546507	0.29	698	13.3%	5.64	0.16	1	652422	7.61
13	6.71	1205	280	355514	0.28	914	10.8%	4.64	0.08	1	37798	2.78
14	23.58	3190	1151	1352378	0.27	634	29.7%	19.38	0.17	1	1160247	24.29
15	1.00	392	59	79213	0.30	662	18.8%	9.51	0.15	1	33382	16.48
16	32.84	3123	1426	1507016	0.30	962	24.7%	18.26	0.14	1	1155685	17.37
17	38.50	4416	2105	2275304	0.28	669	29.2%	19.58	0.16	1	2017357	25.87
18	22.18	4240	1431	1791924	0.30	757	16.3%	8.21	0.16	1	695651	15.48
19	47.79	4142	2572	2455914	0.27	953	26.0%	19.73	0.15	1	1964985	20.30
20	18.04	2668	1062	1169965	0.29	807	19.6%	11.17	0.16	1	602856	16.50
21	21.59	2336	1362	1248383	0.30	1012	21.0%	14.25	0.12	1	639584	14.63
22	38.15	5635	2773	3043907	0.29	766	19.4%	10.77	0.16	1	1505677	19.48
23	10.58	524	216	192918	0.27	1078	23.1%	17.49	0.15	1	131539	6.14
24	19.81	3739	1224	1530486	0.28	829	25.0%	17.29	0.16	1	1157242	28.84
25	43.88	2335	1279	1204593	0.28	1296	12.6%	7.27	0.09	1	225709	2.54
26	50.52	5636	2105	2608356	0.28	959	14.8%	7.89	0.14	1	833624	8.15
27	16.93	2585	851	1015075	0.25	895	17.4%	9.49	0.08	1	199210	5.81
28	29.36	2606	949	1084107	0.27	850	13.3%	6.24	0.10	1	176573	2.97
29	3.94	658	177	195862	0.26	1155	7.9%	3.44	0.05	1	8919	1.12
30	16.19	1783	782	786397	0.28	854	20.6%	12.46	0.15	1	415974	12.68
31	2.65	252	74	70083	0.26	1097	7.4%	3.10	0.05	1	2838	0.53
32	8.74	2710	757	976538	0.30	632	15.0%	6.52	0.12	1	220653	12.46
33	18.46	8070	1613	2747597	0.28	558	16.4%	6.99	0.09	1	459522	12.29
34	2.05	370	93	99200	0.27	1113	8.5%	3.75	0.06	1	5546	1.34

Alpha 285.00
Beta 0.56

Basin Average 23259.848 tons/mi²
11.483283 ac-ft/mi²

Column Number	Variable	Explanation
1	Subbasin Name	
2	Area	Area of the Sub-Basin in Square Miles.
3, 4	Peak Flow, Volume	From Table 5-1
5	Rw	Alpha*(Discharge* Volume)^Beta
6	K	Soil Erodibility Factor Based on USDA Texture. Subbasin average using soil survey map.
7	Overflow Length (ft)	Overflow length computed for 10-year discharge with flow over 0.5 cfs.
8	Slope	Average percent slope over the subbasin. Computed from digital elevation model grid slope.
9	LS	Obtained from lookup table in SCS New Mexico Technical Note 28 for a given Slope and Overland Flow Length.
10	C	Cover and Management Factor
11	P	Erosion Control Praactice factor, set to 1.0 for range and wild land areas.
12	Ys	Sediment yield in tons=Rw*K*LS*C*P

Table 5-21. Sediment Yield by MUSLE Method for 50-Year Return Period

1	2	3	4	5	6	7	8	9	10	11	12	
Subbasin Name	Area (mi2)	Discharge (cfs)	Runoff Volume (ac-ft)	Rw	K	Overflow Length (ft)	Slope	LS	C	P	Ys (tons)	Ys (ac-ft/mi^2
1	22.37	1800	620	694283	0.22	915	7.5%	2.77	0.08	1	32760	0.72
2	8.10	500	210	184804	0.29	1217	6.8%	2.84	0.11	1	17374	1.06
3	18.40	2100	550	707768	0.30	1017	10.2%	4.48	0.10	1	95375	2.56
4	5.69	580	190	189874	0.28	1031	9.0%	3.79	0.10	1	19495	1.69
5	30.47	4600	1600	1996625	0.29	858	10.9%	4.58	0.09	1	242930	3.94
6	27.55	920	650	489551	0.28	944	7.9%	2.99	0.10	1	40856	0.73
7	24.60	3000	1700	1625864	0.29	867	21.7%	13.82	0.16	1	1033919	20.75
8	88.44	7100	3000	3620241	0.26	897	13.6%	6.69	0.15	1	934328	5.22
9	2.52	240	59	60178	0.26	1430	6.3%	2.76	0.09	1	3882	0.76
10	0.18	47	5	6008	0.28	429	7.0%	1.74	0.06	1	167	0.46
11	1.88	440	74	95929	0.29	874	18.5%	10.41	0.11	1	31141	8.18
12	42.32	4800	1500	1972200	0.29	698	13.3%	5.64	0.16	1	505283	5.89
13	6.71	1100	240	309701	0.28	914	10.8%	4.64	0.08	1	32927	2.42
14	23.58	2500	900	1028175	0.27	634	29.7%	19.38	0.17	1	882103	18.47
15	1.00	320	46	61500	0.30	662	18.8%	9.51	0.15	1	25917	12.80
16	32.84	2600	1200	1234728	0.30	962	24.7%	18.26	0.14	1	946876	14.23
17	38.50	3600	1200	1481548	0.28	669	29.2%	19.58	0.16	1	1313588	16.84
18	22.18	3500	1300	1525216	0.30	757	16.3%	8.21	0.16	1	592111	13.18
19	47.79	3200	1900	1794035	0.27	953	26.0%	19.73	0.15	1	1435413	14.83
20	18.04	2200	860	933084	0.29	807	19.6%	11.17	0.16	1	480797	13.16
21	21.59	1900	1200	1035830	0.30	1012	21.0%	14.25	0.12	1	530686	12.14
22	38.15	4500	2200	2357222	0.29	766	19.4%	10.77	0.16	1	1166006	15.09
23	10.58	400	170	144894	0.27	1078	23.1%	17.49	0.15	1	98794	4.61
24	19.81	3100	1000	1230290	0.28	829	25.0%	17.29	0.16	1	930256	23.18
25	43.88	1800	960	886889	0.28	1296	12.6%	7.27	0.09	1	166179	1.87
26	50.52	4500	1600	1972200	0.28	959	14.8%	7.89	0.14	1	630311	6.16
27	16.93	2100	700	810107	0.25	895	17.4%	9.49	0.08	1	158985	4.64
28	29.36	2100	720	822989	0.27	850	13.3%	6.24	0.10	1	134043	2.25
29	3.94	590	160	174112	0.26	1155	7.9%	3.44	0.05	1	7929	0.99
30	16.19	1600	600	638141	0.28	854	20.6%	12.46	0.15	1	337552	10.29
31	2.65	210	62	57415	0.26	1097	7.4%	3.10	0.05	1	2325	0.43
32	8.74	2300	600	781947	0.30	632	15.0%	6.52	0.12	1	176684	9.98
33	18.46	6600	1400	2267886	0.28	558	16.4%	6.99	0.09	1	379293	10.14
34	2.05	330	82	86487	0.27	1113	8.5%	3.75	0.06	1	4835	1.16

Alpha 285.00
Beta 0.56

Basin Average 17950.326 tons/mi^2
8.8619953 ac-ft/mi^2

Column Number	Variable	Explanation
1	Subbasin Name	
2	Area	Area of the Sub-Basin in Square Miles.
3, 4	Peak Flow, Volume	From Table 5-1
5	Rw	Alpha*(Discharge* Volume)^Beta
6	K	Soil Erodibility Factor Based on USDA Texture. Subbasin average using soil survey map.
7	Overflow Length (ft)	Overflow length computed for 10-year discharge with flow over 0.5 cfs.
8	Slope	Average percent slope over the subbasin. Computed from digital elevation model grid slope.
9	LS	Obtained from lookup table in SCS New Mexico Technical Note 28.
10	C	Cover and Management Factor
11	P	Erosion Control Praactice factor, set to 1.0 for range and wild land areas.
12	Ys	Sediment yield in tons=Rw*K*LS*C*P

Table 5-22. Sediment Yield by MUSLE Method for 25-Year Return Period

1 Subbasin Name	2 Area (mi2)	3 Discharge (cfs)	4 Runoff Volume (ac-ft)	5 Rw	6 K	7 Overflow Length (ft)	8 Slope	9 LS	10 C	11 P	12 Ys (tons)	Ys (ac-ft/mi^2)
1	22.37	1400	480	522603	0.22	915	7.5%	2.77	0.08	1	24659	0.54
2	8.10	410	140	131776	0.29	1217	6.8%	2.84	0.11	1	12389	0.76
3	18.40	1600	420	522603	0.30	1017	10.2%	4.48	0.10	1	70423	1.89
4	5.69	480	160	155113	0.28	1031	9.0%	3.79	0.10	1	15926	1.38
5	30.47	3800	1400	1664774	0.29	858	10.9%	4.58	0.09	1	202553	3.28
6	27.55	710	500	365572	0.28	944	7.9%	2.99	0.10	1	30509	0.55
7	24.60	2400	1100	1124458	0.29	867	21.7%	13.82	0.16	1	715065	14.35
8	88.44	5600	2400	2797361	0.26	897	13.6%	6.69	0.15	1	721955	4.03
9	2.52	190	47	46486	0.26	1430	6.3%	2.76	0.09	1	2999	0.59
10	0.18	39	5	5412	0.28	429	7.0%	1.74	0.06	1	150	0.41
11	1.88	370	62	78846	0.29	874	18.5%	10.41	0.11	1	25596	6.72
12	42.32	3700	1100	1432906	0.29	698	13.3%	5.64	0.16	1	367115	4.28
13	6.71	900	200	249918	0.28	914	10.8%	4.64	0.08	1	26571	1.96
14	23.58	1900	680	753619	0.27	634	29.7%	19.38	0.17	1	646553	13.54
15	1.00	260	36	47726	0.30	662	18.8%	9.51	0.15	1	20113	9.93
16	32.84	2100	910	938320	0.30	962	24.7%	18.26	0.14	1	719569	10.82
17	38.50	2800	1030	1181523	0.28	669	29.2%	19.58	0.16	1	1047576	13.43
18	22.18	2800	920	1109110	0.30	757	16.3%	8.21	0.16	1	430573	9.58
19	47.79	2500	990	1084543	0.27	953	26.0%	19.73	0.15	1	867747	8.96
20	18.04	1800	690	737145	0.29	807	19.6%	11.17	0.16	1	379834	10.39
21	21.59	1600	900	800807	0.30	1012	21.0%	14.25	0.12	1	410277	9.38
22	38.15	3600	1800	1859203	0.29	766	19.4%	10.77	0.16	1	919660	11.90
23	10.58	290	130	104135	0.27	1078	23.1%	17.49	0.15	1	71003	3.31
24	19.81	2500	800	962546	0.28	829	25.0%	17.29	0.16	1	727808	18.14
25	43.88	1400	700	645552	0.28	1296	12.6%	7.27	0.09	1	120959	1.36
26	50.52	3600	1300	1549468	0.28	959	14.8%	7.89	0.14	1	495206	4.84
27	16.93	1800	580	668832	0.25	895	17.4%	9.49	0.08	1	131259	3.83
28	29.36	1600	560	613956	0.27	850	13.3%	6.24	0.10	1	99997	1.68
29	3.94	510	140	148907	0.26	1155	7.9%	3.44	0.05	1	6781	0.85
30	16.19	1000	450	417488	0.28	854	20.6%	12.46	0.15	1	220835	6.73
31	2.65	190	51	48662	0.26	1097	7.4%	3.10	0.05	1	1971	0.37
32	8.74	1800	470	594528	0.30	632	15.0%	6.52	0.12	1	134336	7.59
33	18.46	5400	1000	1678747	0.28	558	16.4%	6.99	0.09	1	280762	7.51
34	2.05	290	72	74799	0.27	1113	8.5%	3.75	0.06	1	4181	1.01

Alpha 285.00
Beta 0.56

Basin Average 13341.527 tons/mi^2
6.5866519 ac-ft/mi^2

Column Number	Variable	Explanation
1	Subbasin Name	
2	Area	Area of the Sub-Basin in Square Miles.
3, 4	Peak Flow, Volume	From Table 5-1
5	Rw	Alpha*(Discharge* Volume)^Beta
6	K	Soil Erodibility Factor Based on USDA Texture. Subbasin average using soil survey map.
7	Overflow Length (ft)	Overflow length computed for 10-year discharge with flow over 0.5 cfs.
8	Slope	Average percent slope over the subbasin. Computed from digital elevation model grid slope.
9	LS	Obtained from lookup table in SCS New Mexico Technical Note 28.
10	C	Cover and Management Factor
11	P	Erosion Control Praactice factor, set to 1.0 for range and wild land areas.
12	Ys	Sediment yield in tons=Rw*K*LS*C*P

Table 5-23. Sediment Yield by MUSLE Method for 10-Year Return Period

1	2	3	4	5	6	7	8	9	10	11	12	
Subbasin Name	Area (mi2)	Discharge (cfs)	Runoff Volume (ac-ft)	Rw	K	Overflow Length (ft)	Slope	LS	C	P	Ys (tons)	Ys (ac-ft/mi^2)
1	22.37	926	315	327324	0.22	915	7.5%	2.77	0.08	1	15445	0.34
2	8.10	305	128	106123	0.29	1217	6.8%	2.84	0.11	1	9977	0.61
3	18.40	1184	295	362290	0.30	1017	10.2%	4.48	0.10	1	48820	1.31
4	5.69	360	113	108721	0.28	1031	9.0%	3.79	0.10	1	11163	0.97
5	30.47	2774	865	1066206	0.29	858	10.9%	4.58	0.09	1	129726	2.10
6	27.55	508	344	245897	0.28	944	7.9%	2.99	0.10	1	20522	0.37
7	24.60	1739	797	783629	0.29	867	21.7%	13.82	0.16	1	498326	10.00
8	88.44	3830	1593	1797675	0.26	897	13.6%	6.69	0.15	1	463952	2.59
9	2.52	142	34	33170	0.26	1430	6.3%	2.76	0.09	1	2140	0.42
10	0.18	30	5	4671	0.28	429	7.0%	1.74	0.06	1	130	0.36
11	1.88	289	49	60300	0.29	874	18.5%	10.41	0.11	1	19575	5.14
12	42.32	2516	713	905688	0.29	698	13.3%	5.64	0.16	1	232040	2.71
13	6.71	735	162	198474	0.28	914	10.8%	4.64	0.08	1	21102	1.55
14	23.58	1328	457	493806	0.27	634	29.7%	19.38	0.17	1	423651	8.87
15	1.00	193	25	32625	0.30	662	18.8%	9.51	0.15	1	13749	6.79
16	32.84	1532	679	667255	0.30	962	24.7%	18.26	0.14	1	511698	7.69
17	38.50	1977	890	895939	0.28	669	29.2%	19.58	0.16	1	794368	10.19
18	22.18	2082	659	779368	0.30	757	16.3%	8.21	0.16	1	302562	6.73
19	47.79	1657	969	851013	0.27	953	26.0%	19.73	0.15	1	680898	7.03
20	18.04	1320	492	512550	0.29	807	19.6%	11.17	0.16	1	264105	7.23
21	21.59	1194	664	573223	0.30	1012	21.0%	14.25	0.12	1	293679	6.72
22	38.15	2593	1200	1232771	0.29	766	19.4%	10.77	0.16	1	609793	7.89
23	10.58	183	74	58587	0.27	1078	23.1%	17.49	0.15	1	39946	1.86
24	19.81	1873	575	680800	0.28	829	25.0%	17.29	0.16	1	514772	12.83
25	43.88	888	462	396531	0.28	1296	12.6%	7.27	0.09	1	74299	0.84
26	50.52	2547	870	1019661	0.28	959	14.8%	7.89	0.14	1	325881	3.18
27	16.93	1397	428	489390	0.25	895	17.4%	9.49	0.08	1	96044	2.80
28	29.36	1137	374	404293	0.27	850	13.3%	6.24	0.10	1	65849	1.11
29	3.94	431	113	120251	0.26	1155	7.9%	3.44	0.05	1	5476	0.69
30	16.19	693	290	265890	0.28	854	20.6%	12.46	0.15	1	140646	4.29
31	2.65	144	39	36027	0.26	1097	7.4%	3.10	0.05	1	1459	0.27
32	8.74	1280	325	399206	0.30	632	15.0%	6.52	0.12	1	90202	5.10
33	18.46	3996	728	1187056	0.28	558	16.4%	6.99	0.09	1	198529	5.31
34	2.05	246	59	61021	0.27	1113	8.5%	3.75	0.06	1	3411	0.82

Alpha 285.00
Beta 0.56

Basin Average 9281.2893 tons/mi^2
4.5821308 ac-ft/mi^2

Column Number	Variable	Explanation
1	Subbasin Name	
2	Area	Area of the Sub-Basin in Square Miles.
3, 4	Peak Flow, Volume	From Table 5-1
5	Rw	Alpha*(Discharge* Volume)^Beta
6	K	Soil Erodibility Factor Based on USDA Texture. Subbasin average using soil survey map.
7	Overflow Length (ft)	Overflow length computed for 10-year discharge with flow over 0.5 cfs.
8	Slope	Average percent slope over the subbasin. Computed from digital elevation model grid slope.
9	LS	Obtained from lookup table in SCS New Mexico Technical Note 28.
10	C	Cover and Management Factor
11	P	Erosion Control Praactice factor, set to 1.0 for range and wild land areas.
12	Ys	Sediment yield in tons=Rw*K*LS*C*P

Table 5-24. Sediment Yield by MUSLE Method for 5-Year Return Period

1 Subbasin Name	2 Area (mi2)	3 Discharge (cfs)	4 Runoff Volume (ac-ft)	5 Rw	6 K	7 Overflow Length (ft)	8 Slope	9 LS	10 C	11 P	12 Ys (tons)	Ys (ac-ft/mi^2
1	22.37	520	180	173284	0.22	915	7.5%	2.77	0.08	1	8176	0.18
2	8.10	190	75	60392	0.29	1217	6.8%	2.84	0.11	1	5678	0.35
3	18.40	710	180	206301	0.30	1017	10.2%	4.48	0.10	1	27800	0.75
4	5.69	220	65	60511	0.28	1031	9.0%	3.79	0.10	1	6213	0.54
5	30.47	1800	520	629157	0.29	858	10.9%	4.58	0.09	1	76550	1.24
6	27.55	290	190	128792	0.28	944	7.9%	2.99	0.10	1	10748	0.19
7	24.60	1300	540	535542	0.29	867	21.7%	13.82	0.16	1	340562	6.83
8	88.44	2200	890	951174	0.26	897	13.6%	6.69	0.15	1	245483	1.37
9	2.52	80	21	18240	0.26	1430	6.3%	2.76	0.09	1	1177	0.23
10	0.18	19	5	3618	0.28	429	7.0%	1.74	0.06	1	100	0.28
11	1.88	210	25	34525	0.29	874	18.5%	10.41	0.11	1	11208	2.94
12	42.32	1700	450	561947	0.29	698	13.3%	5.64	0.16	1	143972	1.68
13	6.71	500	110	128661	0.28	914	10.8%	4.64	0.08	1	13679	1.01
14	23.58	800	280	282477	0.27	634	29.7%	19.38	0.17	1	242346	5.07
15	1.00	150	17	23041	0.30	662	18.8%	9.51	0.15	1	9710	4.79
16	32.84	1000	430	406993	0.30	962	24.7%	18.26	0.14	1	312111	4.69
17	38.50	1300	510	518672	0.28	669	29.2%	19.58	0.16	1	459871	5.90
18	22.18	1500	320	432853	0.30	757	16.3%	8.21	0.16	1	168040	3.74
19	47.79	940	530	441968	0.27	953	26.0%	19.73	0.15	1	353620	3.65
20	18.04	820	300	297693	0.29	807	19.6%	11.17	0.16	1	153394	4.20
21	21.59	810	450	371018	0.30	1012	21.0%	14.25	0.12	1	190084	4.35
22	38.15	1800	790	795186	0.29	766	19.4%	10.77	0.16	1	393341	5.09
23	10.58	80	32	23092	0.27	1078	23.1%	17.49	0.15	1	15745	0.73
24	19.81	1200	330	388646	0.28	829	25.0%	17.29	0.16	1	293866	7.32
25	43.88	550	280	229011	0.28	1296	12.6%	7.27	0.09	1	42911	0.48
26	50.52	1700	550	628781	0.28	959	14.8%	7.89	0.14	1	200957	1.96
27	16.93	980	290	322756	0.25	895	17.4%	9.49	0.08	1	63341	1.85
28	29.36	700	220	229011	0.27	850	13.3%	6.24	0.10	1	37300	0.63
29	3.94	300	78	79727	0.26	1155	7.9%	3.44	0.05	1	3631	0.45
30	16.19	440	180	157809	0.28	854	20.6%	12.46	0.15	1	83475	2.55
31	2.65	88	22	19747	0.26	1097	7.4%	3.10	0.05	1	800	0.15
32	8.74	820	200	237223	0.30	632	15.0%	6.52	0.12	1	53602	3.03
33	18.46	2700	450	728128	0.28	558	16.4%	6.99	0.09	1	121776	3.26
34	2.05	180	41	41779	0.27	1113	8.5%	3.75	0.06	1	2336	0.56

Alpha 285.00
Beta 0.56

Basin Average 5487.3281 tons/mi^2
2.7090692 ac-ft/mi^2

Column Number	Variable	Explanation
1	Subbasin Name	
2	Area	*Area of the Sub-Basin in Square Miles.*
3, 4	Peak Flow, Volume	From Table 5-1
5	Rw	Alpha*(Discharge* Volume)^Beta
6	K	Soil Erodibility Factor Based on USDA Texture. Subbasin average using soil survey map.
7	Overflow Length (ft)	Overflow length computed for 10-year discharge with flow over 0.5 cfs.
8	Slope	*Average percent slope over the subbasin. Computed from digital elevation model grid slope.*
9	LS	Obtained from lookup table in SCS New Mexico Technical Note 28.
10	C	Cover and Management Factor
11	P	Erosion Control Praactice factor, set to 1.0 for range and wild land areas.
12	Ys	Sediment yield in tons=Rw*K*LS*C*P

Table 5-25. Sediment Yield by MUSLE Method for 2-Year Return Period

1	2	3	4	5	6	7	8	9	10	11	12	
Subbasin Name	Area (mi2)	Discharge (cfs)	Runoff Volume (ac-ft)	Rw	K	Overflow Length (ft)	Slope	LS	C	P	Ys (tons)	Ys (ac-ft/mi^2)
1	22.37	74	74	35221	0.22	915	7.5%	2.77	0.08	1	1662	0.04
2	8.10	34	34	15000	0.29	1217	6.8%	2.84	0.11	1	1410	0.09
3	18.40	79	79	37862	0.30	1017	10.2%	4.48	0.10	1	5102	0.14
4	5.69	30	30	12622	0.28	1031	9.0%	3.79	0.10	1	1296	0.11
5	30.47	256	256	141745	0.29	858	10.9%	4.58	0.09	1	17246	0.28
6	27.55	84	84	40522	0.28	944	7.9%	2.99	0.10	1	3382	0.06
7	24.60	300	300	169494	0.29	867	21.7%	13.82	0.16	1	107784	2.16
8	88.44	369	369	213625	0.26	897	13.6%	6.69	0.15	1	55133	0.31
9	2.52	10	10	3688	0.26	1430	6.3%	2.76	0.09	1	238	0.05
10	0.18	0	0	0	0.28	429	7.0%	1.74	0.06	1	0	0.00
11	1.88	20	20	8015	0.29	874	18.5%	10.41	0.11	1	2602	0.68
12	42.32	221	221	120554	0.29	698	13.3%	5.64	0.16	1	30886	0.36
13	6.71	59	59	27433	0.28	914	10.8%	4.64	0.08	1	2917	0.21
14	23.58	123	123	62413	0.27	634	29.7%	19.38	0.17	1	53546	1.12
15	1.00	10	10	3688	0.30	662	18.8%	9.51	0.15	1	1554	0.77
16	32.84	236	236	129591	0.30	962	24.7%	18.26	0.14	1	99379	1.49
17	38.50	246	246	135653	0.28	669	29.2%	19.58	0.16	1	120275	1.54
18	22.18	221	221	120554	0.30	757	16.3%	8.21	0.16	1	46801	1.04
19	47.79	226	226	123559	0.27	953	26.0%	19.73	0.15	1	98860	1.02
20	18.04	143	143	73700	0.29	807	19.6%	11.17	0.16	1	37976	1.04
21	21.59	256	256	141745	0.30	1012	21.0%	14.25	0.12	1	72620	1.66
22	38.15	418	418	245773	0.29	766	19.4%	10.77	0.16	1	121572	1.57
23	10.58	10	10	3688	0.27	1078	23.1%	17.49	0.15	1	2514	0.12
24	19.81	152	152	79416	0.28	829	25.0%	17.29	0.16	1	60049	1.50
25	43.88	128	128	65216	0.28	1296	12.6%	7.27	0.09	1	12220	0.14
26	50.52	280	280	157096	0.28	959	14.8%	7.89	0.14	1	50207	0.49
27	16.93	157	157	82291	0.25	895	17.4%	9.49	0.08	1	16150	0.47
28	29.36	98	98	48611	0.27	850	13.3%	6.24	0.10	1	7918	0.13
29	3.94	44	44	19876	0.26	1155	7.9%	3.44	0.05	1	905	0.11
30	16.19	89	89	43201	0.28	854	20.6%	12.46	0.15	1	22851	0.70
31	2.65	10	10	3688	0.26	1097	7.4%	3.10	0.05	1	149	0.03
32	8.74	98	98	48611	0.30	632	15.0%	6.52	0.12	1	10984	0.62
33	18.46	216	216	117558	0.28	558	16.4%	6.99	0.09	1	19661	0.53
34	2.05	25	25	10290	0.27	1113	8.5%	3.75	0.06	1	575	0.14

Alpha 285.00
Beta 0.56

Basin Average 1456.3148 tons/mi^2
0.7189761 ac-ft/mi^2

Column Number	Variable	Explanation
1	Subbasin Name	
2	Area	Area of the Sub-Basin in Square Miles.
3, 4	Peak Flow, Volume	From Table 5-1
5	Rw	Alpha*(Discharge* Volume)^Beta
6	K	Soil Erodibility Factor Based on USDA Texture. Subbasin average using soil survey map.
7	Overflow Length (ft)	Overflow length computed for 10-year discharge with flow over 0.5 cfs.
8	Slope	Average percent slope over the subbasin. Computed from digital elevation model grid slope.
9	LS	Obtained from lookup table in SCS New Mexico Technical Note 28.
10	C	Cover and Management Factor
11	P	Erosion Control Praactice factor, set to 1.0 for range and wild land areas.
12	Ys	Sediment yield in tons=Rw*K*LS*C*P

Table 5-26. Average Annual Sediment Yield Calculation By MUSLE Method

Sediment Yield (tons)							Average Annual Sediment Yield tons	Average Annual Sediment Yield ac-ft/mi^2
Return Period	100 yr	50 yr	25 yr	10 yr	5 yr	2 yr		
Probability	0.01	0.02	0.04	0.1	0.2	0.5		
Sub-basin								
1	43669	32760	24659	15445	8176	1662	5668	0.13
2	21957	17374	12389	9977	5678	1410	3583	0.22
3	123799	95375	70423	48820	27800	5102	17611	0.47
4	24094	19495	15926	11163	6213	1296	3945	0.34
5	308573	242930	202553	129726	76550	17246	48961	0.79
6	53688	40856	30509	20522	10748	3382	7783	0.14
7	1169525	1033919	715065	498326	340562	107784	212746	4.27
8	1261205	934328	721955	463952	245483	55133	170077	0.95
9	4834	3882	2999	2140	1177	238	752	0.15
10	184	167	150	130	100	0	42	0.11
11	37558	31141	25596	19575	11208	2602	6903	1.81
12	652422	505283	367115	232040	143972	30886	91762	1.07
13	37798	32927	26571	21102	13679	2917	7714	0.57
14	1160247	882103	646553	423651	242346	53546	160277	3.36
15	33382	25917	20113	13749	9710	1554	5358	2.64
16	1155685	946876	719569	511698	312111	99379	203431	3.06
17	2017357	1313588	1047576	794368	459871	120275	295501	3.79
18	695651	592111	430573	302562	168040	46801	113073	2.52
19	1964985	1435413	867747	680898	353620	98860	250456	2.59
20	602856	480797	379834	264105	153394	37976	98446	2.69
21	639584	530686	410277	293679	190084	72620	124524	2.85
22	1505677	1166006	919660	609793	393341	121572	252942	3.27
23	131539	98794	71003	39946	15745	2514	13646	0.64
24	1157242	930256	727808	514772	293866	60049	184399	4.60
25	225709	166179	120959	74299	42911	12220	30131	0.34
26	833624	630311	495206	325881	200957	50207	128112	1.25
27	199210	158985	131259	96044	63341	16150	37435	1.09
28	176573	134043	99997	65849	37300	7918	24554	0.41
29	8919	7929	6781	5476	3631	905	2050	0.26
30	415974	337552	220835	140646	83475	22851	57223	1.74
31	2838	2325	1971	1459	800	149	493	0.09
32	220653	176684	134336	90202	53602	10984	33664	1.90
33	459522	379293	280762	198529	121776	19661	71915	1.92
34	5546	4835	4181	3411	2336	575	1293	0.31
						Total	2666470	
						Basin Average	3574	1.76

Average Annual Sediment Yield Computed from the following formula:

Yavg=0.01*Y100+0.005*(Y100+Y50)+0.01*(Y50+Y25)+0.03*(Y25+Y10)+0.05*(Y10+Y5)+0.15*(Y5+Y2)+0.25*Y2

where Yavg, Y100, Y50, Y25, Y10, Y5, and Y2 are average annual sediment yield and sediment yield for return periods of 100, 50, 25, 10, 5 and 2 years respectively.

Table 5-27. Average Annual Sediment Yield by Dendy and Bolton Method

Subbasin Name	Area (Mile^2)	1993 Runoff (in)	Adj. Average Annual Runoff (in)	Sed. Yield tons/mi^2/yr	Sed. Yield ac-ft/mi^2/yr
1	22.37	3.15	0.81	1254	0.62
2	8.10	4.68	1.20	1664	0.82
3	18.40	3.68	0.95	1374	0.68
4	5.69	5.48	1.41	1849	0.91
5	30.47	5.44	1.40	1560	0.77
6	27.55	2.94	0.76	1188	0.59
7	24.60	1.49	0.38	880	0.43
8	88.44	1.20	0.31	689	0.34
9	2.52	5.81	1.49	2041	1.01
10	0.18	6.74	1.73	2677	1.32
11	1.88	3.76	0.97	1713	0.85
12	42.32	1.01	0.26	693	0.34
13	6.71	5.84	1.50	1875	0.93
14	23.58	0.90	0.23	701	0.35
15	1.00	1.40	0.36	1144	0.56
16	32.84	4.94	1.27	1480	0.73
17	38.50	2.18	0.56	998	0.49
18	22.18	1.71	0.44	947	0.47
19	47.79	8.40	2.16	1733	0.86
20	18.04	2.36	0.61	1123	0.55
21	21.59	9.04	2.33	1873	0.92
22	38.15	1.77	0.46	908	0.45
23	10.58	4.87	1.25	1652	0.82
24	19.81	2.85	0.73	1213	0.60
25	43.88	2.94	0.76	1129	0.56
26	50.52	2.06	0.53	943	0.47
27	16.93	2.01	0.52	1049	0.52
28	29.36	2.03	0.52	995	0.49
29	3.94	5.23	1.35	1871	0.92
30	16.19	1.45	0.37	907	0.45
31	2.65	4.95	1.27	1888	0.93
32	8.74	8.24	2.12	2073	1.02
33	18.46	4.06	1.04	1437	0.71
34	2.05	4.89	1.26	1919	0.95
At Ysidora		2.04			
			Basin Average	1148	tons/mi^2/yr
				0.57	ac-ft/mi^2/yr

Notes

1 Adjusted average annual precipitation for subbasins computed by scaling average annual runoff at the Ysidora gage (0.52 inches) to January 1993 storm runoff generated by WEST HEC-1 model.

2 Average annual runoff at the Ysidora gage computed by taking average of natural storm-water annual runoff-volume for water years 1924 to 1975 (Brownlie and Taylor, 1981).

3

and S = 1965 (e^(-0.055 Q)) (1.43-0.26 log A) for Q >= 2 inches,
where Q= mean annual runoff in inches, A= area in mi^2, and
S= annual sediment yield in tons/mi^2

4 Conversion of sediment yield from tons to ac-ft assumed dry unit weight of sediment of 93 lb/ft^3.

5 Subbasin 10 area is less than 1 mi^2, outside Dendy and Bolton formula applicability limit.

Table 5-28. Average Annual Sediment Yield By Taylor Method

Subbasin Name	Area (mi^2)	Area (km^2)	Land Type	Natural Sediment Yield DR (mm/yr)	DR ($ac\text{-}ft/mi^2/yr$)
1	22.37	57.94	H	0.37	0.77
2	8.10	20.98	P	0.05	0.10
3	18.40	47.66	H	0.38	0.79
4	5.69	14.74	H	0.44	0.93
5	30.47	78.92	H	0.35	0.73
6	27.55	71.35	P	0.04	0.09
7	24.60	63.71	H	0.36	0.76
8	88.44	229.06	H	0.30	0.63
9	2.52	6.53	P	0.06	0.12
10	0.18	0.47	H	0.72	1.51
11	1.88	4.87	H	0.52	1.09
12	42.32	109.61	H	0.33	0.70
13	6.71	17.38	H	0.43	0.91
14	23.58	61.07	H	0.36	0.76
15	1.00	2.59	H	0.57	1.19
16	32.84	85.05	H	0.35	0.73
17	38.50	99.71	H	0.34	0.71
18	22.18	57.45	H	0.37	0.77
19	47.79	123.77	H	0.33	0.69
20	18.04	46.72	H	0.38	0.79
21	21.59	55.92	H	0.37	0.77
22	38.15	98.81	H	0.34	0.71
23	10.58	27.40	H	0.41	0.85
24	19.81	51.31	M	0.95	1.99
25	43.88	113.65	P	0.04	0.08
26	50.52	130.85	H	0.33	0.68
27	16.93	43.85	H	0.38	0.80
28	29.36	76.04	H	0.35	0.74
29	3.94	10.20	P	0.05	0.11
30	16.19	41.93	H	0.38	0.80
31	2.65	6.86	P	0.06	0.12
32	8.74	22.64	H	0.42	0.88
33	18.46	47.81	P	0.04	0.09
34	2.05	5.31	P	0.06	0.12

Notes

1. Land Type estimated by comparing the land type map provided by Taylor with WEST subbasin boundaries. Plains, hills, and mountains abbreviated to P, H, and M respectively.
2. Denudation Rate (DR) computed by formula DR = 0.075 (L ^ Beta) (A ^ -0.141)
   where DR is in mm/yr,
   L^ Beta =1.0, 8.63, 22 for plains, hills, and mountains, respectively.
   A= sub-basin area in km^2.

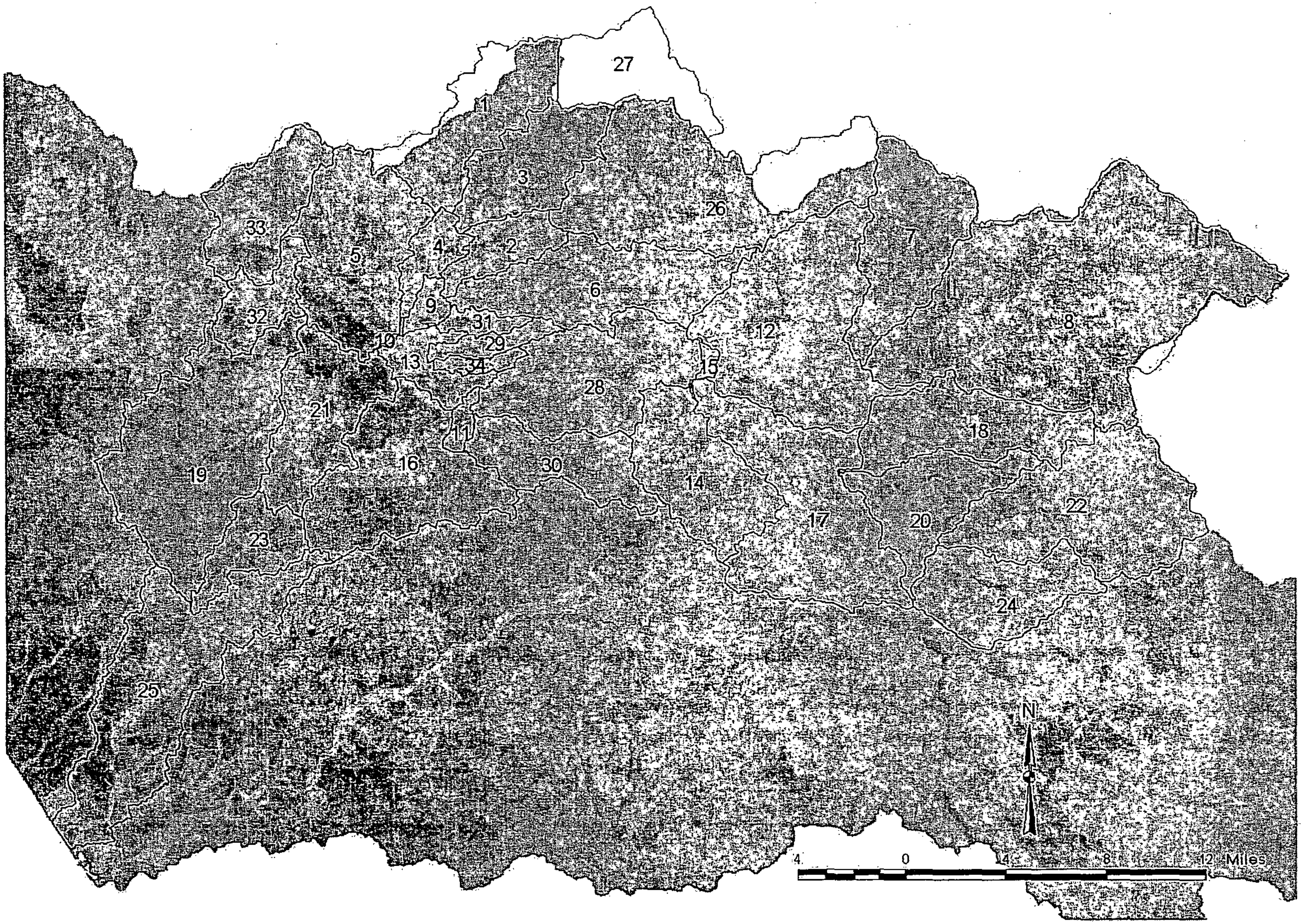
Table 5-29. Average Annual Sediment Yield Summary

Subbasin	Area (mi2)	PSIAC	LA Corps	MUSLE	Dendy and Bolton	Taylor	Weighted Average
		Sediment Yield (ac-ft/mi^2)					
1	22.37	0.28	0.22	0.13	0.62	0.77	0.49
2	8.10	0.35	0.35	0.22	0.82	0.10	0.41
3	18.40	0.36	0.39	0.47	0.68	0.79	0.67
4	5.69	0.34	0.27	0.34	0.91	0.93	0.67
5	30.47	0.38	0.37	0.79	0.77	0.73	0.76
6	27.55	0.27	0.19	0.14	0.59	0.09	0.28
7	24.60	0.49	0.67	4.27	0.43	0.76	1.83
8	88.44	0.42	0.34	0.95	0.34	0.63	0.72
9	2.52	0.33	0.10	0.15	1.01	0.12	0.34
10	0.18	0.19	0.10	0.11	1.32	1.51	0.74
11	1.88	0.51	0.06	1.81	0.85	1.09	1.11
12	42.32	0.43	0.50	1.07	0.34	0.70	0.82
13	6.71	0.31	0.22	0.57	0.93	0.91	0.70
14	23.58	0.45	0.35	3.36	0.35	0.76	1.45
15	1.00	0.34	0.31	2.64	0.56	1.19	1.36
16	32.84	0.47	0.36	3.06	0.73	0.73	1.42
17	38.50	0.65	0.40	3.79	0.49	0.71	1.66
18	22.18	0.45	0.73	2.52	0.47	0.77	1.34
19	47.79	0.63	0.29	2.59	0.86	0.69	1.32
20	18.04	0.47	0.61	2.69	0.55	0.79	1.38
21	21.59	0.57	0.27	2.85	0.92	0.77	1.41
22	38.15	0.45	0.60	3.27	0.45	0.71	1.50
23	10.58	0.49	0.18	0.64	0.82	0.85	0.73
24	19.81	0.41	0.73	4.60	0.60	1.99	2.29
25	43.88	0.38	0.15	0.34	0.56	0.08	0.35
26	50.52	0.37	0.28	1.25	0.47	0.68	0.81
27	16.93	0.30	0.40	1.09	0.52	0.80	0.81
28	29.36	0.39	0.27	0.41	0.49	0.74	0.59
29	3.94	0.23	0.46	0.26	0.92	0.11	0.43
30	16.19	0.39	0.33	1.74	0.45	0.80	1.00
31	2.65	0.15	0.18	0.09	0.93	0.12	0.29
32	8.74	0.27	1.27	1.90	1.02	0.88	1.38
33	18.46	0.31	0.66	1.92	0.71	0.09	0.95
34	2.05	0.21	0.19	0.31	0.95	0.12	0.37
Maximum		**0.65**	**1.27**	**4.60**	**1.32**	**1.99**	**2.29**
Minimum		**0.15**	**0.06**	**0.09**	**0.34**	**0.08**	**0.28**
Median		**0.38**	**0.33**	**1.08**	**0.65**	**0.75**	**0.81**
Basin Average		**0.43**	**0.39**	**1.76**	**0.57**	**0.67**	**1.01**
Weighting		2	2	2	1	2	

Notes

1 Weighted average annual sediment yield computed by assigning weight of 1.0 to Dendy and Bolton method and 2.0 to all other methods.

Figure 5-1
Distribution of Hydrologic Soil Groups



LEGEND
Hydrologic Soil Group
A
B
C
D
MISSING
Subbasin Boundary

WEST CONSULTANTS, INC.

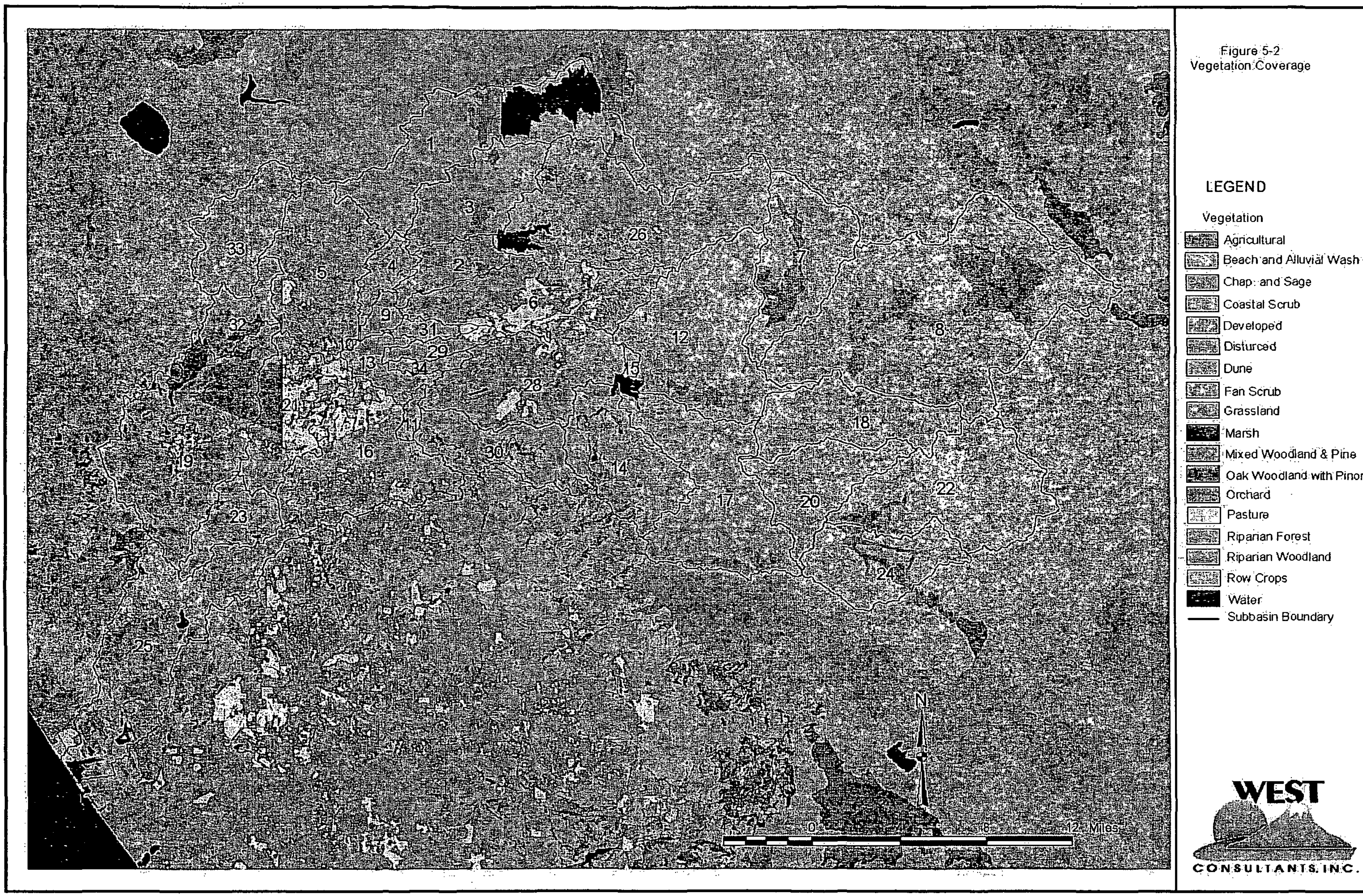


Figure 5-2
Vegetation Coverage
LEGEND
Vegetation
Agricultural
Beach and Alluvial Wash
Chap. and Sage
Coastal Scrub
Developed
Disturbed
Dune
Fan Scrub
Grassland
Marsh
Mixed Woodland & Pine
Oak Woodland with Pinon
Orchard
Pasture
Riparian Forest
Riparian Woodland
Row Crops
Water
Subbasin Boundary
N
0
12 Miles
WEST
CONSULTANTS, INC.

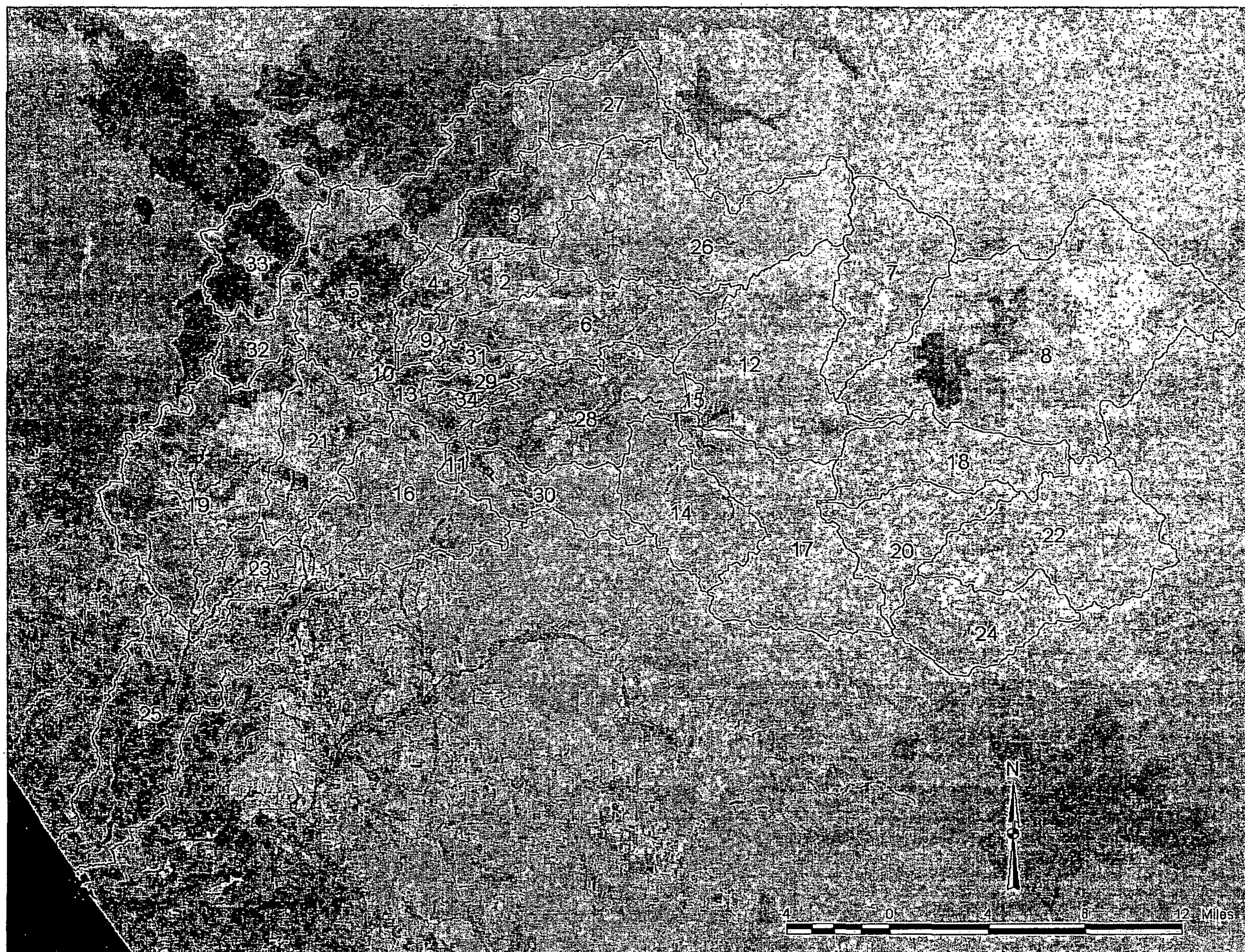


Figure 5-3
Distribution of PSIAC
Ground Cover
Coefficients

LEGEND

PSIAC Ground Cover
Coefficient
-10
-5
0
5
7
10
Subbasin Boundary

WEST
CONSULTANTS, INC.

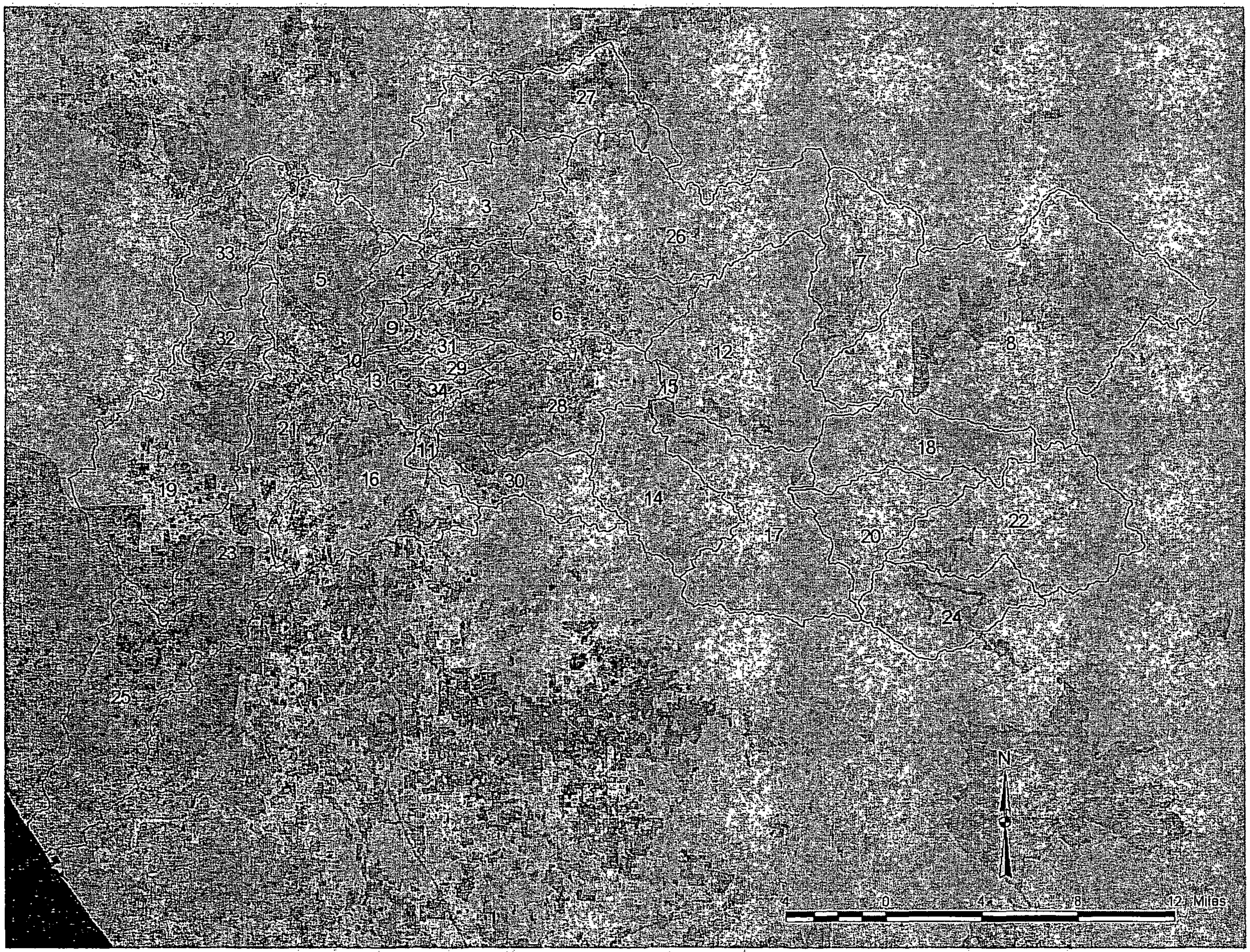


Figure 5-4
Distribution of PSIAC
Land Use
Coefficients

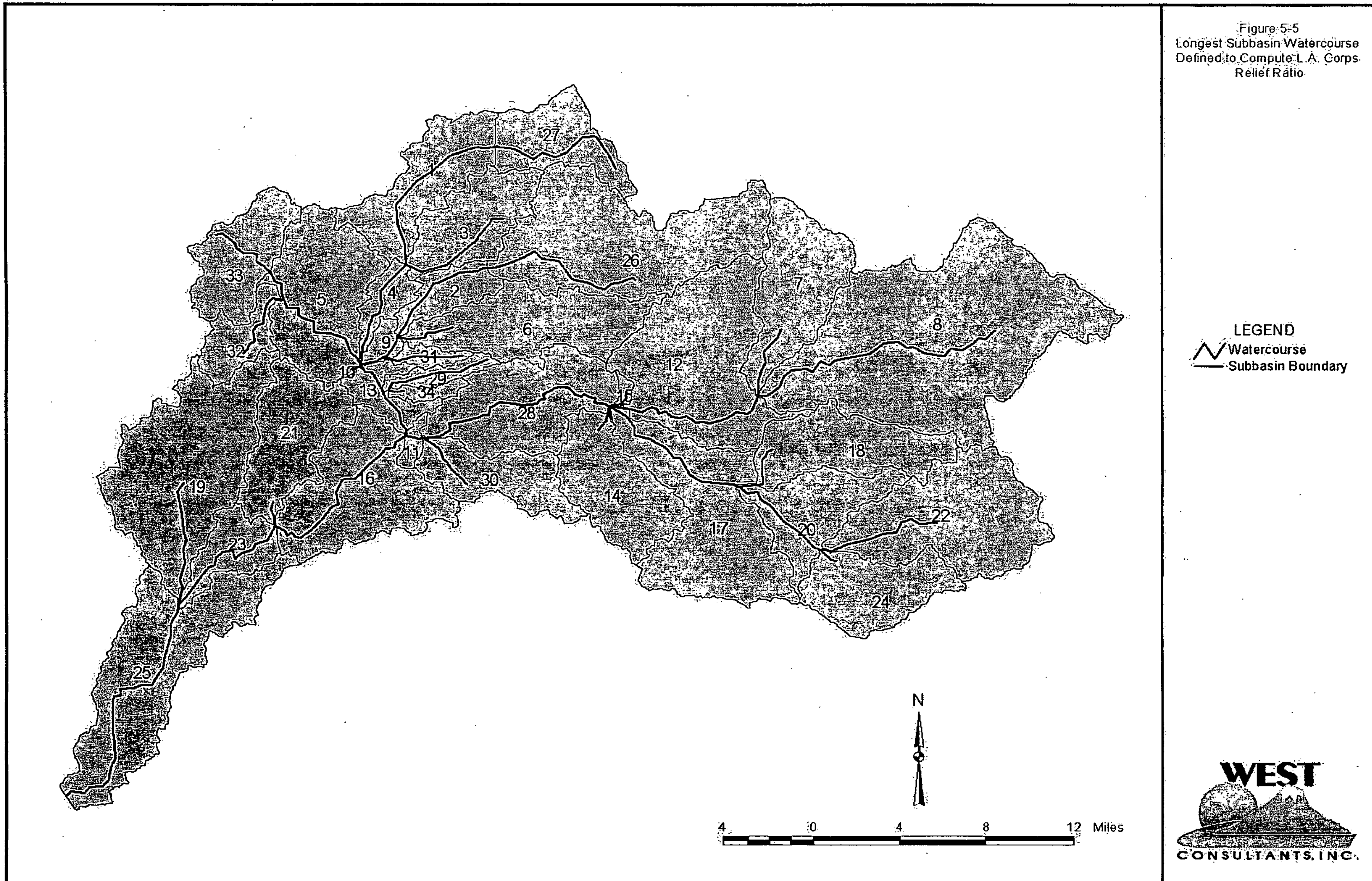
LEGEND

PSIAC Land Use
Coefficient

-10
-5
5
10
Subbasin Boundary

WEST
CONSULTANTS, INC.

Figure 5-5
Longest Subbasin Watercourse Defined to Compute L.A. Corps Relief Ratio



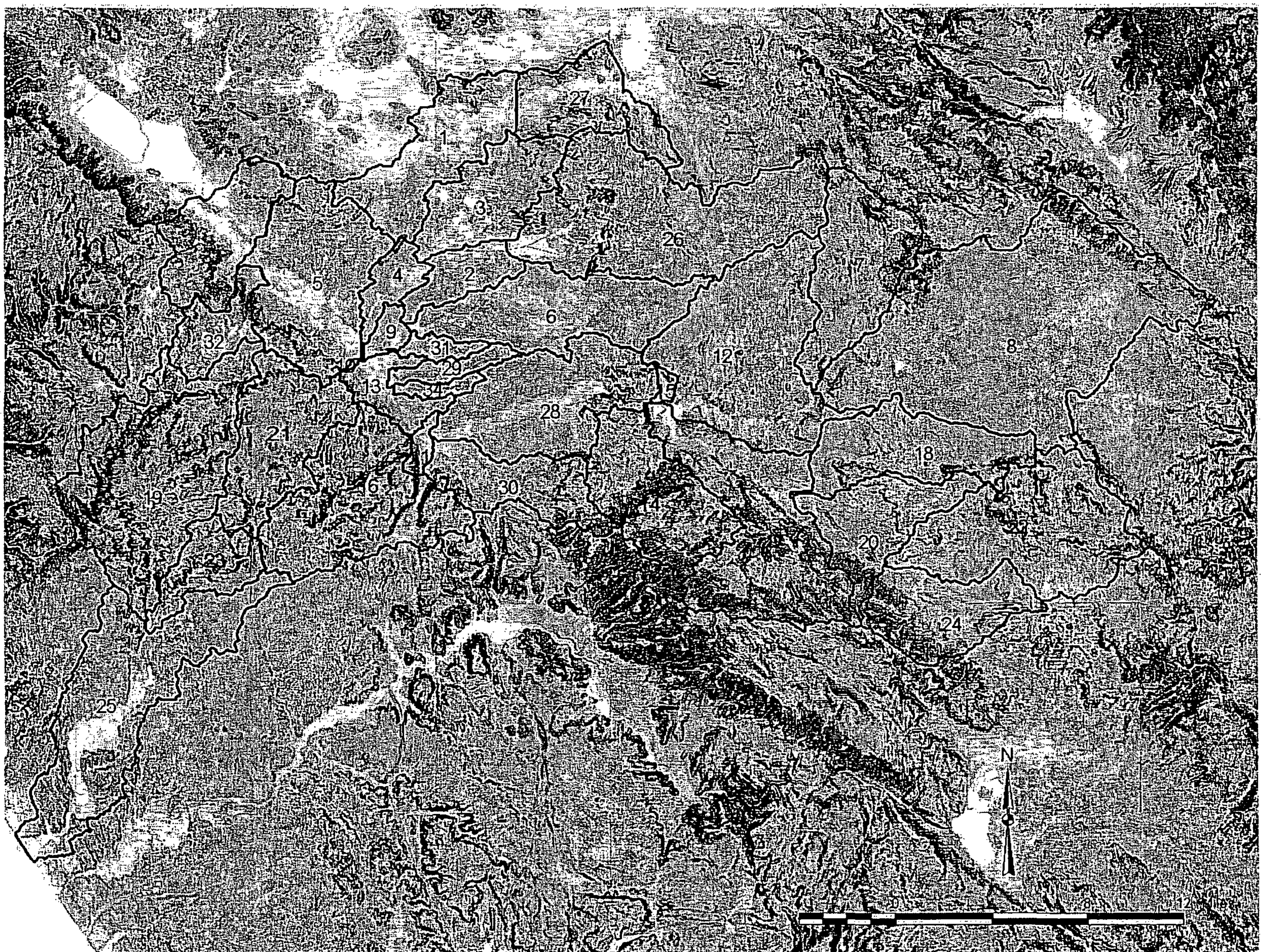


Figure 5-6
Ground Slope
Derived from Digital
Elevation Model

LEGEND

Percent Slope

	0 - 1
	1 - 5
	5 - 15
	15 - 25
	25 - 35
	35 - 45
	45 - 55
	55 - 70
	70 - 90
	90 - 312
	No Data
	Subbasin Boundary

WEST CONSULTANTS, INC.

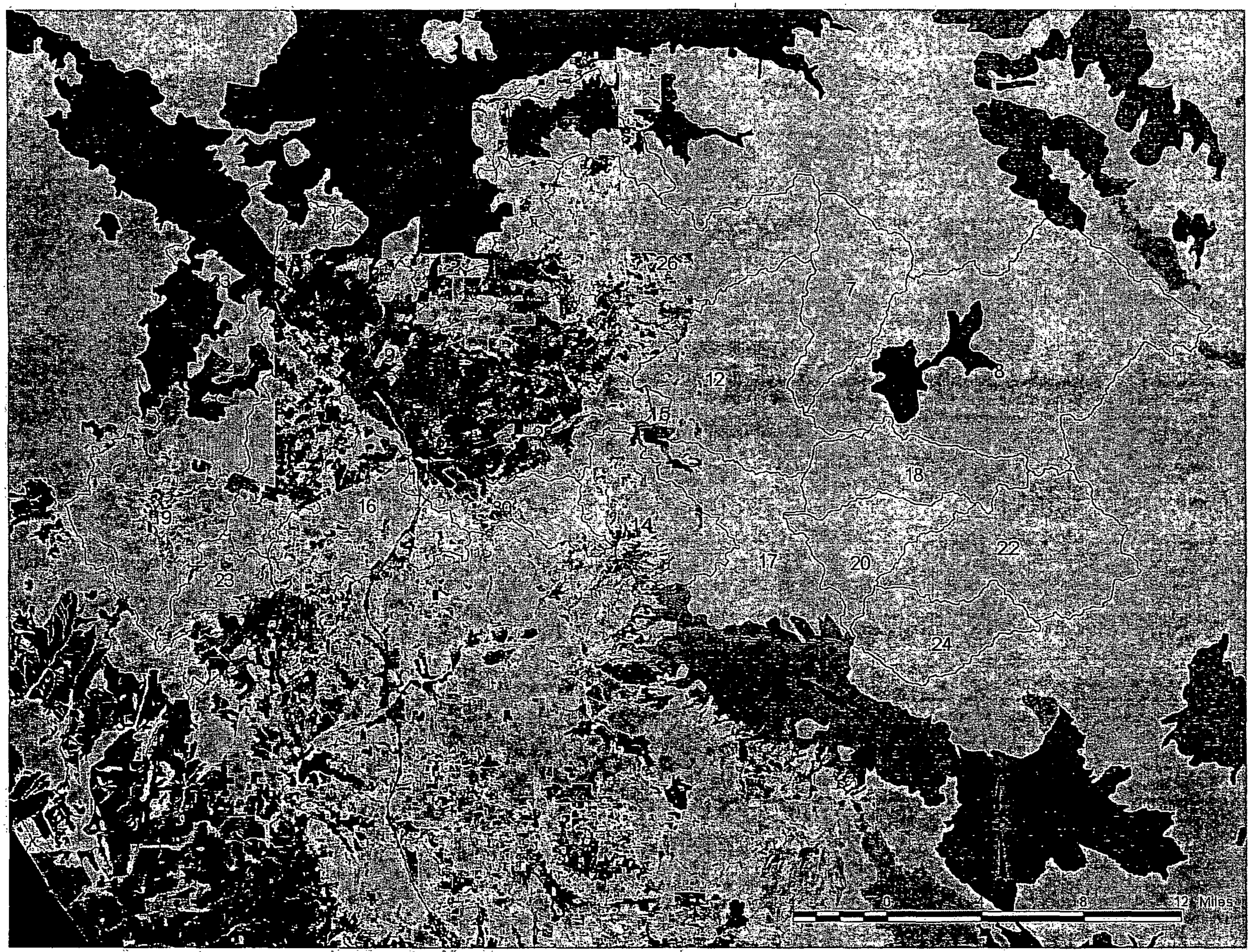


Figure 5-7
Distribution of MUSLE Cover and Management Factor "C"

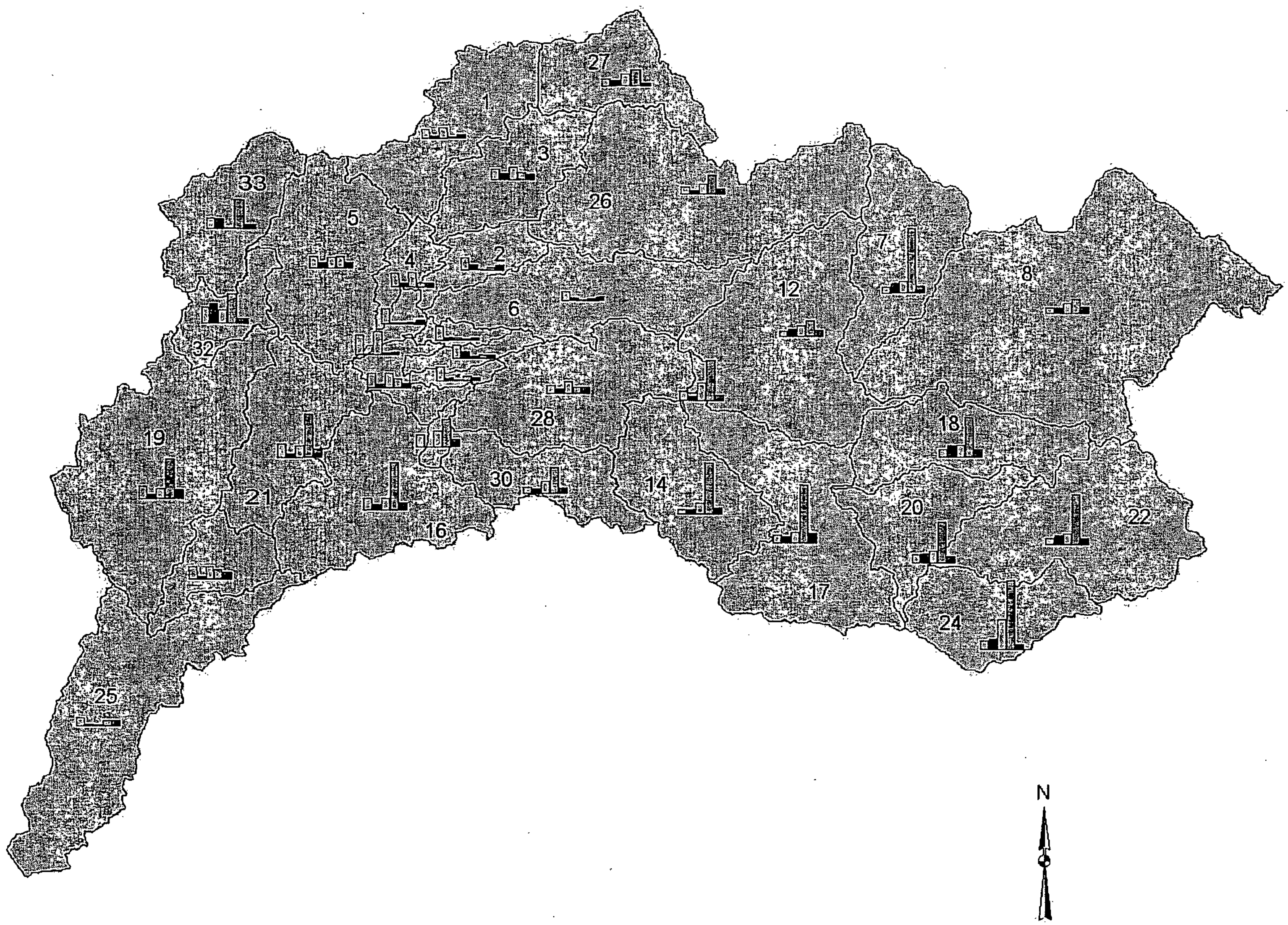
LEGEND

MUSLE C Values

0
0.011
0.043
0.078
0.091
0.14
0.15
0.16
0.17
0.21
0.22
0.45
Subbasin Boundary

WEST CONSULTANTS, INC.

Figure 5-8
Summary of Sediment
Yield for Sub-Basins



LEGEND

Sediment Yield Method
- Dendy and Bolton
- L.A. Corps
- Taylor
- MUSLE
- PSIAC

Sediment Yield Class
- LOW
- NORMAL
- HIGH

4 0 4 8 12 Miles

See Table 5-29 for sediment yield values.

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6 Sediment Transport

6.1 Purpose

The Santa Margarita River is a dynamic stream that conveys not only water but sediment as well. In fact, the hydraulic properties of the river are intimately related to the sediment it carries, and vice versa. In order to understand the hydraulic and sediment transport characteristics of the river system, a movable bed model was developed based on the fixed bed (HEC-RAS) model discussed in Chapter 4. The movable bed (sediment transport) model was developed using HEC-6T (USACE, 1993b; Thomas, 1999), described in more detail in a following section. Sediment inflow rating curves were developed from the sediment yield analysis described in Chapter 5 and sediment transport based on cross section measurements. The model was calibrated based on an historic scenario. Once calibrated, the sediment transport model was prepared and executed using the balanced hydrographs developed for this study. This provided an estimate of sand delivery to the estuary area. The model can be used in future work to predict channel conditions and study the expected impact of river projects (e.g., dredging). Recommendations are provided for ways to improve the sediment transport model in the future.

6.2 Previous Studies

Previous sediment transport studies include those by SLA (1995), and NHC (1997a,b). These reports were reviewed and are summarized in the annotated bibliography.

6.3 Sediment Transport Model

HEC-6T (Thomas, 1999) is an advanced version of HEC-6 (USACE, 1993b), a one-dimensional movable boundary, open channel flow model designed to simulate stream bed profile changes over fairly long time periods. Since its original nationwide distributions by the Hydrologic Engineering Center (HEC) of the Corps of Engineers in 1973 and again in 1977, 1987, and 1991, HEC-6 has become the most widely used one-dimensional sediment transport model in the United States. HEC-6T was created by the primary author of HEC-6, Mr. Tony Thomas. This update of the HEC-6 model contains numerous improvements in accuracy, warnings and errors, and ease-of-use.

In general terms, the model first calculates the hydraulics of each discharge increment in a hydrograph to determine the hydraulic parameters such as flow depth, water velocity, and effective flow width for each cross section. It then computes the sediment transport potential at each cross section using the hydraulics of the main channel. Sediment contribution at the upstream end of the reach being modeled is simulated by the use of a sediment versus discharge relation and is specified by the user. This load is compared to the sediment transport potential of the cross section. If the inflowing load is larger than the transport potential, the difference is deposited in the cross section. If the inflowing load is less than the transport potential, the difference is picked up (scoured) from the bed, taking into account the availability of material in the bed (this may be limited by bedrock, armoring, etc.). The sediment load leaving the cross section becomes the inflowing load to the next downstream cross section. These computations continue until the most downstream cross section is reached. For the next discharge in the hydrograph, the hydraulics are again computed using the new cross sectional geometry formed by the previous discharge. The cycle is repeated until the entire hydrograph is simulated. Further details of the model are presented in the HEC-6T user's manual (Thomas, 1999), the HEC-6 user=s manual (USACE, 1993b) and MacArthur et al. (1990).

Although HEC-6T is one of the most advanced codes available for sediment transport modeling, several limitations exist which may affect the accuracy of this study. There is no provision for simulating the development of meanders or specifying a lateral distribution of sediment load across a cross section. The cross section is divided into two parts with input data: that part which has a movable bed and that which does not; multiple movable/fixed bed areas in a single cross section are not allowed. The entire wetted perimeter of the cross section within the movable bed limits is moved uniformly up or down. Because of this, bank retreat and/or channel widening cannot be simulated. Bed forms and their effect on channel roughness are not explicitly simulated, and sediment contributions from bank failures cannot be simulated explicitly.

HEC-6T requires hydraulic analysis for the water discharge being simulated, the input of representative streambed material size distributions, the creation of an inflowing sediment rating curve, and the development of representative hydrographs. The procedures used in developing the HEC-6T inputs are described in the following sections.

6.4 Development of Base Condition Geometry and Hydraulics

Channel geometry and hydraulics were obtained from the HEC-RAS model described previously in this report. HEC-RAS model data was converted to HEC-6 format. Although HEC-6T does not explicitly model bridges and culverts, the expansion and contraction zones found in the HEC-RAS model were reproduced and energy losses approximated at the bridge locations. At locations with blocked flow, modifications were made to cross section geometry to reflect the blocked areas. Ineffective flow areas were kept as similar as possible as those in the HEC-RAS model. Because it is desirable to have the HEC-6T hydraulics comparable to the HEC-RAS results, a comparison was made which is described below.

6.4.1 Comparison of HEC-6T with HEC-RAS Results

Because the hydraulics are calculated slightly differently in HEC-6T compared to HEC-RAS, water surface profiles were generated in HEC-6T for the 100-year, 50-year, 10-year and 5-year discharges and compared to the HEC-RAS profiles (the HEC-6T models were executed in fixed-bed mode). Identical roughness values were used for both sets of models. Channel geometry, except where changed to model blocked flow, was the same in both models. Ineffective flow areas in the HEC-6T model were set as near as possible to the HEC-RAS model limits, recognizing the differences in model capabilities. Computed water surface elevations and channel velocities were checked and showed very close agreement for most cross sections. The largest differences between the two model results are seen at bridge locations. This is because HEC-6T does not explicitly model losses at bridges. Adjustments were made to the HEC-6T model to approach the same energy losses at bridges as computed in HEC-RAS. The resulting maximum difference in water surface elevations between the HEC-RAS and HEC-6T models was 2 percent with most locations showing a difference of less than 0.2 percent. The velocity difference extremes were +11 and -40 percent, with most locations showing differences less than one percent (the maximum velocity difference was due to critical depth calculations at the De Luz Road Bridge and is an isolated point). These results show that the HEC-6T model adequately reproduces the hydraulics as computed from HEC-RAS.

6.5 Inflowing Sediment

In order to have an accurate model, we needed to estimate (a) the amount of sediment entering the reach at defined inflow points at different tributary discharges (i.e., sediment rating curves); and (b) the sediment gradation of the inflows for each discharge on the sediment rating curve.

6.5.1 Inflowing Sediment Rating Curves

The sediment inflow for a series of discharges was developed for the upstream end of the study reach and inflow points. Two approaches were taken to estimate inflowing sediment. First, in an early part of the study an approximation was made based on the sediment yield analysis presented in Chapter 5. Later, sediment transport calculations were made based on surveyed cross sections. Because greater reliability is placed on the latter method, those results were used as input to the sediment model. Some inflow estimates were, however, modified during the calibration process (described later in this chapter) in order to better replicate actual riverbed changes.

6.5.1.1 Sediment Yield Analysis

The sediment yield analysis presented in Chapter 5 was used to estimate sediment inflows at the three locations where flood frequency estimates had been produced (see Chapter 3). Because of this limitation some of the tributaries were combined to provide a single sediment inflow at one of the three points.

For the upstream inflow, the sediment yield amounts for the subbasins below the dams were added for each of the frequency events. The total yield for each event was then multiplied by a sediment delivery ratio (SDR), a function of tributary area to a basin outlet (Figure 6-1; Renfro, 1975). Tributary subbasins to the associated inflow points, and SDRs are given in Table 6-1. In this table, the tributary area names for the two lateral sediment inflows are in quotation marks because the sediment yields are for the listed subbasins, which include more than just the tributary stream area. These inflows represent all sediment contributions between an inflow point and the next inflow point upstream, not only the inflow from the particular tributary.

The sediment inflow rate for a certain frequency event was obtained by multiplying the ratio of sediment yield to water yield (both in units of volume) by the peak flow for the event. The sediment inflow rate was converted from cubic feet per second to tons per day using a sediment unit weight of 93 pounds per cubic foot. The sediment yield (volume), peak flow, and water volume were taken from calculations for the MUSLE method discussed in the Sediment Yield chapter. The sediment inflow rates from Temecula and Murrieta Creeks were added to give a rough sediment rating curve at the upstream end of the study reach. An adopted rating curve was developed based on the plotted curve by applying a best-fit line through the points, along with engineering judgement as to typical slopes for rating curves with bed material similar to the Santa Margarita River system. The adopted curve was extrapolated to cover a wider range of discharges than the preliminary curve. This adopted rating curve is presented in Table 6-2 and shown in Figure 6-2 (the preliminary rating curve is also shown in the figure).

Sediment inflow rating curves were developed in a similar manner for the tributary inflows. Preliminary and adopted rating curves are shown in Figure 6-2, while the adopted rating curve values are presented in Tables 6-3 and 6-4.

6.5.1.2 Sediment Transport Analysis

Sediment inflow from the tributaries was also estimated by performing equilibrium sediment transport calculations. These computations were performed with the aid of the computer code SAM (USACE, 1998c). For each tributary, a representative cross section and slope were needed, along with the cross section roughness and a bed sediment gradation. Bed sediment gradations, for tributaries as well as the main river, are discussed in the Bed Gradations section of this chapter. Because equilibrium transport results are generally considered more accurate than sediment yield estimates, results from this procedure were used as input to the calibration model discussed later in this chapter.

1.1.1.1.1 Upstream Inflow Point

A unique method was used to estimate the sediment inflow at the upstream end of the river originating from Murrieta and Temecula Creeks. Rating curves were estimated independently for each creek, and a combined rating curve created for inflow to the Santa Margarita River using historic data.

A SAM analysis by the U.S. Army Corps of Engineers, Los Angeles District for Murrieta Creek was provided to WEST and subsequently modified. First, the cross section at the USGS Murrieta Creek at Temecula gage was used for the analysis. Second, the range of flows was changed to meet the needs of the present analysis. Third, the bed material gradation was changed to that of WEST's sample taken in January 2000 near the gage. An energy slope of 0.00479 was obtained from the Murrieta Creek hydraulic (HEC-2) model provide by the District and was kept constant for all flows.

Using a selection method proposed by Williams (1995) and based on prior experience with Southern California coastal streams, the Yang sand and gravel transport method (Yang, 1973, 1984) was chosen for computing inflowing sediment loads (see the Sediment Transport Method section later in this chapter). Other methods considered include Engelund-Hansen, Brownlie, and Ackers and White. Equilibrium transport sediment rating curves were produced with SAM using these sediment transport methods (Figure 6-3).

For Temecula Creek a representative cross section was constructed based on 1:2400 scale Riverside County photo maps (4 foot contours) and USGS 7.5 minute topographic maps (10 or 20 foot contours). The channel slope was also obtained from these maps. The bed sediment gradation was obtained from a sample taken by WEST in January 2000. Again, the Yang method was chosen for Temecula Creek based on the selection criteria. Figure 6-4 shows the sediment rating curves obtained with the Yang and other methods.

Mean daily flow records are available for both the Murrieta Creek at Temecula gage and the Santa Margarita near Temecula gage (SMRT). For this task, WEST made the assumption that the mean daily inflow from Temecula Creek would be equal to the Murrieta flow subtracted from the Santa Margarita flow. A computer program was written that:

- takes the Murrieta mean daily flow and computes the Murrieta mean daily sediment load (total load and for each of 14 sand and gravel size classes)
- takes the Temecula mean daily flow and computes the Temecula mean daily sediment load (total load and for each of 14 sand and gravel size classes)
- adds the flows and sediment loads to obtain a single point (flow, sediment load) for that particular date for the total load and each of 14 size classes. The point represents the flow and sediment load at the upstream end of the Santa Margarita River for that day.

Flows from Water Years 1948 through 1998 were used and filtered for SMRT flows greater than 100 cfs (flows less than this contribute a negligible portion of the overall sediment yield). The output from the computer program was loaded into a spreadsheet and the points plotted for both total load and each of the size classes. A power law regression equation of the form $Q_s = aQ^b$ was fit to the data points for each of the 15 graphs using the least squares method, where Qs is the sediment load (either total or per size class) in tons/day and Q is the discharge in cfs. The regression equation for the total sand and gravel load and each size class was used to generate the sediment rating curve for input to the HEC-6T model. The a and b coefficients in the above equation for the total load and each of the size classes are given in Table 6-5. The total load sediment rating curve is shown in Figure 6-5. Also shown in Figure 6-5 for comparison is the sediment rating curve developed from the sediment yield analysis. The sediment transport analysis predicts more sediment entering the river compared to the sediment yield results.

1.1.1.1.2 Rainbow Creek

WEST surveyed cross sections in January 2000 on Rainbow Creek and collected a bed sediment sample for laboratory analysis. This data was used as input to the SAM program to generate a sediment rating curve for Rainbow Creek. The Yang transport function was used for this tributary as well. A plot of the sediment rating curves for the Yang transport formula and the sediment yield analysis is shown as Figure 6-6 (note that the sediment yield curve includes both Rainbow and Sandia Creeks as well as the river tributary area in between the two creeks). The Yang rating curve shows more sediment inflow at small discharges and less sediment inflow at higher discharges when compared to results from the sediment yield analysis (combined amounts from Rainbow and Sandia Creeks).

1.1.1.1.3 Sandia Creek

A series of cross sections were extracted from a San Diego County 1:2400 topographic survey map and a representative composite cross section developed. Slope was also estimated from the same map. Bed material sediment gradation was taken from analysis of a sample collected by WEST in January 2000. A plot of the adopted sediment rating curve is shown in Figure 6-6. For this case the rating curve using the Yang equation for Sandia Creek shows more sediment inflow than the sediment yield curve which includes both Rainbow and Sandia Creeks. The Yang relationship for Sandia Creek was used for determining inflowing sediment load for the HEC-6T model.

1.1.1.1.4 De Luz Creek

WEST surveyed cross sections and longitudinal profiles in January 2000 on De Luz Creek near the De Luz Creek gage. A representative cross section was used along with the slope information and the gradation of a sediment sample to estimate the sediment rating curve using SAM. A plot of the adopted (Yang transport method) rating curve, together with the sediment yield rating curve, is shown in Figure 6-7. Note that the sediment yield curve includes not only De Luz Creek but also the area contributing sediment to the river between Sandia Creek and De Luz Creek. The rating curve using the Yang method shows less sediment entering from De Luz Creek than the curve derived from the sediment yield analysis, except at very low discharges.

6.5.2 Sediment Inflow Gradations

Because the Yang transport method in SAM computes transport by size class, sediment inflow gradations could be obtained from the SAM output described above.

6.6 Bed Gradations

SLA (1995) collected 21 bed and bank sediment samples in January 1994. Samples were collected from Stuart Mesa upstream to De Luz Creek. Gradations from the 13 samples judged most representative of their study reach (from De Luz Creek to the Pacific Ocean) were compared with a "representative" gradation. The representative gradation is quoted in the 1995 SLA report as being from a 1985 SLA study, but no references are given. In any case, SLA judged that the single representative gradation was still appropriate for their 1995 study. NHC (1997a, b) used this same representative gradation in their sediment studies. WEST compared the representative gradation with those from USGS records (6 gradations from three separate locations, 1967-1982) and found it to be acceptable for the lower portion of the river (below De Luz Creek). In other words, the single gradation adequately represents the characteristics of the bed material along this part of the study reach.

WEST obtained sediment samples in January 2000 at eight locations, including three on the Santa Margarita River (gradations are plotted in Figure 6-8). Of these three, two were located near the Sandia Creek Road crossing (between River Stations 106178-106628). The third was located at the Santa Margarita River near Temecula gaging station (SMRT). From examination of grain size distribution plots, the representative gradation was found to be adequate for the River near the Sandia Creek confluence. The gradation near the gage, as might be expected due to its location in the narrow gorge, is coarser than the representative gradation. By examining the channel slope transition (mild to relatively steep) and the channel cross section shape (flat bottomed to more of a "V" shape), the location to change bed gradations in the model was identified. Downstream of Station 128383 the representative gradation was applied, whereas upstream from this point, the SMRT gradation was applied.

6.7 Movable Bed Limits and Ineffective Flow Areas

Movable bed limits for the model were selected based on field observations, aerial photography and plots of each cross section. Ineffective flow limits had been established in the hydraulic model and were kept as similar as possible in the sediment model. However, since HEC-6T possesses different capabilities for ineffective flow compared to HEC-2, some variation of the effective flow limits was inevitable. Erosional zone limits (found on HE records in HEC-6T) and depositional zone limits (found on HD records) were installed in the model in order to simulate the erosional and depositional trends on each cross-section. Adjustment of these limits was performed as part of the calibration process.

For the river upstream of River Station 128383, the amount of scour was arbitrarily limited to 0.1 feet. This was done based on observations of channel conditions in the upper river (very large boulders and bedrock) as well as for reasons described in the Bed Gradation section.

6.8 Sediment Transport Method

The Yang sand and gravel transport method (Yang, 1973, 1984) was selected for use in the Santa Margarita River model. This method is often recommended for use with sand-bed rivers (e.g., Stevens and Yang, 1989). It is based on extensive data from seven rivers and flume data. It should also be noted that this method was selected for each of the tributary inflows. The Yang method has been found to yield good results by the U.S. Army Corps of Engineers (Los Angeles District) for coastal streams in Southern California, most notably studies on the San Luis Rey and Santa Ana Rivers (USACE, 1983). WEST judged the Yang method as most applicable to the current study based on past experience and results from prior Santa Margarita River sediment studies by SLA (1995) and NHC (1997a).

6.8.1 Cohesive Sediment Transport

Though HEC-6 and HEC-6T were designed for non-cohesive sediment transport (sands and gravels), some very limited cohesive sediment (silt and clay) transport theory was added for special purposes (mainly reservoir studies). The transport of cohesive sediments is much less understood than non-cohesive sediments. No cohesive sediment calculations have been included with the present model. Cohesive sediments are not expected to play much, if any, role in the channel processes upstream of the tidally influenced areas of the study reach. Although the cohesive sediments may be important to the estuary area, tidal effects and two-dimensional flow patterns that cannot be simulated with the present models heavily influence their deposition and entrainment.

6.9 Calibration

Model calibration is usually a two step process. First, model parameters are adjusted so that the results match observed data for a given event or time series (calibration). Second, the model is executed with the calibrated parameters for a different event or time series and the computed results compared with observed data (verification). For the present study, the difficulty lay in obtaining good observed data for calibration. Data was limited both in space (e.g., only certain portions of the study reach had observed data) and time (data was only available for certain dates). Given the data at hand, a rigorous calibration could not be performed. However, data was identified that would lead to a check on the model's performance and ability to predict future behavior. This is the calibration discussed in this section.

After the 1993 flood, a temporary bridge was erected at the Basilone Road crossing and dredging occurred upstream of the bridge. The Base Department of Public Works (DPW) provided contract drawings showing the designed dredging plan, including both longitudinal extent and dredging templates at cross sections. According to DPW personnel, actual dredging finished in late 1993/early 1994. They also reported that the dredged area was filled with sediment in "less than two years." The calibration strategy was therefore to:

1. Modify the base conditions model to reflect the post-dredging conditions in the river.
2. Simulate at least two years of flows to see if the dredged area would fill as historically observed.
3. Adjust model parameters within reasonable limits, as needed, to obtain reasonable results.

6.9.1 Geometric Modifications

The original HEC-RAS model was first modified to reflect the post-dredging conditions. The new Basilone Road Bridge was removed from the model and replaced with the temporary crossing bridge (based on plans provided by DPW). Ineffective flow limits were re-defined for the "old" bridge geometry. The new levee limits beside the Ranch House and along the airfield were moved to where the existing geometry showed the old levee limits. The dredging template from the DPW plans was applied to cross sections 42471 upstream to 50105. Cross section 56240, upstream of the O'Neill Diversion Weir, was also modified to reflect dredging. Reach lengths and roughness coefficients were not adjusted, although bank station limits were changed in the dredged cross sections.

6.9.2 Comparison of Calibration Model HEC-6T with HEC-RAS Results

As with the base conditions model, the fixed-bed HEC-6T model was executed for the same four steady flow discharges and the output compared with the HEC-RAS results. The purpose of this step is to adjust the HEC-6T model such that energy losses approximate those computed with HEC-RAS. As previously explained, this can be difficult, especially at bridge locations. However, water surface elevations agreed within 2 percent (most differences were much less). Average channel velocities showed maximum differences of +20 to –47 percent, but the average difference for all profiles was less than one percent.

6.9.3 Calibration Period Hydrology

Based on the rough estimation of the end of dredging, the calibration period was defined to begin on January 1, 1994. Mean daily flows were available for each of the tributary inflow points for the period January 1994 through September 30, 1998. A schematic of inflow points in the calibration model is shown as Figure 6-9. In this figure one can note that two fictitious "residual" inflow points were added to the model, one at each of the gages. This was done to conserve mean daily flow volume in the system. For example, if the upstream boundary flow (SMRT gage) was 10 cfs and the Rainbow Creek inflow was also 10 cfs, but the Santa Margarita River at FPUD sump gage had a mean daily flow of 30 cfs, a "residual" flow of 10 cfs would be added to the system at the gage location (30-10-10=10). The residual flow at the Ysidora gage location operates in exactly the same manner.

Flows for the entire system were processed as described above in a spreadsheet, and any negative flows changed to 0.99 cfs (occasionally the flows at a gage were less than the sum of the tributary inflows above it). Flows were then filtered such that only dates where the flow below the Ysidora gage was greater than or equal to 100 cfs would be retained for calibration period[1]. A total of 238 event days remained for the period January 1, 1994 through September 30, 1998. These records were converted to HEC-6T format for use as the hydrologic input to the model. Actual simulations included a "warm-up" period just prior to the above mentioned flow records to allow the bed material gradations and bed elevations to become computationally compatible with the flow hydraulics (USACE, 1992c).

6.9.4 Calibration Process

The calibration process focused mainly on adjustment of certain parameters:

- Movable bed limits (erosion and deposition limits)
- Model time step
- Cross section geometry
- Inflowing sediment load

[1] NHC (1997b) determined that 97 percent of the bed material load occurs during the 5 percent of time that the mean daily flow exceeds 100 cfs.

For the base conditions model, most cross sections had the erosion limits set just inside the bank stations. However, this was changed during the calibration process if it was determined that it was realistic for erosion to occur within either a narrower or wider band than the one previously defined.

The model time step needs to be adjusted as a function of sediment loading and flow rates. The time step should be as long as possible to cut down on computer run time, but needs to be short enough so that the model cross sections can adjust to sudden changes in flow and sediment discharge. Although the default time step was one day for each flow event (because we are using mean daily flows), most events had to be subdivided into shorter time steps, some less than an hour.

In some cases, adjustments to cross section geometry were necessary. In most cases this consisted of adding a point or points to the cross section in order to have more flexibility in the movable bed area. In a few cases, for the cross sections that were obtained from 5-foot contours (or greater), a point would be lowered in the bottom of the cross section to minimize the "stair-step" pattern resulting from large (20 foot) contour intervals. Movement of the sediment near the "steps" would cause shocks to the model system and result in questionable output.

Finally, inflowing sediment load to the river system in the model was varied. Although sediment loading was computed as described previously using equilibrium sediment transport, there is a large uncertainty in the amount actually entering the system because there are no measurements to confirm the calculations. Inflows at the residual points were initially clear water (i.e., no sediment inflow with the water), but this gave unsatisfactory results. Sediment inflows were then added at each of the residual inflow points. For the FPUD residual flow, the sediment rating curve from Rainbow Creek was duplicated and sediment loading multiplied by a factor of two to account for the difference in drainage areas. For the Ysidora residual flow, the De Luz sediment rating curve was used with the sediment loading multiplied by a factor of 1.2 to account for differences in drainage areas. The multiplier for both these inflows was computed as the ratio of the drainage areas to the 0.8 power (USDA, 1978). As part of the calibration process, the Ysidora residual inflow point was moved upstream to enter between River Stations 61803 and 62602. This was done because it is felt that most of the sediment accounted for by this residual flow enters the system between Sandia Creek and De Luz Creek, not at the gage location (Basilone Bridge). In addition, the sediment rating curve was later doubled because preliminary results indicated that not enough sediment was entering the system in this area.

6.9.5 Calibration Results

In HEC-6 and –6T, the average bed elevation (ABE) of a cross section is defined as the water surface elevation at that cross section for a given flow rate minus the effective depth. The effective depth is an area-weighted depth of the trapezoidal elements in the wetted area of the cross section. Use of the ABE for calibration is superior to use of the "bed change" output in HEC-6. The bed change output data only reflects movement of the thalweg of the channel and will not necessarily reflect the average bed change or sediment volume change of the cross section. Average bed elevation plots are shown in Figures 6-10, parts (a) through (g). Note that both horizontal and vertical scales vary between the plots in order to present all the data. Table 6-6 contains the average bed data for the calibration model.

Figure 6-11 shows the area that was subjected to dredging in 1994. As can be seen from the increase in average bed elevation for the March 1996 and September 1998 series, the dredge area is filling in, although not completely.

One feature to note is the lowering of the ABE between River Stations 31000 and 43000 (approximately). Although some degradation could be expected in this reach due to trapping of sediment in the dredged area upstream, the computed erosion appears to be excessive. This area is problematic because the channel geometry was obtained from 1998 surveys (1998 data was used from station 20646 to 48145; see Hydraulics chapter). Comparison of profiles from 1994 surveys (SLA, 1995) and 1998 surveys (from Winzler & Kelly) show that in general the 1994 invert elevations were lower than the 1998 invert elevations. We therefore believe that the lowering of the bed in this area is not a true reflection of bed adjustment during the calibration period, but an outcome from the geometric input data used in the base conditions model.

6.10 Calibrated Base Conditions Model

Modifications from the calibration process in inflowing sediment and movable bed limits were implemented in the base conditions model. The model was then executed with the balanced hydrographs to estimate sediment loading to the estuary for frequency flow events and on an average annual basis.

6.10.1 Hydrology

Flow hydrographs are simulated in HEC-6T by a series of steady flows. The balanced hydrographs described previously in the report were discretized and prepared for HEC-6T input.

The balanced hydrographs are synthetic representations of flow versus time based on the peak- and volume-frequency analysis discussed previously. In generating flows for HEC-6T for a certain frequency event (the 100-year flood or 1% chance event, for example), discharges of the same frequency were assumed to occur simultaneously at all three gages. In reality, this would not necessarily happen but it is a good approximation of the actual events. Because of this assumption, however, flows in the reach represented by the Ysidora gage would sometimes be less than those upstream represented by the Fallbrook gage. However, for most recorded events greater than the 2-year flow, the flow *increases* in the downstream direction. WEST therefore adjusted the balanced hydrograph records such that flows would always be increasing in the downstream direction. The majority of the adjustments were made at the leading and trailing "tails" of the hydrograph. This action affected the 3- to 5-day volumes, but did not significantly alter the volumes closest to the peak flows where the majority of the sediment transport occurs. Therefore, the adjustments have minimal impact on sediment transport results.

The balanced hydrographs were developed for each storm event at each of the three gage locations. However, because the calibrated HEC-6T model uses five inflow points (Figure 6-9), the flows needed to be adjusted. The inflows associated with the balanced hydrographs at the Ysidora gage location were divided between the Sandia Creek, De Luz Creek and Ysidora residual inflow points. The inflows at the FPUD location were divided between the Rainbow Creek and FPUD residual inflows. The relative contribution of inflow at each of the points was based on contributing drainage area. No adjustments were made to the upstream boundary inflow hydrograph. As previously described under the calibration hydrology section of this report, a "warm-up" period was used at the start of the simulations to allow the bed material gradations and bed elevations to become computationally compatible with the flow hydraulics.

6.10.2 Base Conditions Model Results

6.10.2.1 Aggradation and Degradation Trends

Changes in average bed elevation from the end of the warm-up period to the end of the balanced hydrograph are shown in Figure 6-12 (a) through (e). From these figures, trends of aggradation, degradation, or stability may be observed for various areas of the river (note that the large difference between horizontal and vertical scales on these figures exaggerates the amount of computed bed change). Reaches were defined based on the bed change trends, and these are summarized in Table 6-7. One should remember that these results are from simulating individual flow events with a duration of only a few days and do not necessarily represent long-term changes in the river bed elevations. The aggradation and degradation trends for the defined reaches are described in the following paragraphs.

From the Ocean to Interstate 5 (River Stations 0 to 3075), the model predicts lowering of the average bed elevation (degradation) ranging from 0 for the 2-year hydrograph to 3 feet from the 100-year hydrograph. These results may be suspect because a) the HEC-6T model cannot simulate tidal influence in this reach (unsteady flow), b) cannot simulate two-dimensional flow patterns, c) does not simulate the added resistance to erosion of existing cohesive sediments in the estuary, and d) the current model does not include non-cohesive sediment which may deposit in the estuary. However, the degradation computed during these flow events could also be filled in during subsequent lower flows. Results for this reach also show that the 10- through 100-year events cause erosion at the bridge opening due to the constriction of flow.

From the Interstate 5 bridges upstream through the Ysidora Basin (River Station 18460) model results show the channel as being relatively stable. A few notable features in this reach are deposition between the Interstate 5 and Stuart Mesa Road bridges, scour at the latter bridge, and some degradation in the area of "the narrows" (approximately cross section 1100 to 14640). With the exception of changes in two cross sections during the 100-year hydrograph, neither aggradation nor degradation surpassed 2 feet in this reach.

From the Ysidora basin upstream past the Basilone Bridge crossing and the end of the levee the channel is shown to degrade during all flood hydrographs greater than the 2-year event (up to Station 49000). The average bed elevations are lowered by as much as five feet in this reach. It appears that the principal reason for the degradation is the construction of the flood protection works along the left bank of the river. Coincidentally, perhaps, this is the reach that is modeled using geometric data from the Winzler & Kelly survey (see Chapter 4). One can appreciate from Figure 6-12 how the spacing between cross sections is less in this reach, and how the variability in bed change results is greater here than other reaches in the complete profile. The increase in variability is due not only to the increased frequency of cross sections but also to the increased detail of the cross sections (greater number of ground points) in this reach.

From Station 49000 upstream past the O'Neill Diversion Weir to Station 56780, the model results show channel deposition (up to 2 feet of aggradation) resulting from most of the flood events. The exception to this statement is the scour shown in the cross section just downstream of the weir at River Station 54830. Interestingly enough, the average bed elevation is not substantially lowered here except for the 100-year balanced hydrograph.

The next reach upstream, to around station 62000 shows mainly degradation for all flow events (up to three feet lowering of the average bed elevation). It appears that this reach is strongly influenced by the Ysidora residual inflow at the upstream end of the reach (see section 6.9.4 for description of this inflow point). Therefore, the results here should be viewed with some caution, especially at cross section 61803. This reach is also the first of those examined to use cross sections derived from Camp Pendleton's topography (5-foot contours). This topographic data source provides less resolution of the channel shape compared to other cross sections in the reaches downstream.

Between River Stations 6200 and 6600 model results show an increase in average bed elevations for all events other than the 2-year hydrograph (up to a three feet of aggradation). The results in this area are influenced by two factors: the increase in floodplain width near the confluence with De Luz Creek and the sediment supply from De Luz Creek itself.

The channel between River Station 6600 and the De Luz Road crossing is a moderate canyon area. Results for this reach show alternating areas of erosion and deposition (up to 5 feet and 3 feet, respectively). Although these results are partly due to changes in cross section width influencing sediment transport through areas of the reach, they are also dependent on the topographic detail of the original cross sections. These cross sections obtained from the 5-foot contours lack information on the actual low point of the channel. When plotted in profile a "stair-step" pattern appears with the levels of the stairs at even 5-foot increments. When this type of data is used in the sediment transport model, the edges of the stairs are eroded while the area between stair steps receives sediment deposits in order to form a relatively smooth slope. This discussion applies to all areas of the model where 5-foot or 20-foot contours were used for cross section data.

While scouring is evident at the De Luz Road crossing, the reach between this crossing and River Station 109000 is in a depositional mode. Particularly evident is the large amount of deposition in the area of Sandia Creek (up to six feet). In this area both the Sandia Creek inflow and the FPUD residual inflow enter the sedimentation model. Although deposition is expected in this area, it is probably exaggerated in the model due to the FPUD inflow applied at a point rather than spread over a reach of the stream (not an option with HEC-6T). Deposition in this area was however noted during field visits to the area.

The reach between River Stations 109000 and 125000 appears to be relatively stable, with aggradation and degradation less than two feet. There is a local flattening of the channel slope which may account for some of the aggradation computed. From Station 125000 to 151000, the reach is relatively stable with the exception of two "spikes" of deposition (up to 8 feet) and one of erosion. The depositional spikes are believed to be fictitious due to model instabilities. Cross sections in this reach at and below River Station 128383 were derived from 5-foot contours while those above were obtained using 20-foot contours from USGS topographic maps. The lack of cross section resolution from the larger contour spacing caused flow instabilities that in turn caused the deposition spikes. The erosion spike, on the other hand, is due to both the change in bed reservoir depth (see Section 6.7) and the deposition spike in the cross section just upstream (excessive deposition upstream causes a deficit of transportable material and hence, erosion). The reach at the very upstream end of the model (Station 15100 to 15443) shows up to 5 feet of deposition. Although some deposition may be expected here due to the local flattening of the slope, the amount predicted by the model is probably excessive and is a product of the upstream boundary condition (inflowing sediment load).

Overall, the model showed areas of both erosion and deposition over the Santa Margarita River for the events modeled. For the scenarios modeled (levee/floodwall and new bridge constructed, no changes in vegetation patterns, balanced hydrographs for the various frequency flows), the reaches within Camp Pendleton along the new flood protection works are expected to degrade. Other reaches within the base appear to be fairly stable with slight degradation possible. In general, topographic data of limited or questionable accuracy are also a constraint to effective modeling, especially where the active channel geometry is not adequately reproduced (see discussion in Chapter 4 and recommendations in this chapter).

6.10.2.2 Sediment Delivery

The amount of sediment passing the Interstate 5 bridge between the end of the warm-up period and the end of the simulation was noted for each of the balanced hydrographs. Average annual sediment delivery was computed by integrating the amount from each event with the probability of occurrence of the event in any given year. The equation used for the computations is

$$Y_{annual} = 0.45Y_2 + 0.23Y_{10} + 0.04Y_{25} + 0.015Y_{50} + 0.015Y_{100}$$

where Y_i is the sediment delivery for event i. Results are presented with those from the sensitivity analysis, described in the following section.

6.10.3 Sensitivity Analysis

Due to a number of uncertainties in the input data for the sediment transport model, a sensitivity analysis was performed. Model results were examined for sensitivity to roughness values, inflowing sediment load, and sediment transport function. The model was modified and executed (a model run was performed) for each of the conditions identified in Table 6-8 (note that Run A is the base conditions model described in the previous sections).

The sensitivity model results showed the same general aggradation and degradation trends as the base conditions model. The sediment delivery downstream of Interstate 5 varied between the models. The results are presented in Table 6-9 and graphically in Figure 6-13 (note the logarithmic scale).

As seen from Table 6-9 and Figure 6-13, the sediment delivery downstream of Interstate Highway 5 for a given flow event can vary by an order of magnitude between sensitivity runs. Although these differences may appear exceedingly large, they are actually within the uncertainty experienced in many sediment transport studies. However, if we exclude the runs that do not use the Yang transport equation (Runs F and G), the differences between the remaining runs are much less. Results from the 2-year event are relatively insensitive to the variation of all parameters except the transport function. With the increase in return period of an event, the results appear to become more sensitive to the sensitivity parameters as more sediment is entering the system. As expected, higher roughness values and lower inflowing sediment amounts provide less sediment passing the bridge while lower roughness values and higher inflowing sediment have the opposite effect. For sensitivity Runs B, C, D, and E, the differences in sediment passing under Interstate 5 compared to Run A results are –19%, +16%, +5%, and –6%, respectively. This indicates that for the chosen sensitivity ranges the amount passing the bridge is more sensitive to roughness values than to inflowing sediment load. It also indicates that 44,000 tons/year plus or minus 20 percent would be a conservative bracket for the actual amount passing the bridge on an average annual basis.

6.11 Recommendations

The present models have certain limitations that have been identified both in this chapter and Chapter 4 (Hydraulics). Recommendations are given in the following sections for data collection that could be used for future improvement of the current models.

6.11.1 Topographic Data Collection

Periodic aerial surveys should be performed for the Santa Margarita River Valley on Camp Pendleton. This updating of the topography will serve two purposes as relates to modeling. First, the updated topography itself may be used for new model geometry. Second, the historic topographic data will provide information that can be used (profiles and cross sections) for sedimentation model calibration. In addition to the uses for modeling, topographic data will also be useful to track and document any geomorphic changes in the river, especially after future flood events or changes in the hydrologic regime. The information will also be of value to studies involving habitat and environmental restoration, as well as public works projects.

New river valley topography on the base should be obtained at five to ten year intervals, or more frequently if major flood events occur. The accuracy of the surveys should be sufficient to produce 2-foot contour maps. Off base, the 5-foot contour intervals used in the San Diego County maps are probably sufficient, although the maps themselves need to be updated. One option available to Camp Pendleton to monitor changes upstream of the base would be to establish a certain number of "reference cross sections." Periodic surveys of these "permanent" cross sections would provide insight into changes in the river system. Benchmarks would need to be established to consistently locate the cross sections over time. For the area of the river currently mapped with only the USGS quadrangle maps (20-foot contours), more detail is needed for the valley bottom in order to better define channel shape. However, this could also be accomplished using reference cross sections.

If reference cross sections are established, their location should be coordinated with the professionals involved with management of environmental resources. From the standpoint of geomorphic and hydraulic monitoring, several locations on the Santa Margarita River might be desirable:

- Upstream of De Luz Creek – to assess hydraulic, sediment and geomorphic conditions of the river before it enters the more populated area of the base.
- Upstream of the O'Neill Diversion Weir – to assess the amount of deposition occurring due to the weir's presence.
- Downstream of Basilone Road about even with the midpoint of the airfield runway – to assess any degradation due to the construction of the flood protection works.
- In the Narrows downstream of the Ysidora Basin - to assess hydraulic, sediment and geomorphic conditions of the river in the lower portion of the base before reaching the estuary.

6.11.2 Hydraulic Data Collection

Continued flow data collection by the USGS is essential for carrying out future hydrologic, hydraulic, and sediment transport studies. In addition, collection and documentation of high water marks by base personnel or others during moderate to high flood events will aid in future calibration of the hydraulic model (especially roughness parameters). Calibration of roughness values for the hydraulic model will also lead to a more accurate sediment transport model.

6.11.3 Sediment Data Collection

Sediment inflow to the Santa Margarita River is perhaps the biggest unknown factor influencing model results. To improve estimates of sediment entering the river, sediment gaging stations need to be established. At a minimum, a suspended sediment gaging program should be established at the gorge just below the confluence of Murrieta and Temecula Creeks (at the location of the USGS flow gage "Santa Margarita near Temecula"). Camp Pendleton should investigate a cooperatively funded sampling program with the USGS and U.S. Army Corps of Engineers. Another recommended location for sediment sampling is at the new Basilone Road Bridge on Camp Pendleton (it is expected that the USGS flow gage "Santa Margarita at Ysidora" will be relocated there in the near future). When combined with sediment information from the gorge, sampling at this location will help define sediment contributions from tributaries.

Suspended sediment data should be used to develop revised sediment rating curves at the gorge and, if possible, at the major tributaries. Data generated by the sampling program is expected to be useful for several purposes other than sediment transport modeling. These include establishing background sediment data for possible Total Maximum Daily Load (TMDL) requirements and providing necessary input for environmental and habitat studies and permitting.

Table 6-1. Sediment Delivery Ratios

Tributary Area	Subbasins	Area	SDR
Temecula Creek (Below Vail Lake)	11, 28, 30	47.43	0.12
Murrieta Creek	1-6, 9, 10, 13, 29, 32-34	157.83	0.08
"Rainbow Creek"	16, 21	54.43	0.11
"De Luz Creek"	19, 23	58.37	0.10

Table 6-2. Temecula Sediment Inflow Rating Curve

Discharge (cfs)	Sediment Discharge (t/day)
0	0
200	100
600	2,000
2,000	40,000
5,000	200,000
10,000	560,000
20,000	1,300,000
60,000	3,300,000

Table 6-3. "Rainbow" Sediment Inflow Rating Curve

Discharge (cfs)	Sediment Discharge (t/day)
0	0
100	100
200	2,000
800	49,000
1,800	233,000
8,000	1,200,000
10,000	1,500,000
20,000	2,200,000

Table 6-4. "De Luz" Sediment Inflow Rating Curve

Discharge (cfs)	Sediment Discharge (t/day)
0	0
100	100
200	4,000
439	29,000
1,000	132,200
2,500	400,000
8,000	1,200,000
20,000	2,200,000
25,000	2,500,000

Table 6-5. Regression Coefficients

Class	Description*	a	b	R^2
6	VFS	2.011	1.3967	0.9333
7	FS	0.9749	1.3913	0.9334
8	MS	0.3198	1.3870	0.9344
9	CS	0.0709	1.3981	0.9376
10	VCS	0.0103	1.4398	0.9427
11	VFG	0.0003	1.2404	0.6881
12	FG	0.0002	1.3076	0.9661
13	MG	3.00E-06	1.7288	0.9324
14	CG	1.00E-09	2.5736	0.9053
-	Total	3.3879	1.3948	0.9354

* Abbreviations:
V = Very
F = Fine, M = Medium, C = Coarse
S = Sand, G = Gravel

Table 6-6. Average Bed Elevations

River Station	Average Bed Elevation (ft MSL)					
	PreWarm	PostWarm	Mar-96	D-C	Sep-98	F-C
A	B	C	D	E	F	G
0	3.3	2.9	2.4	-0.5	2.1	-0.8
1320	3.4	3.4	3.4	0.0	3.4	0.0
2300	3.8	4.0	3.8	-0.2	3.8	-0.2
3075	5.1	4.2	3.7	-0.4	4.0	-0.2
3680	5.1	4.7	3.9	-0.8	4.3	-0.4
4760	4.2	4.2	5.4	1.2	5.9	1.7
5570	5.0	5.1	6.5	1.4	7.0	1.9
6085	5.3	5.5	6.1	0.6	6.9	1.4
6440	5.2	5.7	6.9	1.2	7.5	1.9
6760	4.0	5.7	6.6	0.8	7.4	1.6
6960	4.5	4.5	6.0	1.5	6.9	2.4
7580	4.8	6.0	7.1	1.0	7.9	1.9
8230	8.4	8.5	9.2	0.8	10.0	1.5
8910	9.2	8.6	9.3	0.7	10.0	1.3
9600	8.5	8.8	9.3	0.6	10.2	1.4
10110	9.7	10.2	10.8	0.6	11.7	1.5
10610	11.5	10.9	11.0	0.2	11.8	0.9
11100	10.5	10.9	11.3	0.3	12.0	1.1
11340	10.3	10.7	11.3	0.7	12.0	1.3
11925	12.6	11.2	11.6	0.4	12.3	1.1
12430	12.2	12.5	12.9	0.4	13.6	1.0
13010	15.6	13.5	13.7	0.3	14.5	1.0
13320	14.7	13.5	13.9	0.4	14.6	1.1
13880	11.8	13.1	14.1	1.0	14.7	1.6
14155	15.0	15.2	15.5	0.2	15.8	0.6
14445	16.0	16.3	16.3	0.0	17.0	0.7
14640	15.3	16.9	17.0	0.1	17.4	0.5
14920	18.3	17.5	17.7	0.2	17.7	0.2
15345	17.6	17.9	18.1	0.2	18.5	0.6
16145	20.6	19.6	19.5	-0.1	19.8	0.2
17025	20.8	21.6	21.4	-0.2	21.7	0.1
17330	21.9	22.4	22.3	-0.1	22.6	0.2
17940	23.9	23.2	23.2	0.1	23.5	0.3
18460	24.8	24.6	24.3	-0.3	24.6	0.1
19135	25.8	25.3	25.0	-0.3	25.3	0.0
19820	26.2	26.2	26.0	-0.1	26.2	0.1
20590	28.8	28.0	28.0	0.0	28.0	0.0
20600	29.9	29.1	28.8	-0.3	28.9	-0.2
20620	31.3	31.0	30.0	-1.0	30.2	-0.8
20646	29.6	30.9	30.0	-0.9	30.0	-0.9
21461	29.3	29.9	30.9	1.0	30.9	1.0
21971	32.0	31.7	32.3	0.6	32.4	0.7
22507	30.0	31.3	32.1	0.8	32.3	1.0
23368	32.0	32.6	33.2	0.5	33.4	0.8
24041	33.7	33.1	34.3	1.1	34.5	1.4
24555	36.3	34.7	35.9	1.2	36.1	1.4
24948	35.1	35.3	35.8	0.5	36.2	0.9
25422	36.1	36.3	36.7	0.4	37.1	0.8

Table 6-6. Average Bed Elevations

River Station	Average Bed Elevation (ft MSL)					
	PreWarm	PostWarm	Mar-96	D-C	Sep-98	F-C
A	B	C	D	E	F	G
25926	37.5	37.9	38.0	0.1	38.4	0.5
26468	38.5	39.0	39.3	0.3	39.7	0.7
27143	40.1	39.4	40.0	0.7	40.4	1.0
27753	42.1	41.2	41.3	0.1	41.7	0.5
28268	42.4	42.2	42.2	0.0	42.5	0.3
28810	41.1	41.6	43.0	1.4	43.4	1.8
29328	44.9	44.4	44.7	0.3	45.0	0.6
29978	46.6	46.4	46.3	-0.1	46.7	0.3
30954	48.4	48.1	47.7	-0.4	48.1	-0.1
31805	51.1	50.2	49.2	-1.1	49.5	-0.8
32607	52.1	51.1	50.4	-0.7	50.6	-0.5
33660	55.0	54.5	53.2	-1.3	53.2	-1.3
35044	58.6	57.4	55.8	-1.6	55.6	-1.8
35651	60.4	60.0	57.6	-2.4	57.3	-2.7
36045	61.3	61.0	58.5	-2.6	57.9	-3.1
36501	62.1	61.8	58.9	-3.0	58.0	-3.8
36912	63.2	61.9	60.0	-2.0	59.1	-2.8
37324	64.3	63.2	60.6	-2.6	59.4	-3.8
37742	65.2	64.6	61.7	-2.9	60.3	-4.3
38009	66.9	65.5	62.7	-2.7	61.3	-4.2
38375	66.7	66.4	63.9	-2.5	62.3	-4.1
38767	67.4	67.1	64.5	-2.6	62.9	-4.2
39206	69.0	68.3	65.5	-2.8	63.8	-4.5
39553	69.6	69.0	66.6	-2.5	65.0	-4.1
39909	70.4	69.8	67.3	-2.5	65.8	-4.0
40360	70.8	70.8	68.0	-2.9	66.4	-4.4
40692	71.7	71.1	68.8	-2.3	67.2	-3.8
41099	72.8	72.6	70.5	-2.1	69.4	-3.2
41398	73.2	72.9	70.3	-2.6	68.8	-4.1
41674	73.5	72.9	71.1	-1.8	70.1	-2.8
41958	74.3	74.1	71.4	-2.7	70.2	-3.9
42314	75.7	74.1	72.3	-1.8	71.1	-3.0
42471	76.9	75.7	73.5	-2.2	72.1	-3.7
42715	75.4	74.6	73.1	-1.5	72.0	-2.6
43194	74.5	75.5	74.6	-1.0	73.5	-2.0
43408	74.9	75.5	74.8	-0.7	74.0	-1.5
43667	75.8	76.1	75.5	-0.6	74.7	-1.4
44084	76.9	76.9	76.7	-0.2	76.2	-0.6
44405	77.2	75.6	76.9	1.3	76.5	0.9
44644	77.2	77.7	77.4	-0.3	77.2	-0.5
44848	77.1	77.6	77.7	0.1	77.5	-0.2
45057	78.0	78.4	78.5	0.1	78.3	-0.1
45281	78.5	79.1	79.2	0.2	79.2	0.1
45548	79.5	79.2	79.7	0.5	79.7	0.6
45818	79.7	79.2	80.1	0.9	80.3	1.1
46179	80.7	80.8	81.6	0.8	81.8	1.0
46496	81.1	80.9	82.0	1.1	82.2	1.3
46840	81.8	81.0	82.5	1.5	82.8	1.8

Table 6-6. Average Bed Elevations

River Station			Average Bed Elevation (ft MSL)			
Station	PreWarm	PostWarm	Mar-96	D-C	Sep-98	F-C
A	B	C	D	E	F	G
47124	81.9	83.5	83.9	0.4	84.1	0.6
47528	82.8	84.1	85.5	1.4	85.9	1.8
47846	83.6	84.6	86.6	2.0	87.1	2.5
48145	84.3	84.2	87.0	2.8	87.6	3.4
49580	87.9	88.5	90.5	2.0	91.5	3.0
50105	89.8	91.0	93.3	2.3	94.0	3.0
51105	99.8	97.9	96.8	-1.1	97.9	0.0
51305	99.6	100.1	98.9	-1.1	99.7	-0.4
52130	101.8	102.3	101.8	-0.6	102.0	-0.3
53130	105.1	105.1	105.9	0.8	106.4	1.2
53980	107.7	107.7	108.9	1.2	109.5	1.8
54830	110.7	109.7	111.8	2.2	112.4	2.8
55579	113.0	110.1	108.4	-1.7	110.5	0.4
55583	116.6	116.5	116.6	0.0	116.6	0.0
56240	114.3	117.0	119.9	2.9	120.5	3.5
56780	120.0	118.0	121.9	3.9	122.9	4.8
57470	130.0	127.2	125.3	-2.0	125.8	-1.5
58918	130.0	131.8	129.3	-2.5	130.0	-1.8
59981	132.5	132.0	132.3	0.3	132.8	0.9
61043	135.0	135.2	136.4	1.2	136.7	1.5
61803	139.9	139.8	141.9	2.1	141.2	1.4
62602	140.0	139.7	142.2	2.5	142.5	2.8
63402	140.0	141.5	146.0	4.5	146.5	5.0
64421	142.5	142.7	146.7	3.9	149.0	6.3
65441	145.0	145.2	151.9	6.7	152.1	6.9
66215	150.0	147.7	152.3	4.6	153.5	5.8
66989	154.4	153.3	154.3	1.1	155.8	2.5
67901	155.0	156.0	155.9	0.0	157.6	1.7
69275	155.0	157.1	160.3	3.2	162.5	5.4
69979	160.0	159.7	162.6	2.9	164.6	4.9
70966	165.0	164.3	165.6	1.2	167.5	3.1
71949	170.1	169.0	169.3	0.3	171.1	2.2
72708	170.0	171.2	172.3	1.1	174.0	2.7
74195	180.0	176.4	177.6	1.2	178.8	2.4
74615	180.0	180.1	178.7	-1.4	180.0	-0.1
75540	184.9	183.3	182.5	-0.9	183.4	0.1
75952	185.0	184.6	184.4	-0.2	185.1	0.5
76721	185.0	186.9	187.0	0.1	187.8	0.9
77179	190.0	188.1	188.9	0.8	189.6	1.6
78244	195.0	194.0	193.2	-0.8	193.7	-0.3
78919	195.0	195.5	196.6	1.2	197.2	1.7
79817	203.3	200.3	200.8	0.5	201.1	0.8
80813	205.0	205.1	204.2	-0.9	204.8	-0.3
81975	206.4	208.0	209.1	1.1	209.8	1.8
82661	211.8	211.5	212.8	1.3	213.3	1.7
84060	216.6	216.9	219.7	2.8	220.4	3.5
84866	222.5	220.2	222.6	2.4	223.3	3.1
85671	228.8	227.2	226.5	-0.7	227.0	-0.2

Table 6-6. Average Bed Elevations

River Station	Average Bed Elevation (ft MSL) PreWarm	PostWarm	Mar-96	D-C	Sep-98	F-C
A	B	C	D	E	F	G
86547	230.0	231.1	229.9	-1.2	230.5	-0.7
87513	232.5	233.0	233.1	0.1	233.7	0.7
88479	235.0	236.6	238.3	1.7	238.4	1.8
89499	240.0	239.4	242.9	3.5	243.1	3.7
90155	244.9	243.6	246.5	3.0	246.7	3.2
90621	245.0	245.8	248.8	3.0	248.7	2.9
91027	253.0	250.3	251.8	1.5	252.1	1.8
91671	254.8	253.7	253.4	-0.4	253.5	-0.3
92279	254.8	256.4	255.4	-1.0	256.1	-0.3
92777	255.0	258.6	258.0	-0.6	259.1	0.5
93227	258.3	259.6	260.8	1.2	262.4	2.7
94068	261.2	263.5	267.3	3.7	268.1	4.6
94468	267.2	264.9	268.6	3.6	269.8	4.9
95068	267.1	268.4	271.9	3.5	273.4	5.0
95703	273.4	271.5	273.8	2.4	274.8	3.4
95968	277.0	274.4	275.8	1.3	277.0	2.5
96818	282.1	282.3	281.4	-0.9	282.5	0.2
97818	289.6	288.9	288.6	-0.3	289.4	0.5
98818	296.9	296.0	294.8	-1.2	295.3	-0.8
100068	302.1	303.1	303.0	-0.1	302.9	-0.2
100328	303.0	304.8	305.0	0.2	305.0	0.3
101428	311.5	310.7	311.7	1.0	311.9	1.1
102278	317.2	317.4	317.9	0.5	318.0	0.7
103128	322.3	322.9	323.7	0.8	324.5	1.6
104578	332.2	331.0	331.7	0.7	331.4	0.5
105628	335.0	337.2	338.9	1.7	339.4	2.2
106178	337.2	341.0	342.5	1.5	343.3	2.3
106596	337.4	342.9	345.4	2.5	347.5	4.6
106628	337.4	343.1	345.3	2.2	346.3	3.2
107708	348.9	348.2	350.4	2.2	351.7	3.5
108383	347.6	349.7	352.5	2.8	354.4	4.7
109683	362.1	359.7	359.8	0.1	360.1	0.4
110533	367.3	367.5	366.2	-1.3	366.6	-0.9
111333	372.3	372.5	372.8	0.3	372.1	-0.3
112133	378.4	378.5	378.7	0.2	378.0	-0.5
113033	386.1	386.2	385.7	-0.5	385.4	-0.8
113933	394.2	394.2	394.3	0.1	393.1	-1.1
114983	403.1	402.8	402.5	-0.3	400.1	-2.7
116033	412.3	411.1	409.7	-1.4	408.2	-2.8
117533	420.5	420.6	418.8	-1.8	417.5	-3.1
119033	428.6	428.4	428.5	0.1	426.5	-2.0
120408	434.7	434.8	435.1	0.3	433.0	-1.8
121783	442.0	442.5	443.6	1.1	441.0	-1.5
122383	452.2	451.1	451.6	0.5	451.8	0.7
123483	456.9	458.9	458.6	-0.4	459.0	0.1
124533	462.3	462.3	463.4	1.1	463.9	1.6
125583	468.4	469.1	470.5	1.4	470.5	1.4
126408	477.8	476.8	477.1	0.2	477.0	0.2

Table 6-6. Average Bed Elevations

River	Average Bed Elevation (ft MSL)					
Station	PreWarm	PostWarm	Mar-96	D-C	Sep-98	F-C
A	B	C	D	E	F	G
127233	487.3	486.9	484.4	-2.5	483.1	-3.8
128383	499.1	500.2	500.5	0.4	500.6	0.4
128883	511.8	513.7	518.6	4.9	519.4	5.7
130383	538.3	538.3	538.3	0.1	538.5	0.3
131383	553.5	553.4	554.1	0.7	555.8	2.4
132383	568.6	568.7	568.7	0.0	568.9	0.2
133683	594.4	594.4	594.4	0.0	594.4	0.0
134483	612.3	612.3	612.2	0.0	612.2	0.0
135633	649.8	649.7	649.7	0.0	649.7	0.0
136783	687.3	687.2	687.2	0.0	687.2	0.0
137970	716.9	716.9	716.8	0.0	716.8	0.0
139158	746.6	746.6	746.6	0.0	746.6	0.0
140445	766.7	766.8	766.6	-0.2	766.6	-0.2
141733	785.3	785.2	785.2	0.0	785.2	0.0
142858	809.8	809.6	809.7	0.0	809.7	0.0
143983	835.8	835.7	835.7	0.0	835.7	0.0
145108	862.4	862.3	862.3	0.0	862.3	0.0
146445	879.7	879.6	879.5	0.0	879.9	0.3
147783	898.7	898.7	898.7	0.0	898.8	0.0
148983	907.0	907.2	907.1	-0.1	906.8	-0.4
150183	913.7	913.6	914.3	0.6	914.8	1.1
151033	923.3	923.3	923.2	0.0	923.3	0.1
151883	935.2	935.7	936.5	0.9	936.7	1.1
153168	946.2	946.8	948.6	1.8	949.3	2.5
154453	958.2	958.8	960.5	1.7	960.9	2.1

Table 6-7. Aggradation and Degradation Trends

Stations Defining Reach Limits	Trend	Note
Pacific Ocean (Station 0)		
	Degradation	Tides, littoral transport not modeled
Interstate 5 (Station 3075)		
	Stable / Aggradation	
Stuart Mesa Rd. (Station 6760)		
	Stable / Degradation	The Narrows
Station 15000		
	Stable	Ysidora Basin
Station 18460		
	Degradation	Levee/Floodwall, Basilone Bridge, 1998 Topo.
Station 49000		
	Aggradation	Erosion at Cross section downstream of weir
O'Neill Weir (Sta. 55583)		
	Aggradation	Deposition upstream of weir
Station 56780		
	Degradation	Narrow; downstream of Ysidora Residual Inflow
Station 62000		
	Aggradation	Downstream of DeLuz Creek
Station 66000		
	Alternating Aggradation and Degradation	Moderate Canyon Area
DeLuz Road Crossing (Station 95968)		
	Aggradation	Sandia Creek and FPUD Residual Inflows
Station 109000		
	Stable / Degradation	
Station 125000		
	Aggradation	Local flattening of slope
Station 133000		
	Stable	Canyon area
Station 151000		
	Aggradation	Flatter slope area in gorge
Station 154453		

Table 6-8. Sensitivity Analysis Matrix

Model Run	Roughness	Sediment Inflow	Transport Equation
A	Normal	Normal	Yang
B	High	Normal	Yang
C	Low	Normal	Yang
D	Normal	High	Yang
E	Normal	Low	Yang
F	Normal	Normal	Toffaleti-Schoklitsch
G	Normal	Normal	Ackers-White

Table 6-9. Sediment Passing Downstream of Interstate 5 Crossing (tons)

	Sensitivity Run						
Event	A	B	C	D	E	F	G
2-Yr	272	295	245	272	272	3766	333
10-Yr	62371	52475	70794	62310	61228	40301	327683
25-Yr	245124	189855	300863	254877	235774	97606	744686
50-Yr	491745	386696	575413	510510	464264	152930	1111699
100-Yr	829031	667934	953544	924236	734857	210029	1608457
Avg. Annual	44084	35616	51362	46170	41623	20313	146107

Figure 6-1
Sediment Delivery Ratio versus Size of Drainage Area

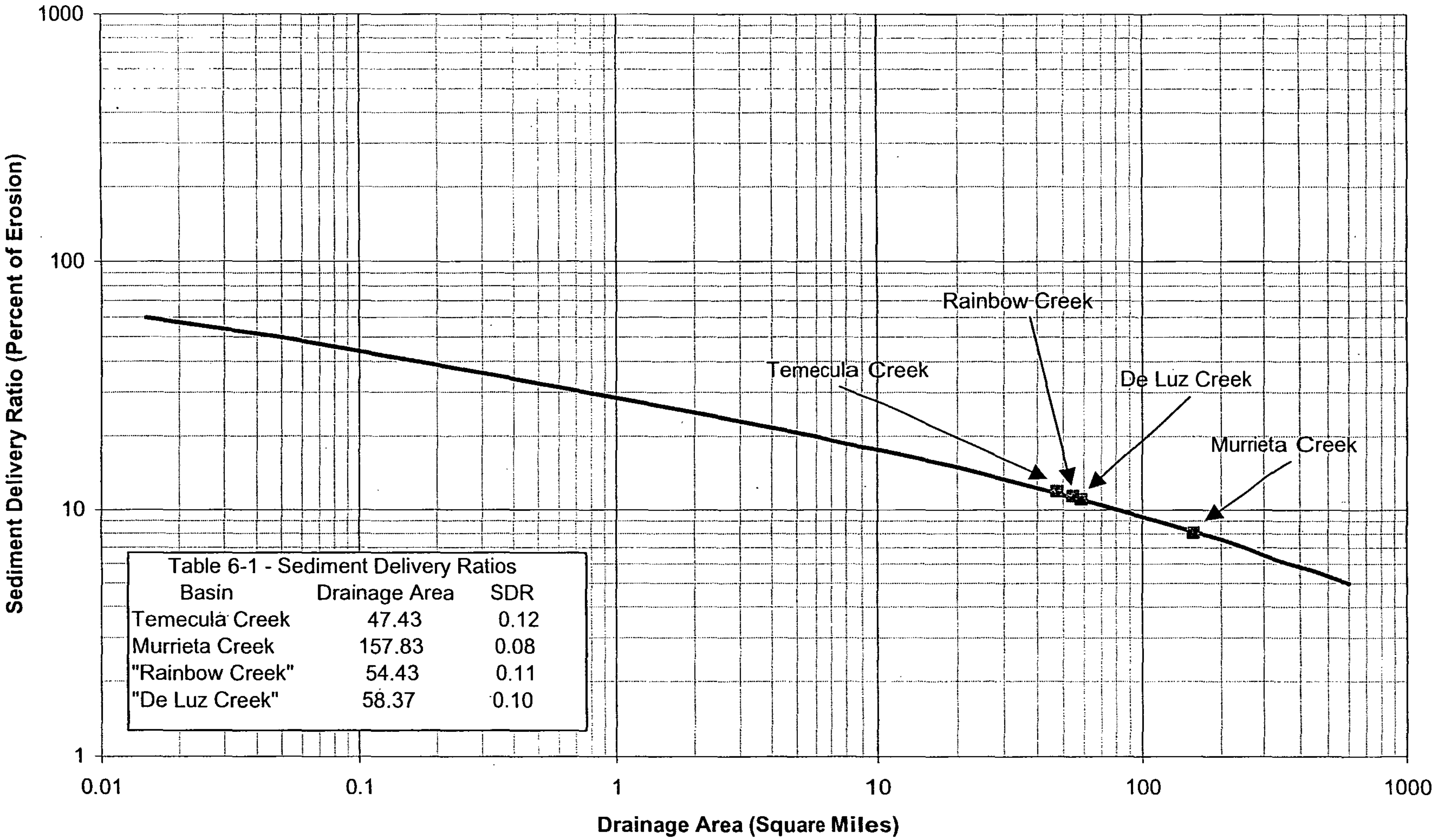


Table 6-1 - Sediment Delivery Ratios

Basin	Drainage Area	SDR
Temecula Creek	47.43	0.12
Murrieta Creek	157.83	0.08
"Rainbow Creek"	54.43	0.11
"De Luz Creek"	58.37	0.10

Figure 6-2
Sediment Inflow Rating Curves

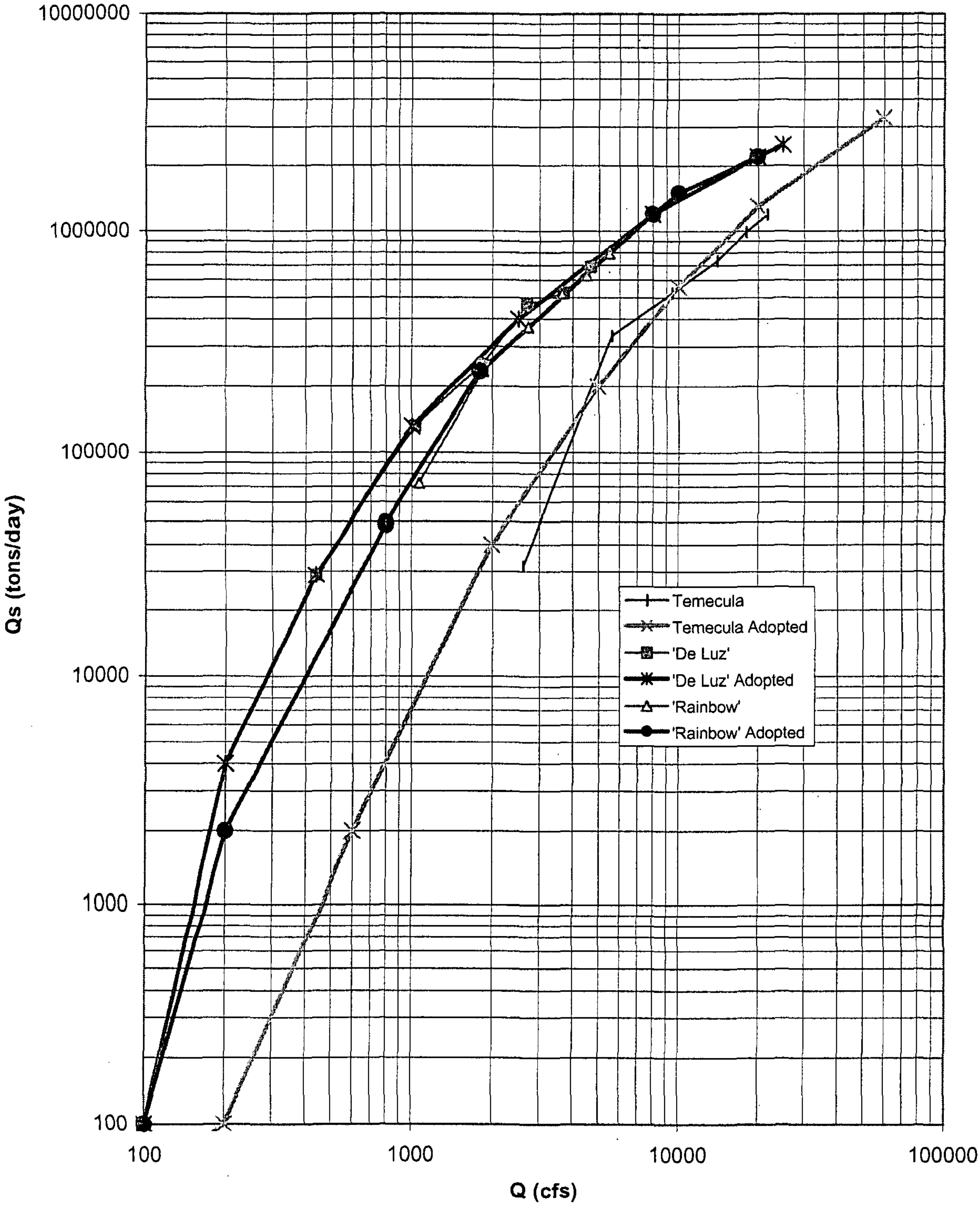


Figure 6-3
Murrieta Creek Sediment Rating Curves

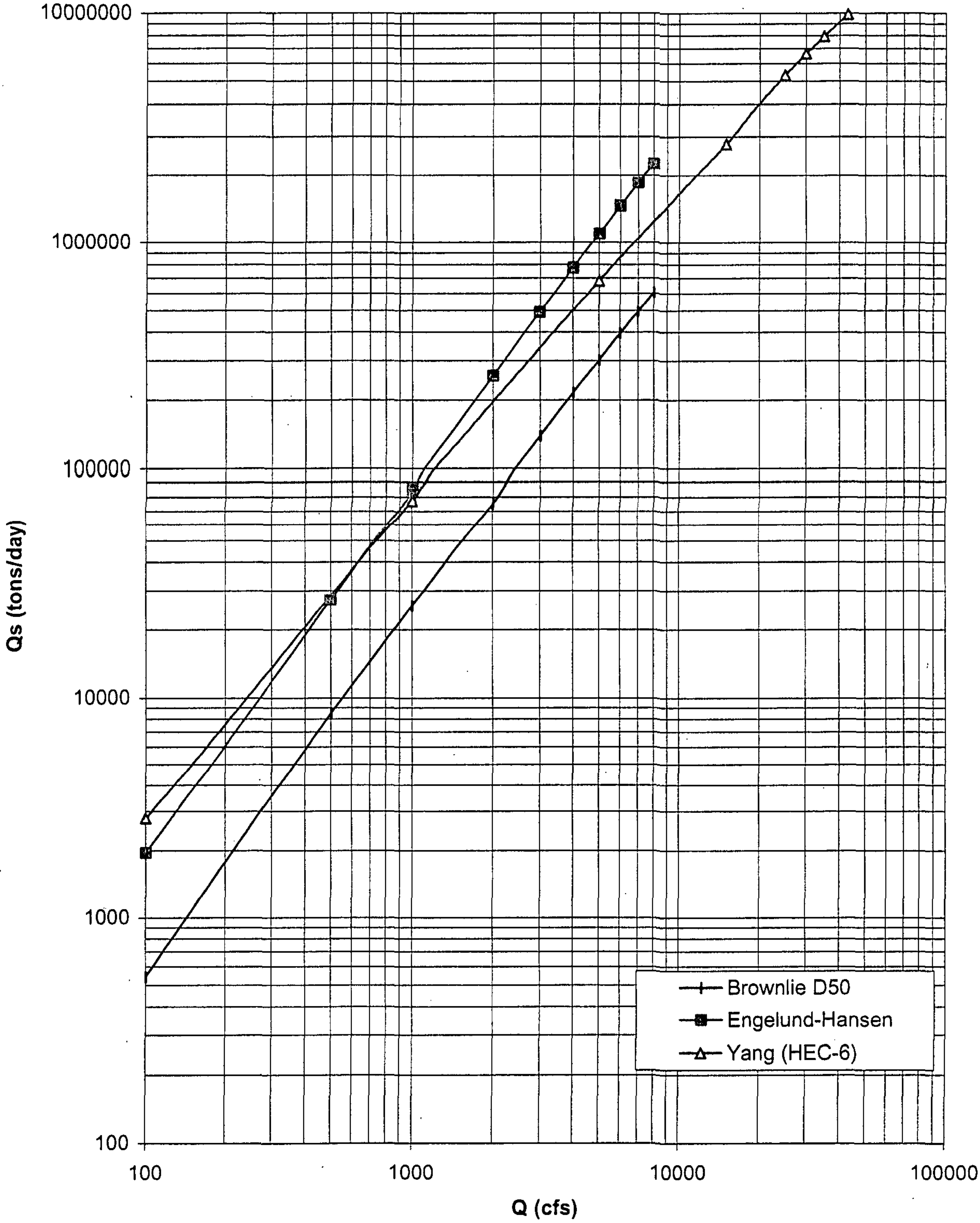


Figure 6-4
Temecula Creek Sediment Rating Curves

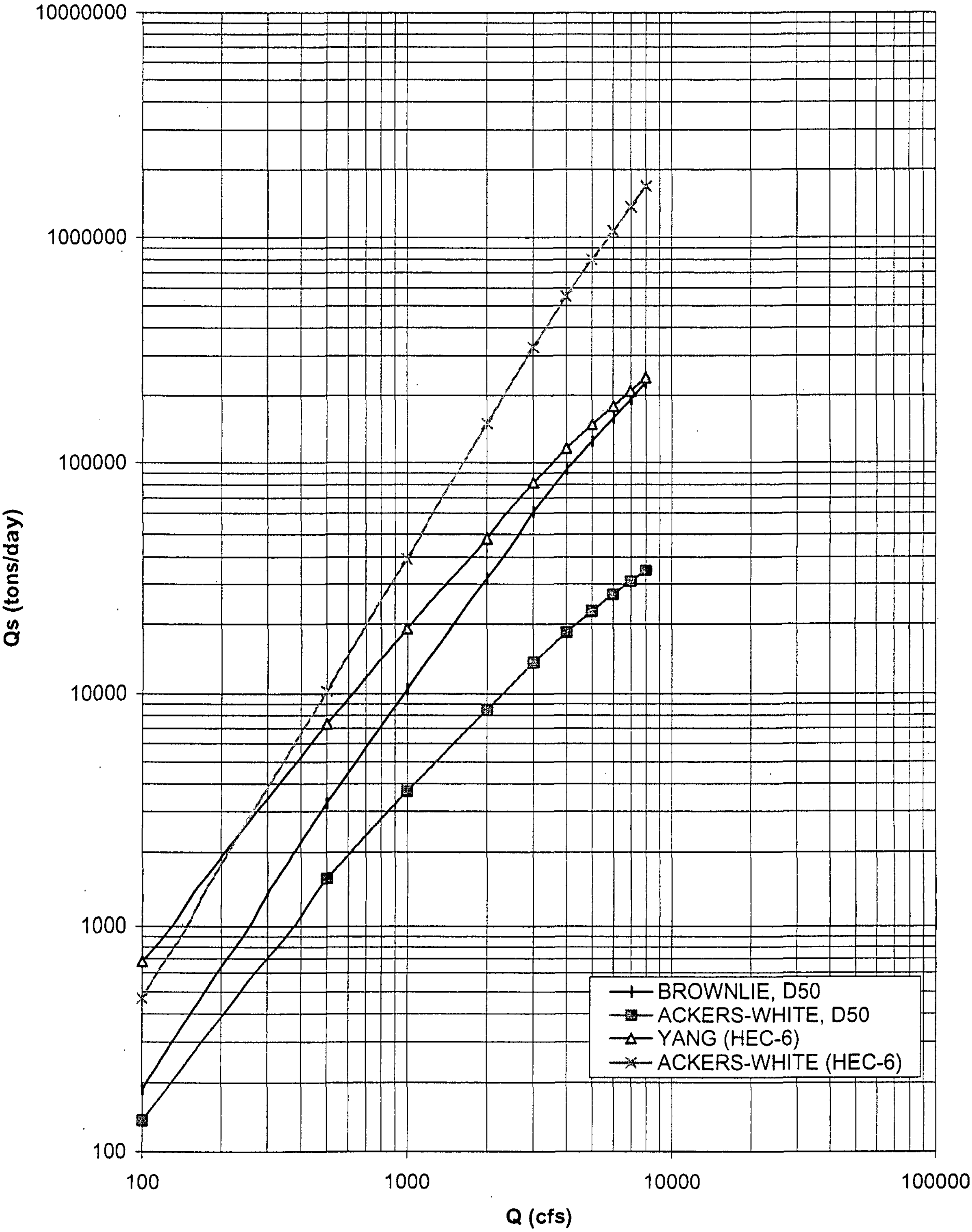


Figure 6-6
Sediment Inflow Rating Curves, Rainbow & Sandia Creeks

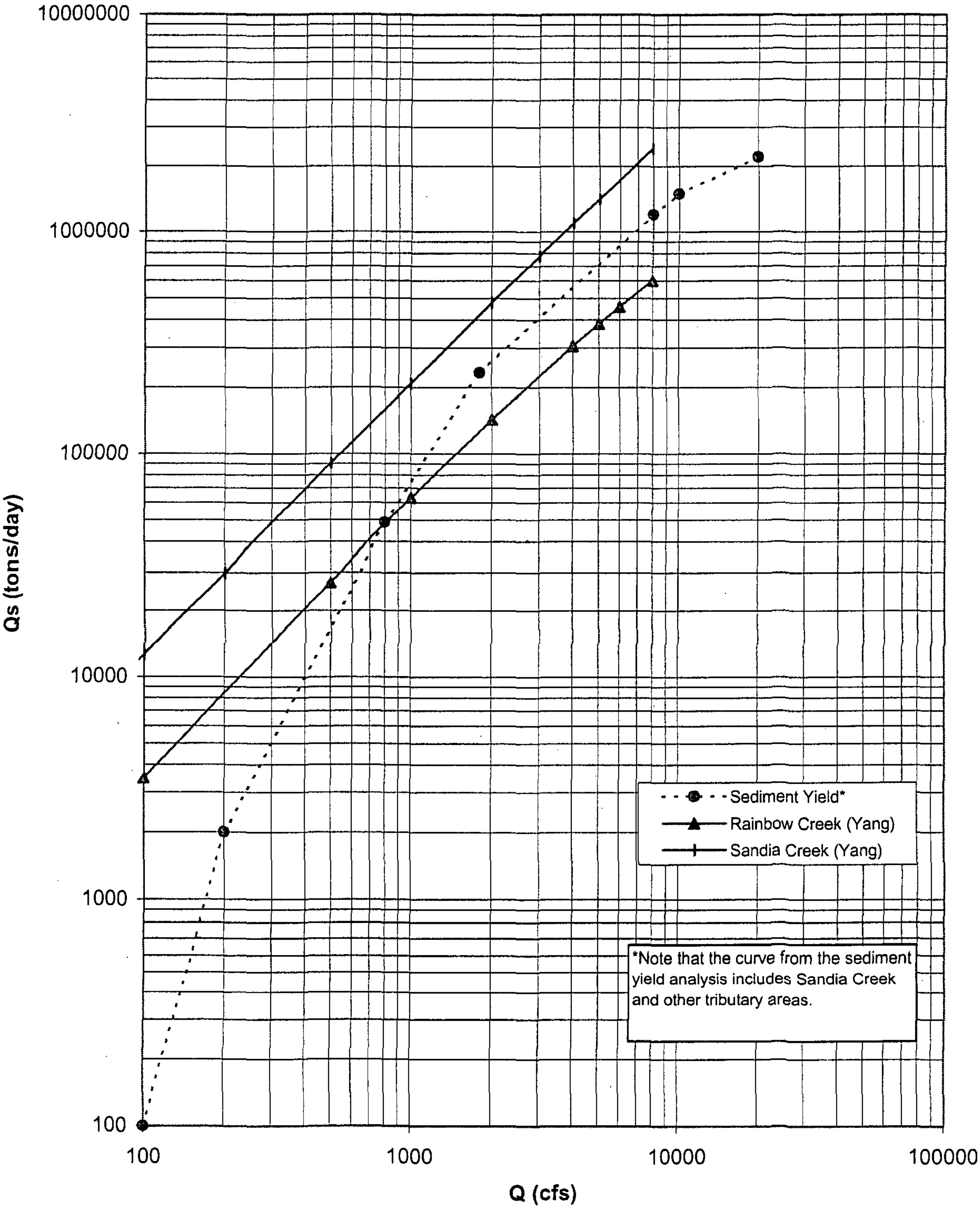


Figure 6-7
Sediment Inflow Rating Curves, De Luz Creek

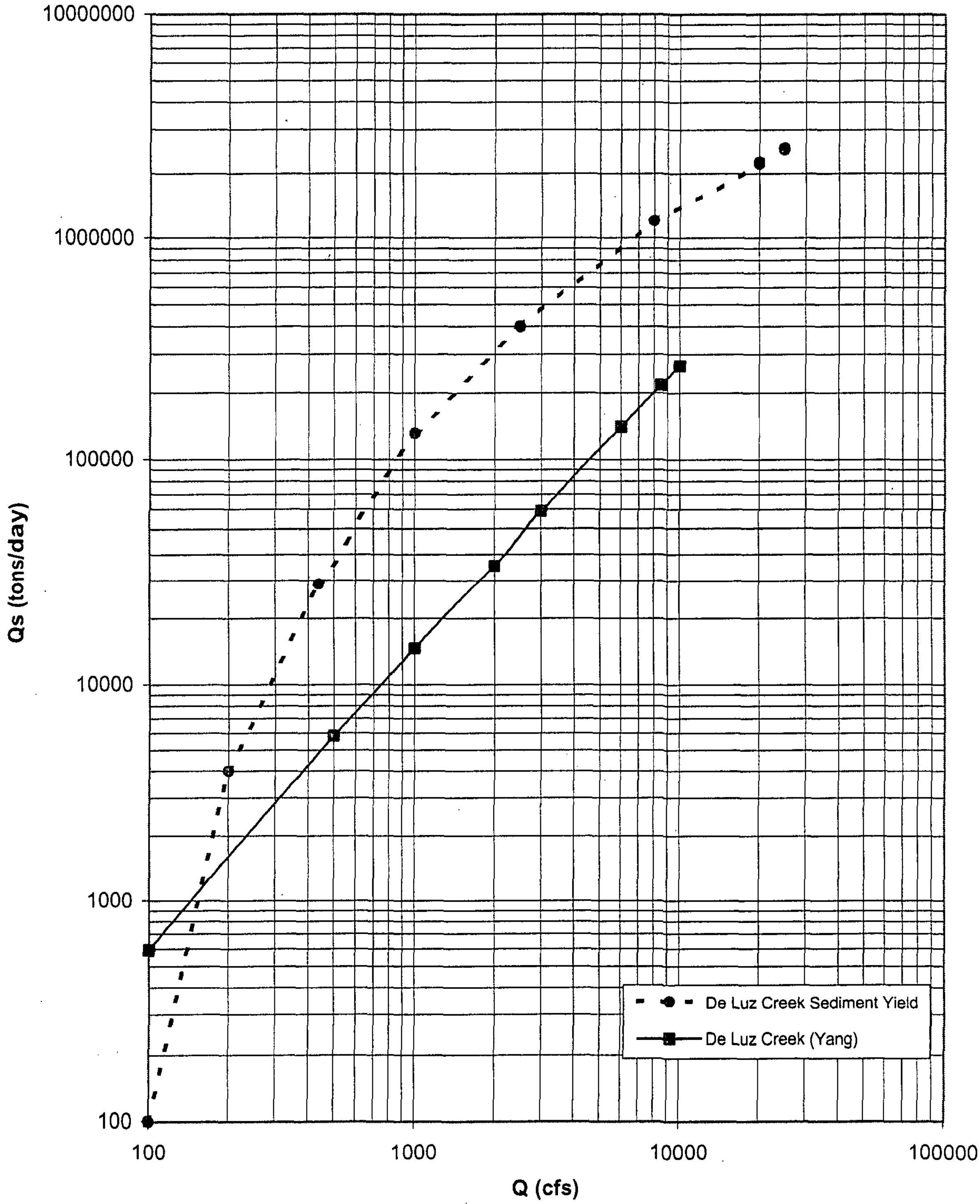
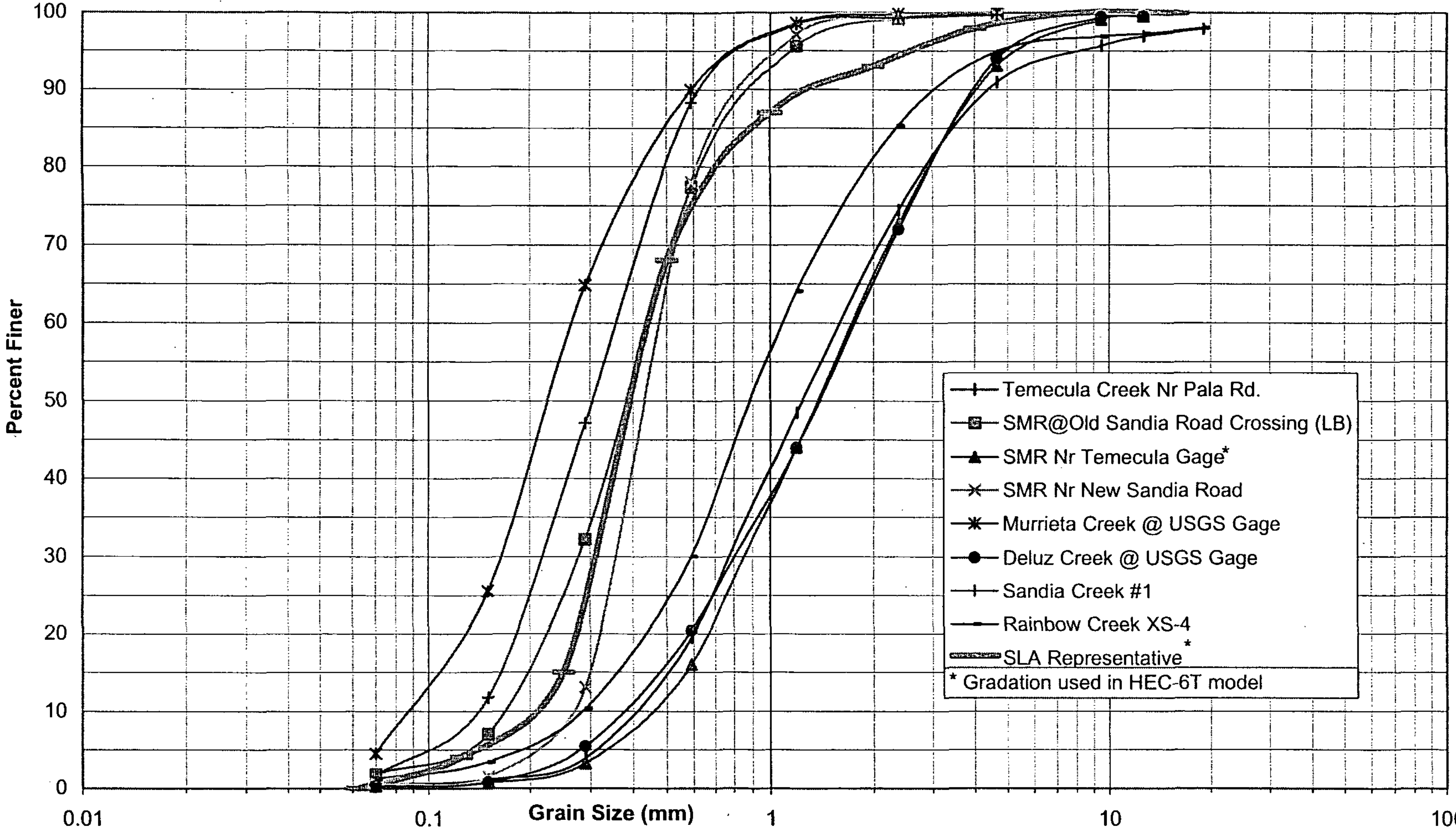
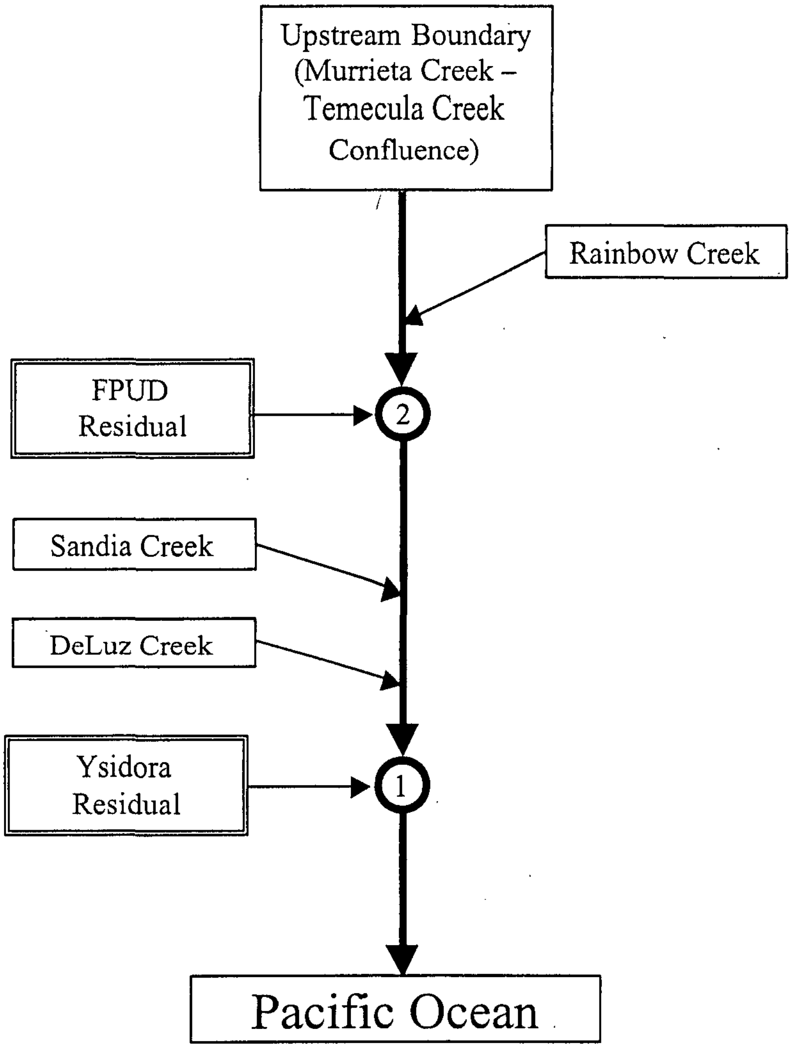


Figure 6-8
Sediment Grain Size Distributions



Fine	Medium	Coarse	V. Fine	Fine	Medium	Coarse	VCoarse	V. Fine	Fine	Medium	Coarse	VCoarse
Silt			Sand					Gravel				

Figure 6-9
Santa Margarita HEC-6T Model
Inflow Point Schematic
(Not to Scale)



Gages
1 – Ysidora
2 – FPUD Sump Nr Fallbrook

Figure 6-10 (a)
Calibration ABE Comparison

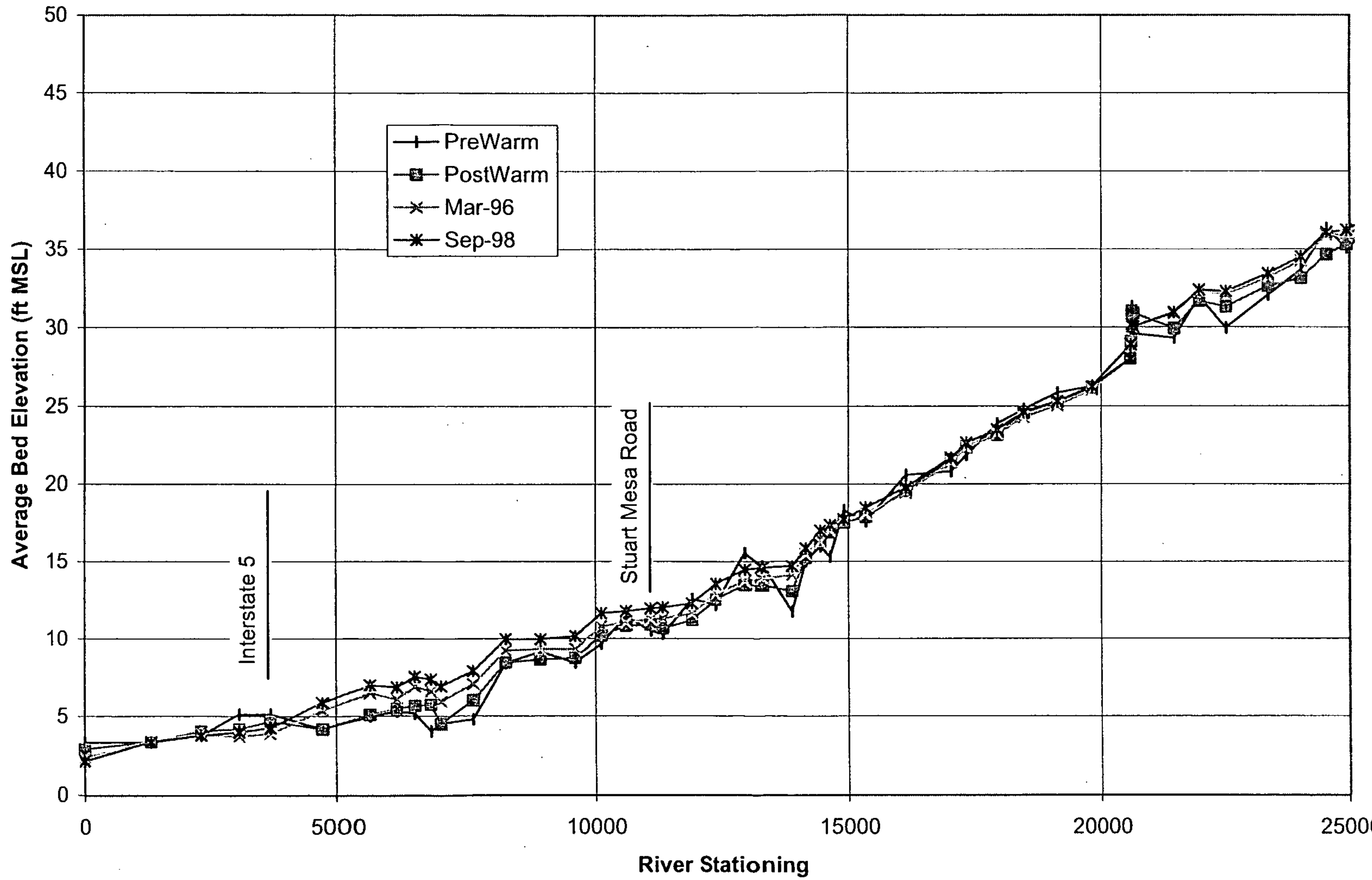
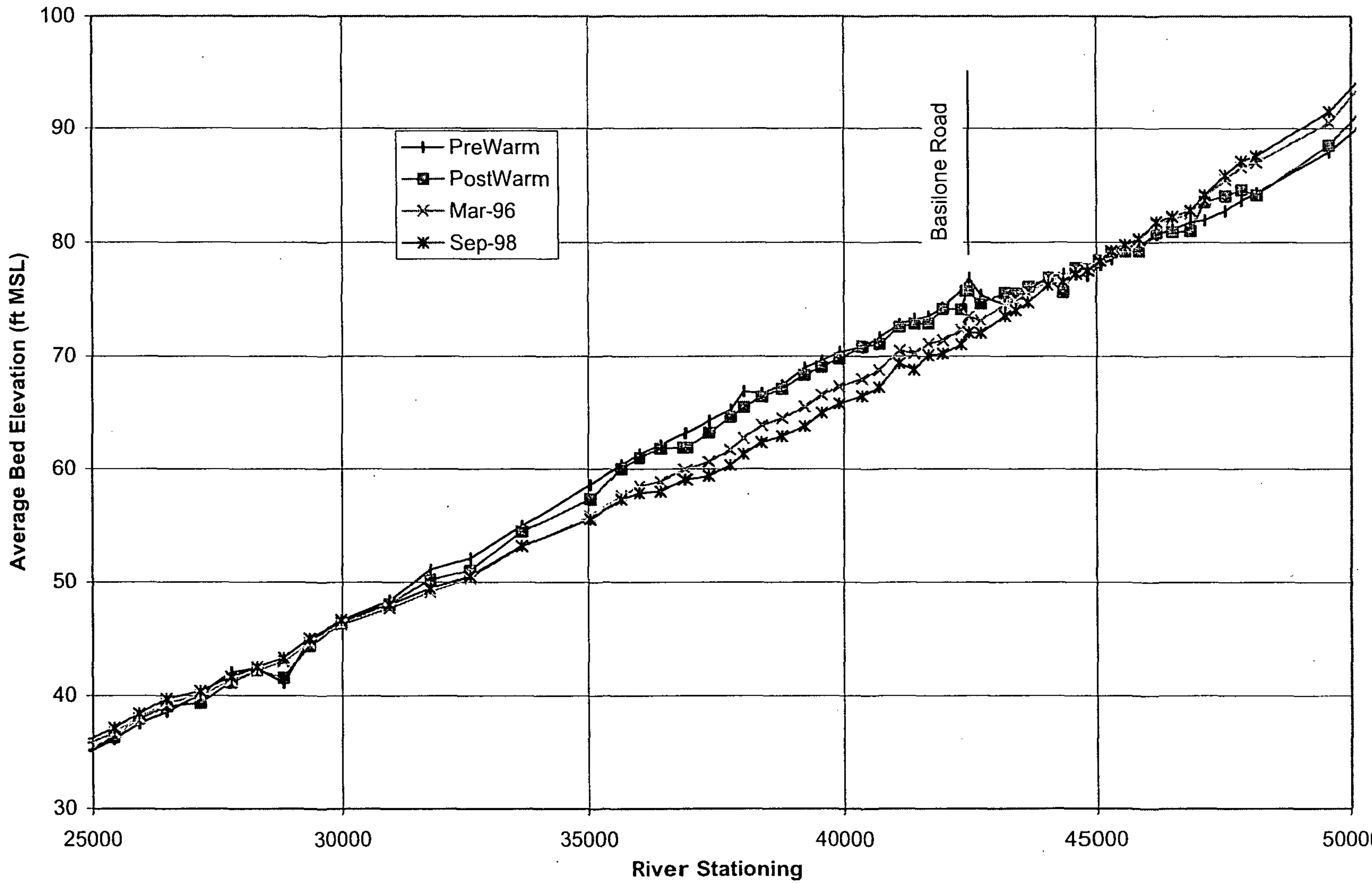


Figure 6-10 (b)
Calibration ABE Comparison



dredge abe.xls

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Figure 6-10 (c)
Calibration ABE Comparison

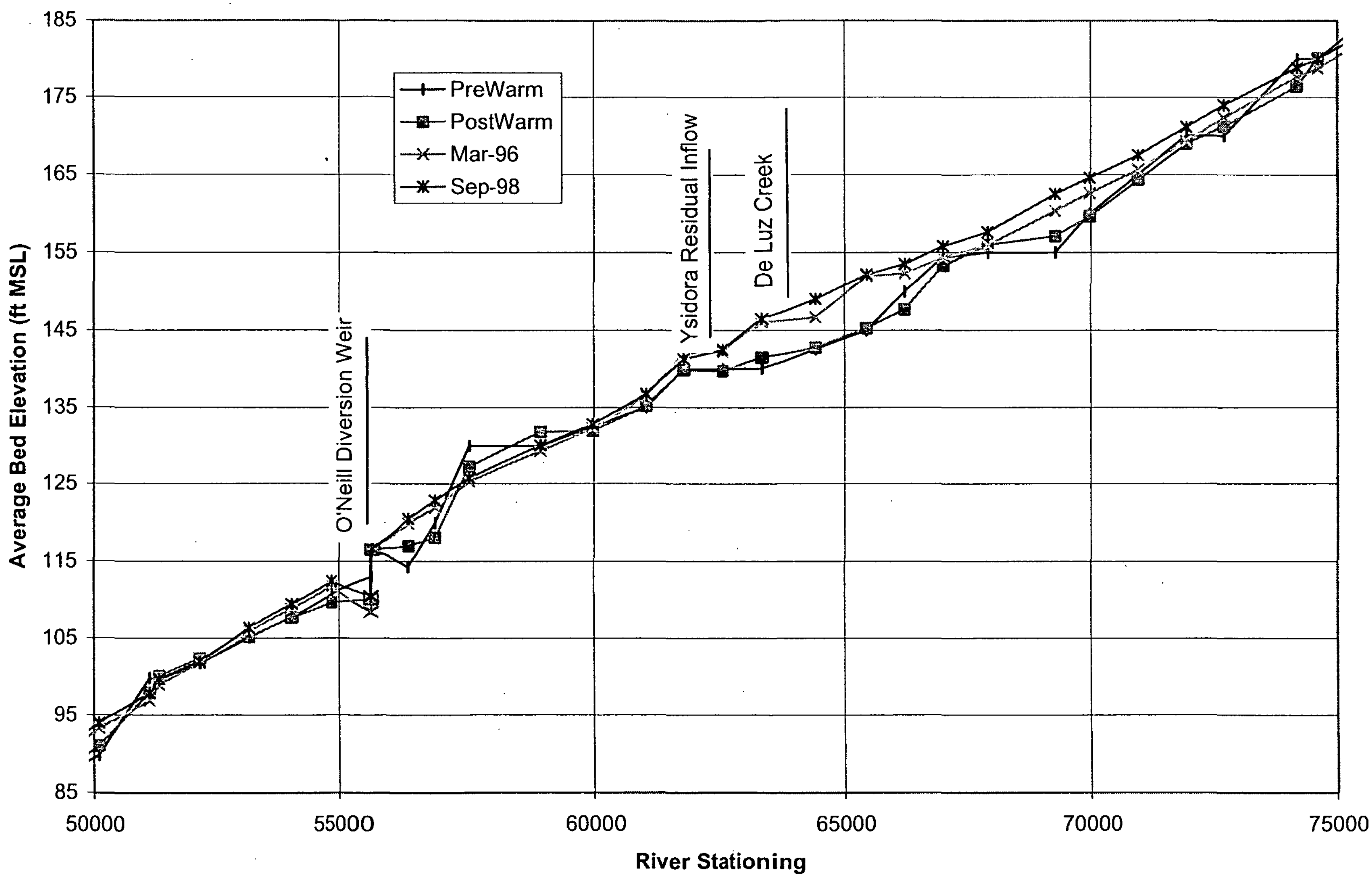
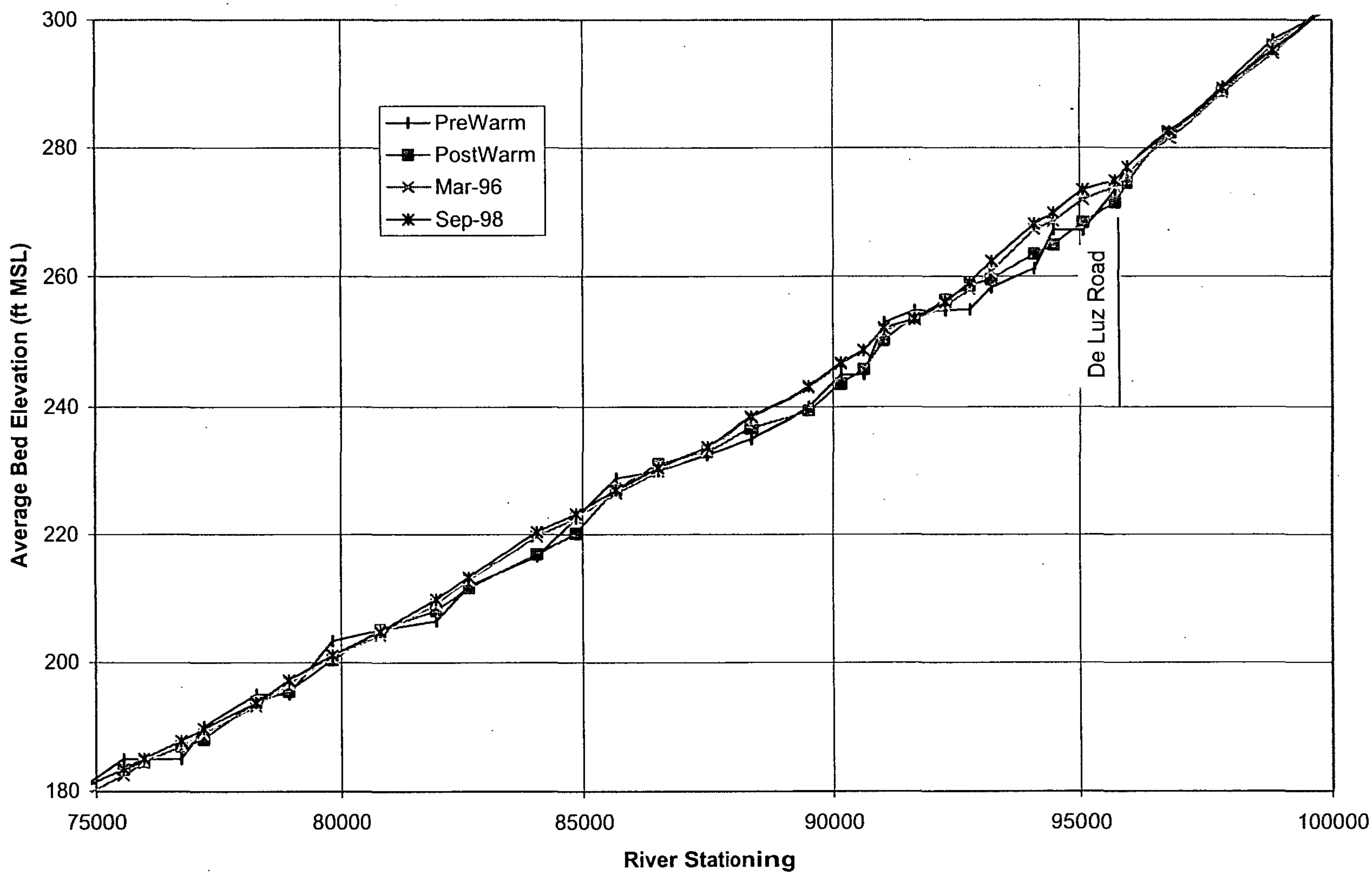


Figure 6-10 (d)
Calibration ABE Comparison



dredge abe.xls

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Figure 6-10 (e)
Calibration ABE Comparison

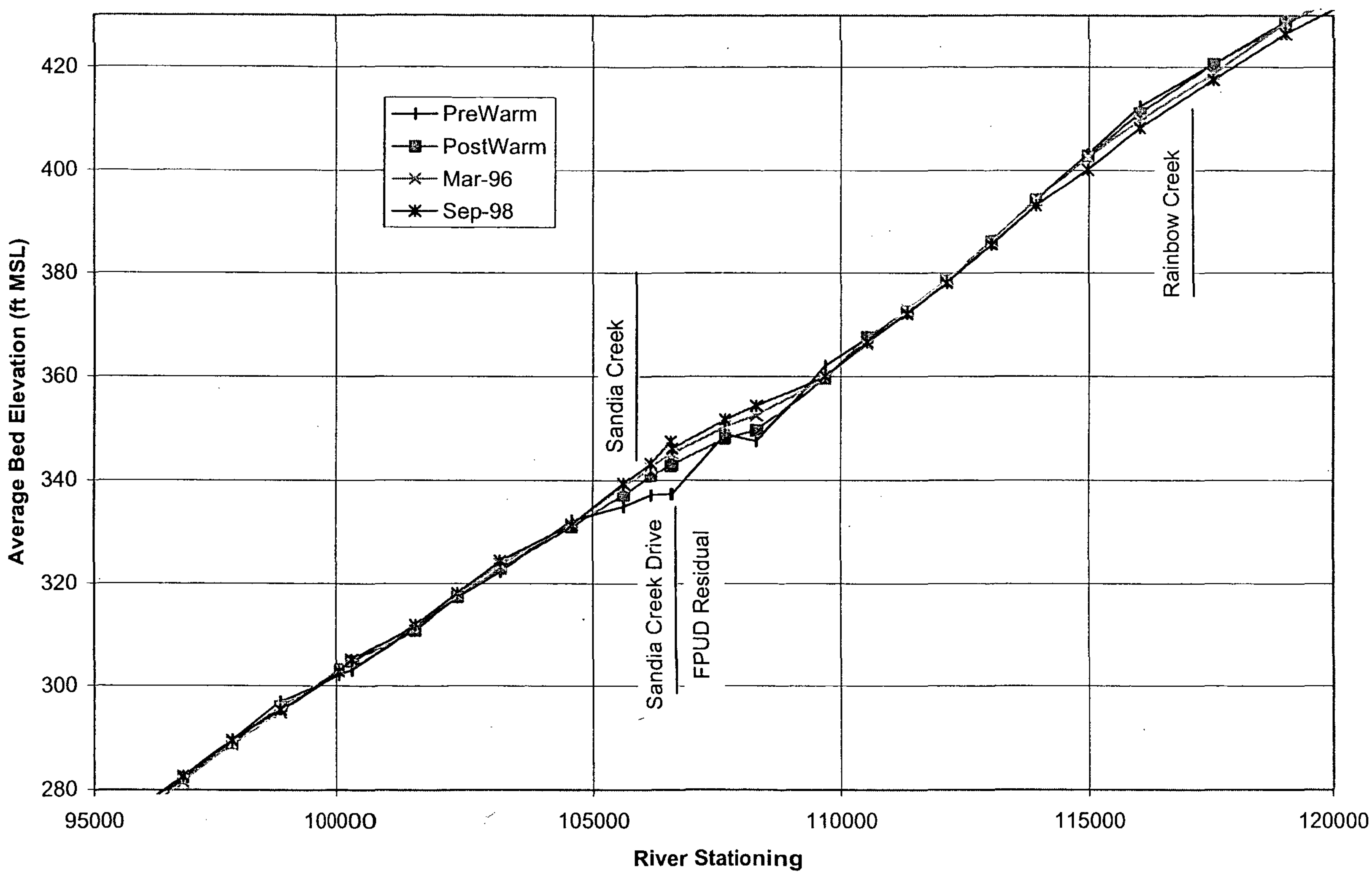


Figure 6-10 (f)
Calibration ABE Comparison

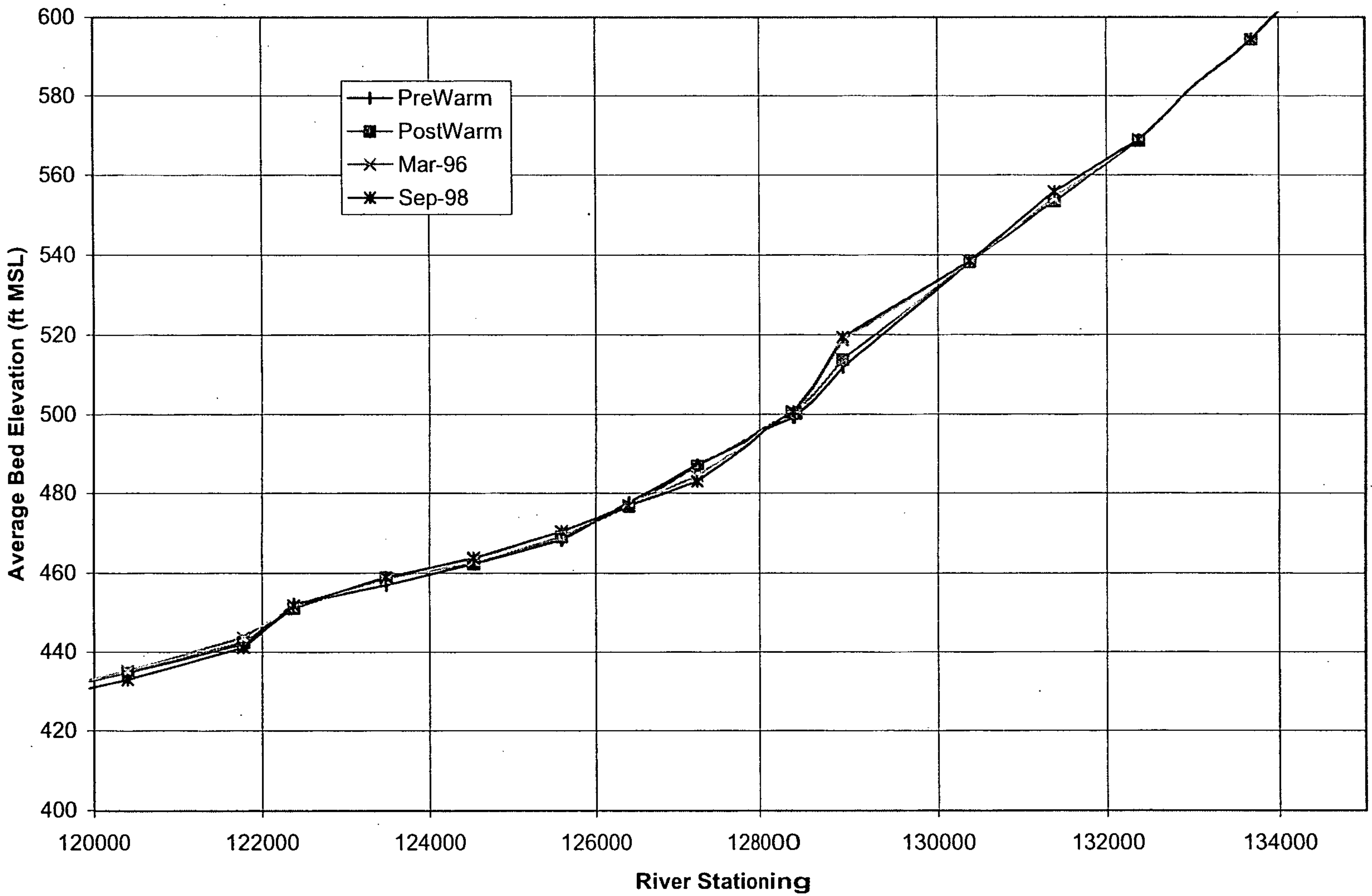


Figure 6-10 (g)
Calibration ABE Comparison

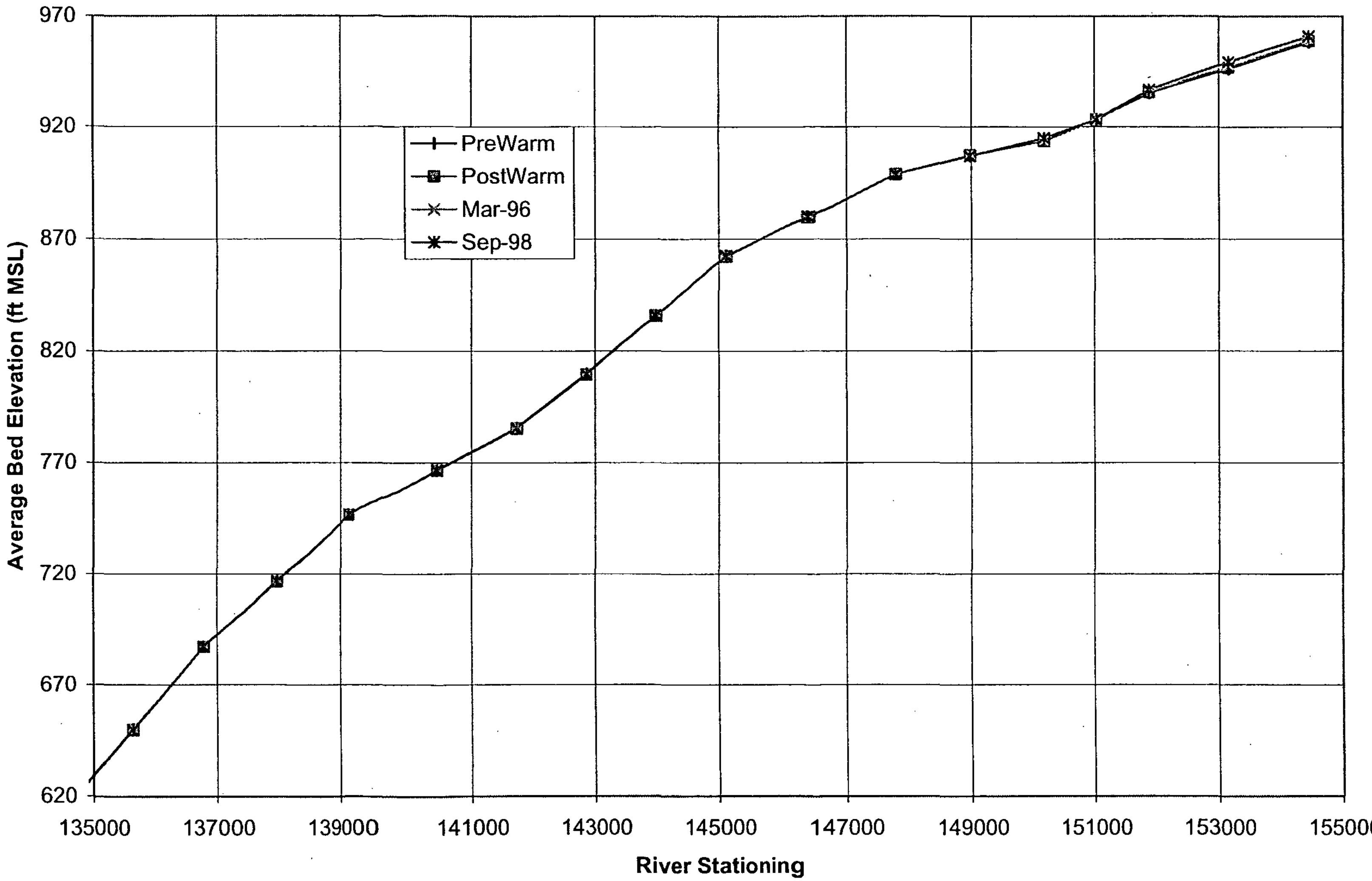


Figure 6-11
Calibration ABE Comparison, Dredge Area

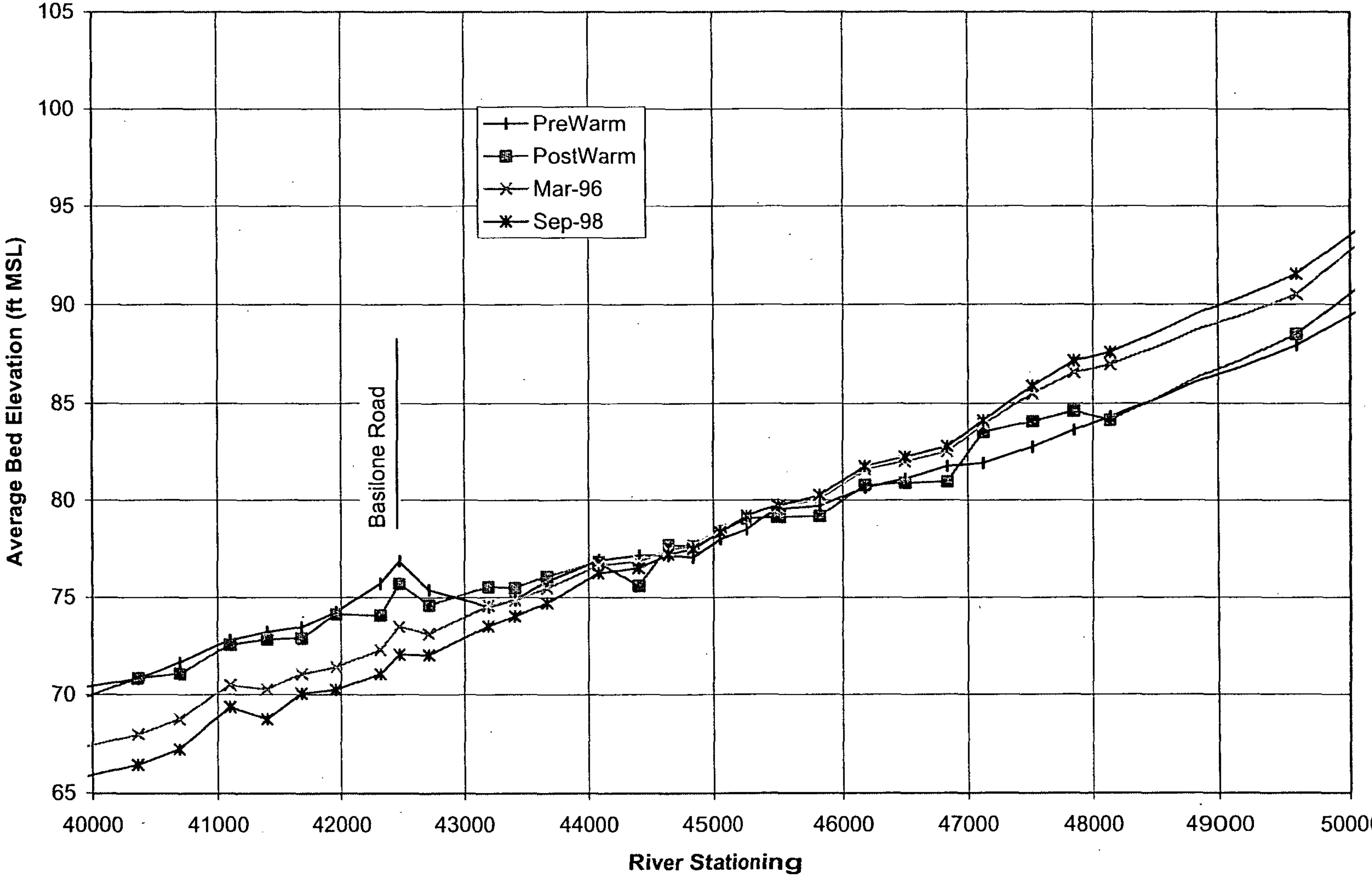


Figure 6-12 (a)
Change in Average Bed Elevations

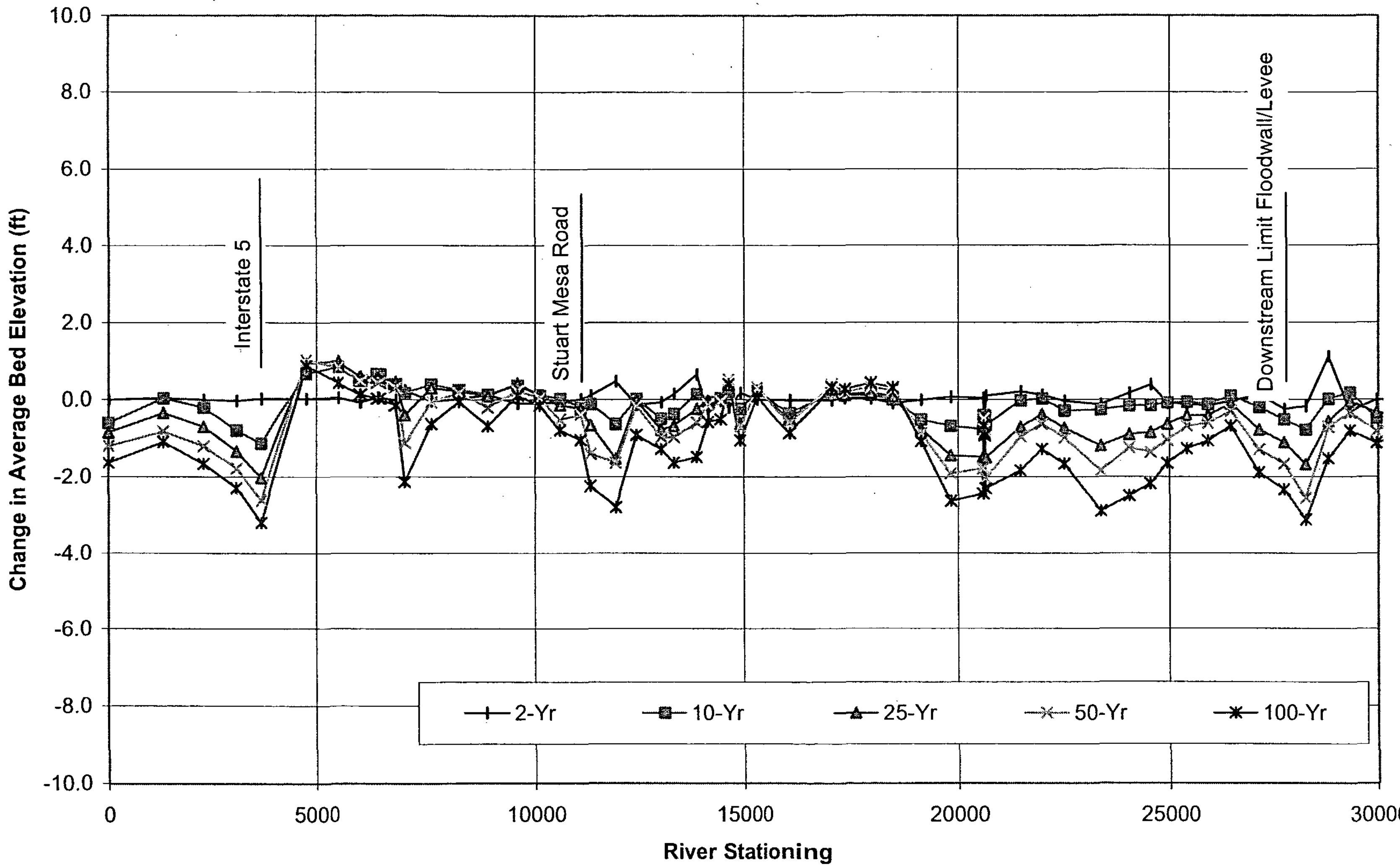


Figure 6-12 (b)
Change in Average Bed Elevations

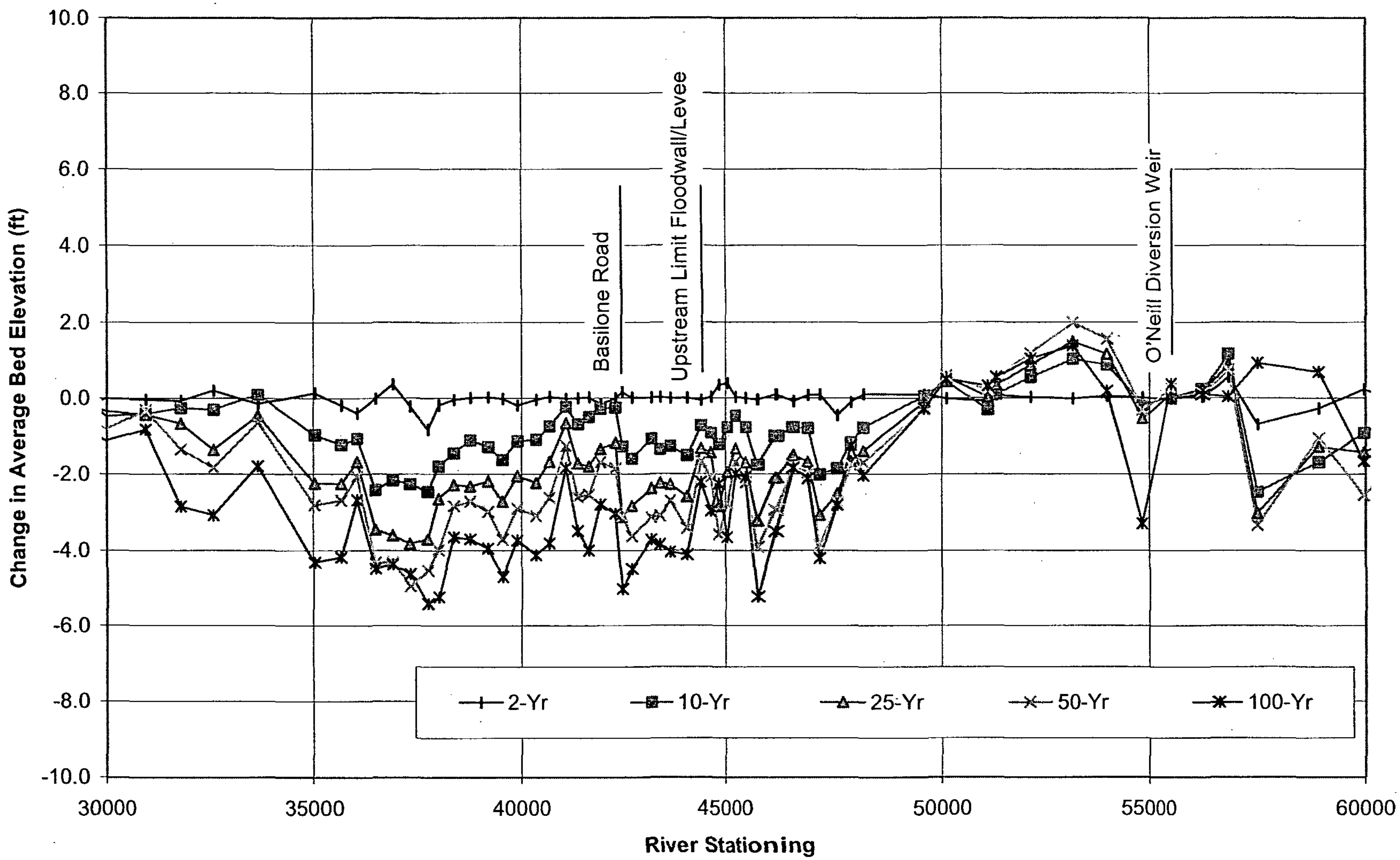
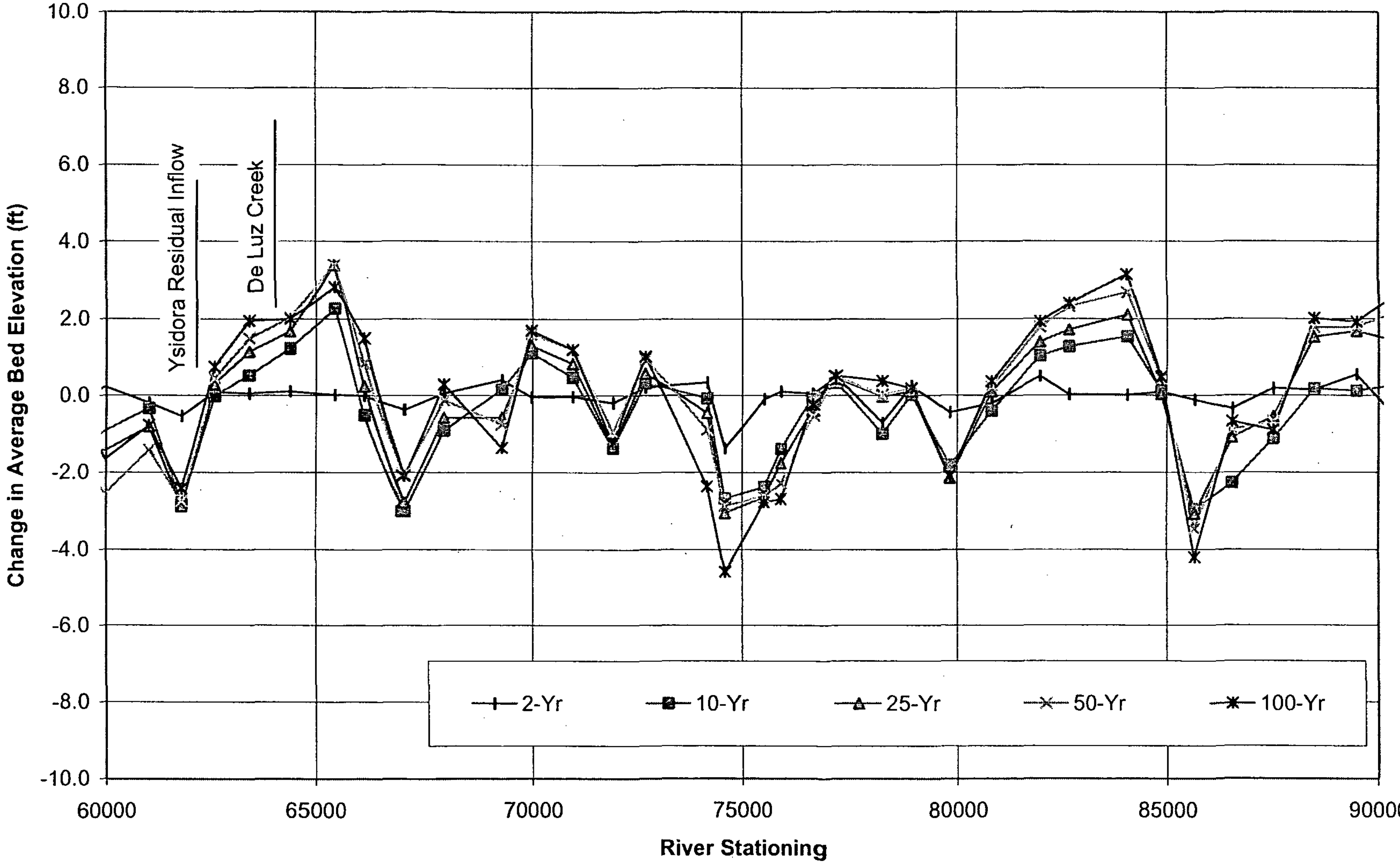


Figure 6-12 (c)
Change in Average Bed Elevations



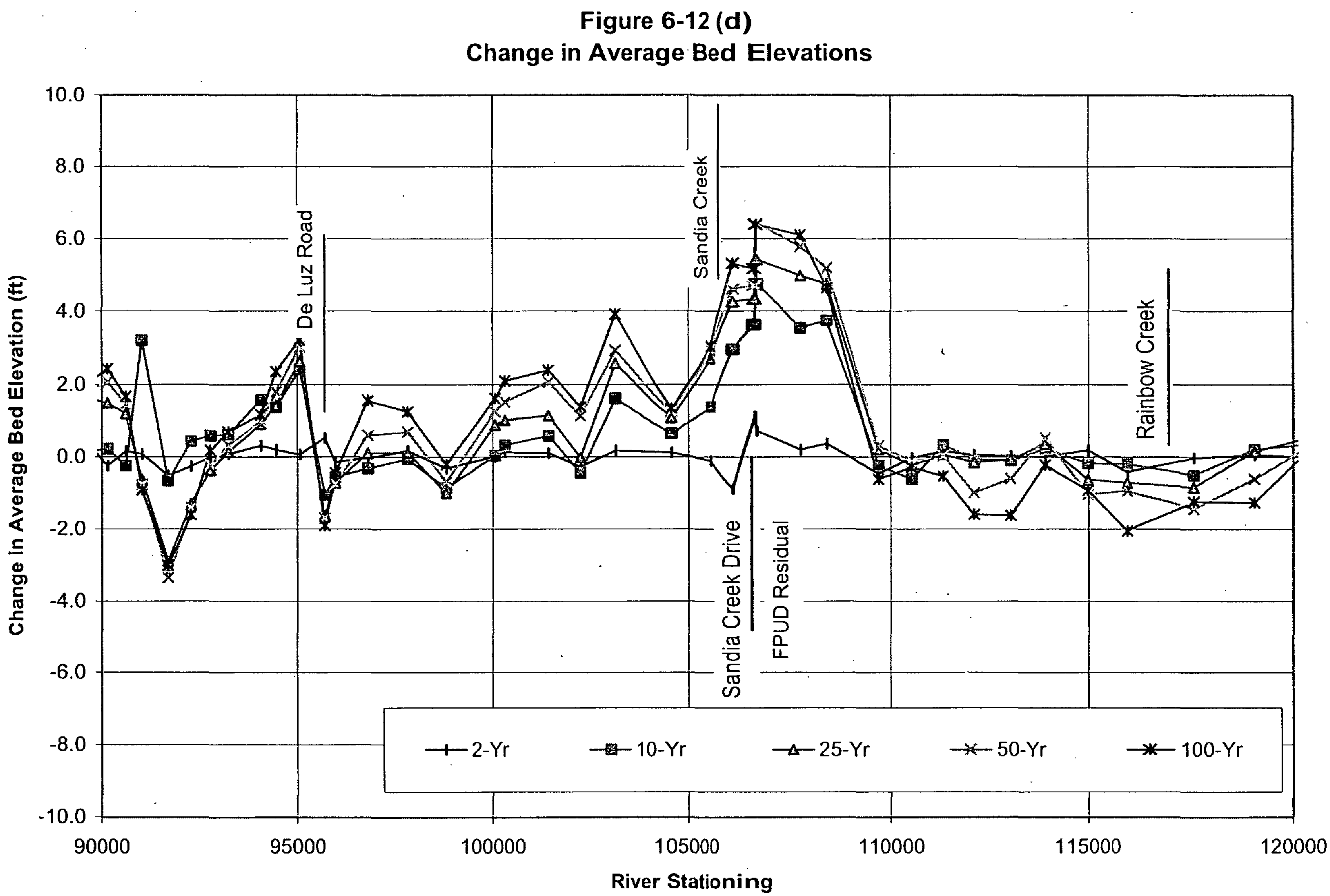


Figure 6-12 (d)
Change in Average Bed Elevations
Change in Average Bed Elevation (ft)
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
90000
95000
100000
105000
110000
115000
120000
River Stationing
De Luz Road
Sandia Creek
Sandia Creek Drive
FPUD Residual
Rainbow Creek
2-Yr
10-Yr
25-Yr
50-Yr
100-Yr

Figure 6-12 (e)
Change in Average Bed Elevations

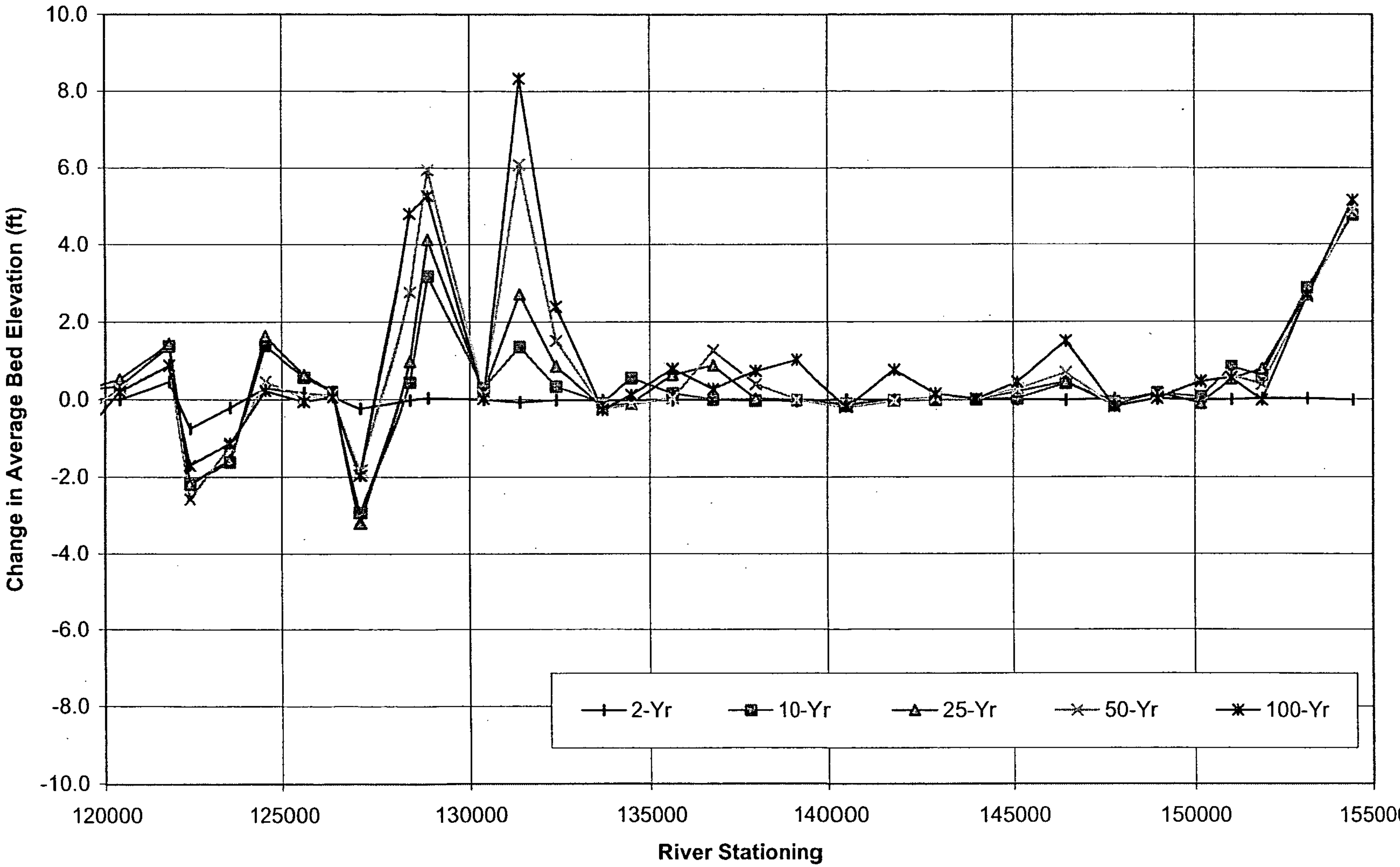
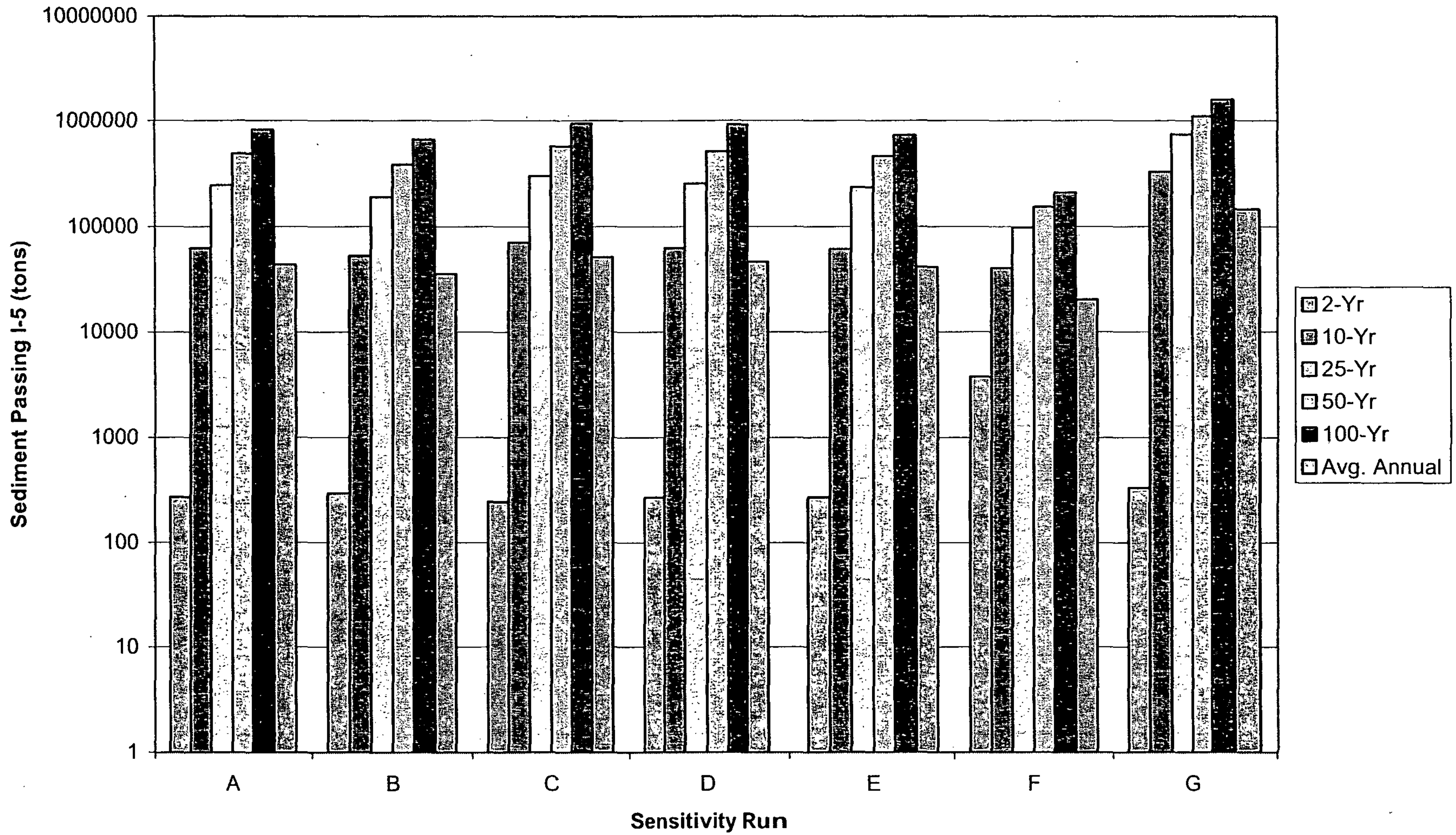


Figure 6-13
Sediment Delivery Downstream of Interstate Highway 5



7 Conclusions

The purpose of the present study was to develop a set of working hydrologic, hydraulic and sediment transport analytical tools to address water resource and sedimentation problems/issues on the Santa Margarita River Watershed for the Marine Corps Base, Camp Pendleton (the Base). This report documents the background data review and model development performed for the study.

Tasks performed for this study included:

11. Review of prior hydrologic, hydraulic and sediment studies for the Santa Margarita River watershed and preparation of an annotated bibliography.
12. Compilation of historical data on rainfall, streamflow and sedimentation, aerial photos, topography, GIS/CADD data and other pertinent information.
13. Field reconnaissance of the study area to observe existing channel hydraulics, watershed runoff and sediment transport characteristics.
14. Development of a detailed hydrologic model of the entire watershed and calibration to measured storm events.
15. Determination of peak discharge frequency and volume frequency relationships for key locations.
16. Development of a steady state hydraulic model for the lower basin and delineation of flood prone areas for different frequency events.
17. Estimation of average annual sediment yield for subareas of the entire watershed.
18. Construction of an uncalibrated base conditions sediment transport model of the lower river utilizing information from this and other studies.
19. Construction and calibration of a sediment transport model representing an historic post-dredging period.
20. Finalization of the base conditions model, sensitivity analysis of model results, and recommendation of data collection for improvements to the model.
21. Compilation of this report documenting the procedures, data used and results of the analyses.

Chapter 1 of this report introduced the purpose and scope of the study while Chapter 2 presented background information on the Santa Margarita River Watershed. An annotated bibliography, presented in Appendix A, summarizes findings from some of the more important references encountered during the background information search and literature review.

Chapter 3 (Hydrology) presented the development of the hydrologic model for the basin as well as the frequency analyses. The hydrologic model results were compared with observed values for three different historic storms and, overall, provided good estimates. It is therefore believed that the hydrologic model will be useful as a tool for prediction of flows over a wide range of storm events. The peak flow-frequency analyses provided estimates of peak flow for different recurrence intervals at three different locations along the Santa Margarita River. Using this information with the volume-frequency analyses for these locations, balanced hydrographs were developed which preserve the peak flow and volume for different recurrence intervals at these locations.

Chapter 4 presented the development of the hydraulic model. The model was constructed using the peak flows generated in the hydrologic analyses and channel geometry data from several sources. Roughness (Manning's "n") values were estimated based on professional judgement, field visits and standard engineering references. There is concern regarding the accuracy of the survey data that forms the basis for the cross section geometry. These concerns include deficiencies found by other investigators in data from earlier surveys, lack of detail in cross section geometry, and use of five-foot to twenty-foot contour data. Consideration should be given to new surveys in the study reach. In any case, floodplain inundation limits were developed for the 10-, 50-, and 100-year flows and are shown in Appendix E.

Chapter 5 presented the results of the sediment yield analysis. Using several different methods, average annual sediment yield was determined for the subbasins developed for the hydrologic model. A weighted averaging of the results from the different methods produced a unique yield for each subbasin. Based on the distribution of yields over the entire watershed, each subbasin was qualitatively classified as "High," "Normal," or "Low" in terms of sediment production. Although the methods use different input parameters for sediment yield estimates (land type, vegetation, etc.), we found that ground slope was a good general indicator of qualitative yield classification.

Chapter 6 presented a discussion of the sediment transport modeling efforts. A base conditions sediment transport model was produced based on the hydraulic model described in Chapter 4. Sediment inflows to the modeled area were calculated based on both the sediment yield analysis (Chapter 5) and equilibrium transport concepts. The latter estimates were used as input to a separate calibration model. Model parameters such as movable bed limits, time step, and inflowing sediment load were adjusted in the calibration model to qualitatively reproduce historic river response after channel dredging in 1993. The calibrated parameters were then used in the base conditions model. Balanced hydrographs developed in the hydrologic part of the study (Chapter 3) were used as model input. The model results provided estimates of aggradational (deposition) and degradational (erosion) areas and sand delivery to the estuary (downstream of the Interstate 5 bridge). Sensitivity of the model results to roughness values, sediment inflow amounts, and sediment transport function was also investigated. Recommendations were provided for future data collection to improve model results.

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Rancho Water

SAN DIEGO REGIONAL
WATER QUALITY
CONTROL BOARD

2001 APR 25 A 11: 06

April 24, 2001

Executive Officer
Regional Water Quality Control Board
San Diego Region
9771 Clairemont Mesa Boulevard, Suite A
San Diego, California 92124-1324

Dear Sir:

Enclosed is the requested information for the Annual Monitoring Report dated January-December 2000.

1. Summary and Analysis of Year 2000 Data Receiving Water Stations 1-4.

If you have any recommendations or questions, please call me at (909) 296-6900, Extension 6951.

Sincerely,

RANCHO CALIFORNIA WATER DISTRICT

ADAM L

Kenneth C. Dealy
Director of Operations and Maintenance

File: 01-0601.01
Technical. Part of January-Dec. 2000 AI

AL

Rancho California Water District
42135 Winchester Road • Post Office Box 9017 • Temecula, California 92589-9017 • (909) 296-6900 • FAX (909) 296-6860

SUMMARY AND ANALYSIS OF YEAR 2000 DATA
RECEIVING WATER STATIONS 1 - 4

STATION NO. 1

Station Location

Receiving Water Station No. 1 is located on Murrieta Creek immediately upstream from the Rancho California Water District (RCWD) Santa Rosa Water Reclamation Facility (SRWRF).

Summary and Analysis of 2000 Data

Monitoring and Reporting Program No. 96-54 requires RCWD to record visual observations at Station No. 1 and to collect samples when Murrieta Creek flow is observed. Monitoring is required on a quarterly basis during November through April, and on a monthly basis during March through December. In accordance with this schedule, visual observations were recorded on the following dates:

March 14, 2000
May 9, 2000
June 20, 2000
July 19, 2000
August 22, 2000
September 19, 2000
October 24, 2000
December 11, 2000

As reported to the Regional Board, no flow in Murrieta Creek was observed at Station No. 1 on any of the above dates. As a result, no water quality samples were collected at Station No. 1 during 2000.

Effect of RCWD Discharge

Receiving Water Station No. 1 is located upstream from the SRWRF recycled water stream discharge point, and is not affected by SRWRF operations.

Recommended Management Actions

No management actions are recommended.

STATION NO. 2

Station Location

Receiving Water Station No. 2 (Willow Glen) is located on the Santa Margarita River near Willow Glen Road. The station is located approximately six miles downstream from the confluence of Murrieta and Temecula Creeks.

Summary and Analysis of 2000 Data

Monitoring and Reporting Program No. 96-54 requires RCWD to record visual observations and collect samples at Station No. 2 on a quarterly basis during November through April, and on a monthly basis during March through December.

Visual Observations. Table 1 summarizes sample dates and visual observations during 2000 at Receiving Water Station No. 2. As shown in Table 1, no unusual visual or aesthetic conditions were observed at Station No. 2 during 2000. Water clarity was described as "clear" on all observation dates. No incidents of excessive biostimulation were recorded. Sandy and rock streambed conditions were observed year-round. Emergent vegetation was noted only in the March observation at the end of the storm flow season.

Table 1
Summary of 2000 Visual Observations[1]
Station No. 2 - Santa Margarita River at Willow Glen

2000 Sample Date	Observed Water Velocity (fps)	Observed Percent Algae Cover	Observed Percent Emergent Vegetation	Observed Water Clarity
Mar 14	0.25	0%	20%	"clear"
May 9	0.5	0%	0%	"clear"
Jun 20	0.25	0%	0%	"clear"
Jul 19	0.25	0%	0%	"clear"
Aug 22	0.25	0%	0%	"clear"
Sept 19	0.25	0%	0%	"clear"
Oct 17	0.25	0%	0%	"clear"
Dec 11	0.15	0%	0%	"visibility 100%"

1 From 2000 monitoring reports submitted to Regional Board.

Nutrients. Table 2 summarizes nutrient concentrations at Station No. 2 during 2000. Several conclusions are evident from the 2000 data:

- During the period May through October (which represents the period when the SRWRF discharge may most influence downstream conditions), total phosphorus concentrations at Station No. 2 are in compliance with the Basin Plan objective of 0.1 mg/l. The only total phosphorus sample which exceeded 0.1 mg/l was the March sample, which was 0.11 mg/l.
- Phosphorus appears to be the limiting nutrient at Station No. 2 on a year-round basis. Nitrogen to phosphorus (N:P) ratios exceeded 15:1 for all 2000 samples, and N:P ratios frequently exceed 30:1. Because phosphorus is the limiting nutrient, increased concentrations of nitrogen would appear to represent less a threat to biostimulation than increased concentrations of phosphorus.
- Nitrogen concentrations in the Santa Margarita River are almost exclusively comprised of organic nitrogen and nitrate.
- Concentrations of nitrogen and phosphorus are typically lower during summer months (May through October) than during months of probable storm flow (November through April). Since storm flows can be a number of orders of magnitude greater than the SRWRF discharge flow, river conditions during November through April are primarily dependent on hydrologic conditions. The SRWRF discharge would likely have the greatest potential for affecting concentrations during months of little or no storm flow (May through October). Based on the Table 2 data, however, the 2 mgd SRWRF discharge does not appear to have any discernible negative impacts on nutrient concentrations at Station No. 2.

Table 2
Summary of 2000 Nutrient Concentrations[1]
Station No. 2 - Santa Margarita River at Willow Glen

2000 Sample Date	Concentration in mg/l				N:P Ratio
	Total phosphorus	Total nitrogen	Organic Nitrogen (as N)	Nitrate Nitrogen (as N)	
Mar 14	0.11	4.4	0.5	3.9	40
May 10	< 0.05	1.4	0.6	0.8	> 28
Jun 20	< 0.05	1.7	0.7	1.0	> 34
Jul 19	0.06	1.0	0.5	0.5	17
Aug 22	< 0.05	0.9	0.6	0.3	> 18
Sept 19	< 0.05	1.1	0.5	0.5	> 22
Oct 17	< 0.05	1.7	0.4	1.3	> 34
Dec 11	0.06	2.8	1.1	1.7	47

1 From 2000 monitoring reports submitted to Regional Board.

Dissolved Oxygen. Monitoring and Reporting Program No. 96-54 requires the collection of 24-hour profiles of receiving water dissolved oxygen. Table 3 summarizes minimum observed dissolved oxygen (DO) concentrations observed at Station No. 2 during the year 2000 sampling periods. As shown in the table, minimum hourly average observed DO concentrations remained near saturation at all times. Minimum DO concentrations were typically observed in early morning.

Because of the low concentrations of BOD in the SRWRF effluent (typically less than 5 mg/l) and high observed receiving water DO concentrations, the RCWD discharge does not appear to discernibly affect receiving water DO at Station No. 2.

Bacteriological Parameters. Table 3 also summarizes year 2000 data at Station No. 2 for bacteriological parameters. Detectable concentrations of fecal streptococci, total coliform, and fecal coliform were reported at Station No. 2 throughout 2000. SRWRF is not the source of the bacteriological contamination, however. At all times during 2000, SRWRF 7-day median total and fecal coliform concentrations remained below 2 organisms per 100.

Table 3
Summary of 2000 TDS, DO, and Bacteriological Concentrations[1]
Station No. 2 - Santa Margarita River at Willow Glen

2000 Sample Date	TDS Concentration (mg/l)	Minimum Average Hourly DO Concentration (mg/l)	Time of Day for Minimum Hourly DO	Fecal Streptococci (organisms per 100 ml)	Total Coliform (organisms per 100 ml)	Fecal Coliform (organisms per 100 ml)
Mar 14	960	8.75	2 a.m.	130	300	13
May 10	780	7.16	6 a.m.	300	300	50
Jun 20	730	7.23	5 a.m.	300	800	8
Jul 19	660	8.28	1 a.m.	1700	3000	11
Aug 22	670	8.75	2 a.m.	1300	230	< 2
Sept 19	640	8.43	6 a.m.	230	240	4
Oct 17	740	10.1	7 a.m.	50	500	13
Dec 11	920	9.28	8 a.m.	80	170	2

1 From 2000 monitoring reports submitted to Regional Board.

TDS. Table 3 also summarizes year 2000 TDS concentrations at Station No. 2. As shown in Table 3, TDS concentrations were lowest during the May through October period (when the SRWRF discharge would be expected to have the highest potential for affecting downstream waters). It is concluded that the SRWRF discharge does not discernibly and adversely affect receiving water TDS concentrations at Station No. 2.

Effect of SRWRF Discharge

As documented above, the SRWRF discharge does not appear to have any observable negative effect on the receiving waters at Station No. 2.

Recommended Management Actions

No additional management actions are recommended.

STATION NO. 3

Station Location

Station No. 3 is located on the Santa Margarita River near De Luz Road. The station is located approximately 10 miles downstream from the confluence of Murrieta and Temecula Creeks.

Summary and Analysis of 2000 Data

Monitoring and Reporting Program No. 96-54 requires RCWD to record visual observations and collect samples at Station No. 3 on a quarterly basis during November through April, and on a monthly basis during March through December.

Visual Observations. Hydraulic conditions at Station No. 3 are, in part, influenced by a Camp Pendleton diversion dam that exists at the site. Table 4 summarizes observation dates and visual observations at Station No. 3 during 2000. Visual observations at Station No. 3 did not indicate any unusual visual or aesthetic conditions. Water clarity was described as "clear" during all 2000 observation dates. No incidents of excessive biostimulation were recorded. Algae was observed only during May at the end of the storm flow season; algae cover was estimated at 5% during this May observation.

Table 4
Summary of 2000 Visual Observations[1]
Station No. 3 - Santa Margarita River at De Luz

2000 Sample Date	Observed Water Velocity (fps)	Observed Percent Algae Cover	Observed Percent Emergent Vegetation	Observed Water Clarity
Mar 14	1.5	0%	0%	"clear"
May 9	1.0	5%	0%	"clear"
Jun 20	2.0	0%	0%	"clear"
Jul 19	2.0	0%	0%	"clear"
Aug 22	0	(no flow)	0%	(no flow)
Sept 19	0	(no flow)	0%	(no flow)
Oct 17	1.0	0%	0%	"clear"
Dec 11	1.0	0%	0%	"visibility 100%"

1 From 2000 monitoring reports submitted to Regional Board.

Nutrients. Table 5 summarizes nutrient concentrations at Station No. 3 during 2000. As shown in Table 5, total phosphorus concentrations at Station No. 3 are in compliance with the Basin Plan objective of 0.1 mg/l during May through October. The only total phosphorus sample which exceeded 0.1 mg/l was the March sample, which was 0.13 mg/l. Other conclusions evident from the Station No. 3 nutrient data include:

- In general, phosphorus appears to be the limiting nutrient. N:P rations exceeded 20:1 during the March and May samples, and phosphorus concentrations were below detection limits for the all samples in the latter half of 2000. A N:P ration of 9:1, however, was observed during June 2000, suggesting (given the accuracy of the tests) that either nitrogen or phosphorus could be limiting during the June sample.
- Nitrogen concentrations in the river are almost exclusively comprised of organic nitrogen and nitrate.
- Concentrations of nitrogen and phosphorus are typically lower during summer months (May through October) than during months of probable storm flow (November through April).

Overall, based on the Table 5 data (and data presented for Station No. 2 in Table 2), the 2 mgd SRWRF discharge does not appear to have any discernible negative impacts on nutrient concentrations at Station No. 3.

Table 5
Summary of 2000 Nutrient Concentrations[1]
Station No. 3 - Santa Margarita River at De Luz

2000 Sample Date	Concentration in mg/l				N:P Ratio
	Total phosphorus	Total nitrogen	Organic nitrogen (as N)	Nitrate nitrogen (as N)	
Mar 14	0.13	3.6	0.6	3.0	28
May 10	0.05	1.5	0.4	1.1	30
Jun 20	0.08	< 0.7	0.5	< 0.2	< 9
Jul 19	< 0.05	0.4	0.4	< 0.2	> 8
Aug 22	(no flow)	(no flow)	(no flow)	(no flow)	(no flow)
Sept 19	(no flow)	(no flow)	(no flow)	(no flow)	(no flow)
Oct 17	< 0.05	0.3	0.2	< 0.2	> 6
Dec 11	< 0.05	0.7	0.3	0.4	> 14

1 From 2000 monitoring reports submitted to Regional Board.

Dissolved Oxygen. Monitoring and Reporting Program No. 96-54 requires the collection of 24-hour profiles of receiving water dissolved oxygen. Table 6 summarizes minimum observed dissolved oxygen (DO) concentrations observed at Station No. 3 during the year 2000 sampling periods. As shown in the table, except during the early morning hours of the June sample, minimum observed DO concentrations remained near saturation at all times. During the June 20 sampling period, DO concentrations decreased from approximately 15 mg/l during midnight to near 3 mg/l during the hours at dawn.

Because of the low concentrations of BOD in the SRWRF effluent (typically less than 5 mg/l), the high concentrations of DO at the upstream Station No. 2, and the typically high observed receiving water DO concentrations at Station No. 3, the RCWD discharge does not appear to discernibly affect receiving water DO at Station No. 3.

Bacteriological Parameters. Table 6 also summarizes year 2000 data at Station No. 3 for bacteriological parameters. As shown in Table 6, detectable concentrations of fecal streptococci, total coliform, and fecal coliform were reported at Station No. 3 throughout 2000. Again, however, SRWRF is not the source of the bacteriological contamination. At all times during 2000, SRWRF 7-day median coliform concentrations remained below 2 organisms per 100 for both fecal coliform and total coliform.

Table 6
Summary of 2000 TDS, DO, and Bacteriological Concentrations[1]
Station No. 3 - Santa Margarita River at De Luz

2000 Sample Date	TDS Concentration (mg/l)	Minimum Average Hourly DO Concentration (mg/l)	Time of Day for Minimum Hourly DO	Fecal Streptococci (organisms per 100 ml)	Total Coliform (organisms per 100 ml)	Fecal Coliform (organisms per 100 ml)
Mar 14	780	9.66	5 p.m.	300	9000	50
May 10	870	9.50	12 p.m.	130	800	50
Jun 20	860	3.30	7 a.m.	230	2200	17
Jul 19	840	7.50	2 p.m.	230	2400	500
Aug 22	(no flow)	(no flow)	(no flow)	(no flow)	(no flow)	(no flow)
Sept 19	(no flow)	(no flow)	(no flow)	(no flow)	(no flow)	(no flow)
Oct 17	850	5.38	1 a.m.	230	3000	170
Dec 11	890	9.44	12 a.m.	50	500	7

1 From 2000 monitoring reports submitted to Regional Board.

TDS. Table 6 also summarizes year 2000 TDS concentrations at Station No. 3. As shown in Table 6, TDS concentrations were relatively consistent throughout the year at Station No. 3. As noted in the discussion regarding Station No. 2 (see Table 3), it does not appear that the SRWRF discharge discernibly and adversely affect receiving water TDS concentrations at either Station Nos. 2 or 3.

Effect of SRWRF Discharge

As documented above, the SRWRF discharge does not appear to have any observable negative effect on the receiving waters at Station No. 3.

Recommended Management Actions

No additional management actions are recommended.

STATION NO. 4

Station Location

Station No. 4 is located at the Santa Margarita River Estuary. The station is downstream from Camp Pendleton's wastewater treatment plant discharges of secondary effluent.

Summary and Analysis of 2000 Data

Monitoring and Reporting Program No. 96-54 requires RCWD to record visual observations and collect samples at Station No. 4 on a quarterly basis during November through April, and on a monthly basis during March through December.

Visual Observations. Station No. 4 is under tidal influence. Table 7 compares visual observations with receiving water TDS for 2000. As shown in the table, visual observations at Station No. 4 during 2000 indicate that water clarity was generally good during the first half of 2000, regardless of whether the estuary waster was saline, brackish, or fresh water. Poor water clarity during the latter half of 2000 may have been caused by a spill of Camp Pendleton raw sewage.

Table 7
Summary of 2000 TDS, DO, and Bacteriological Concentrations[1]
Station No. 4 - Santa Margarita River Estuary

2000 Sample Date	TDS Concentration (mg/l)	Observed Water Velocity (fps)	Observed Percent Algae Cover	Observed Percent Emergent Vegetation	Observed Water Clarity
Mar 14	780	1.0	0%	0%	"clear"
May 10	1,290	1.0	0%	0%	"clear"
Jun 20	20,800	0	0%	0%	"clear"
Jul 19	17,400	0	0%	0%	"clear"
Aug 22	6,340	0	0%	0%	"clear"
Sept 19	No samples[2]	0	0%	0%	"not clear"
Oct 17	12,600	0	0%	0%	"not clear"
Dec 11	9,700	0	0%	0%	"12-inch visibility"

1 From 2000 monitoring reports submitted to Regional Board.
2 No samples collected due to 2.7 million gallon raw sewage spill at Camp Pendleton.

Nutrients. As noted, Station No. 4 is located downstream from Camp Pendleton discharges of secondary treated wastewater. Table 8 summarizes nutrient concentrations at Station No. 4 during 2000. As shown by comparing Table 8 with Table 2 (Station No. 2) and Table 5 (Station No. 3), receiving water nutrient quality at Station No. 4 appears to be influenced by the Camp Pendleton secondary effluent discharges. Total phosphorus concentrations at Station No. 4 varied significantly. Summer concentrations of total phosphorus were typically 1 mg/l, and concentrations in excess of 2 mg/l occurred after a August 2000 spill of raw sewage at Camp Pendleton.

Nitrogen to phosphorus (N:P) ratios were typically less than 10, suggesting nitrogen as the limiting nutrient. N:P ratios at Station No. 4, however, may be highly influenced by the Camp Pendleton secondary effluent discharges; natural N:P ratios in the estuary are unknown.

Table 8
Summary of 2000 Nutrient Concentrations[1]
Station No. 4 - Santa Margarita River Estuary

2000 Sample Date	Concentration in mg/l				N:P Ratio
	Total phosphorus	Total nitrogen	Organic nitrogen (as N)	Nitrate nitrogen (as N)	
Mar 14	0.23	1.4	0.6	0.8	6
May 10	0.32	1.3	1.3	< 0.2	4
Jun 20	1.0	8.7	1.2	7.5	9
Jul 19	1.1	5.9	1.9	4.0	5
Aug 22	1.1	1.1	1.1	< 0.2	1
Sept 19	No samples[2]	No samples[2]	No samples[2]	No samples[2]	No samples[2]
Oct 17	2.1	7.4	1.9	5.5	4
Dec 11	2.2	8.7	1.6	6.0	4

1 From 2000 monitoring reports submitted to Regional Board.
2 No samples collected due to 2.7 million gallon raw sewage spill at Camp Pendleton.

Dissolved Oxygen. Table 9 summarizes minimum observed dissolved oxygen (DO) concentrations observed at Station No. 4 during the year 2000 sampling periods. As shown in the table, minimum hourly DO concentrations varied during the year. Observed DO concentrations at Station No. 4 may be influenced by the Camp Pendleton secondary effluent discharges and by tides.

Bacteriological Parameters. Table 9 also summarizes year 2000 data at Station No. 4 for bacteriological parameters. As discussed above, however, the SRWRF is not believed to influence concentrations of bacteriological parameters anywhere along the Santa Margarita River.

Table 9
Summary of 2000 TDS, DO, and Bacteriological Concentrations[1]
Station No. 4 - Santa Margarita River Estuary

2000 Sample Date	TDS Concentration (mg/l)	Minimum Average Hourly DO Concentration (mg/l)	Time of Day for Minimum Hourly DO	Fecal Streptococci (organisms per 100 ml)	Total Coliform (organisms per 100 ml)	Fecal Coliform (organisms per 100 ml)
Mar 14	780	7.93	11 p.m.	230	9000	30
May 10	1,290	5.80	6 a.m.	80	5000	30
Jun 20	20,800	3.30	7 a.m.	230	80	23
Jul 19	17,400	10.8	8 a.m.	300	3000	70
Aug 22	6,340	8.47	9 a.m.	50	130	2
Sept 19	No samples[2]	No samples[2]	No samples[2]	No samples[2]	No samples[2]	No samples[2]
Oct 17	12,600	4.43	7 a.m.	50	300	30
Dec 11	9,700	5.61	7 a.m.	220	300	130

1 From 2000 monitoring reports submitted to Regional Board.
2 No samples collected due to 2.7 million gallon raw sewage spill at Camp Pendleton.

TDS. As shown in Table 9, significant variability in TDS occurs at Station No. 4. TDS concentrations at Station No. 4 are most influenced by storm flows and tides.

Effect of SRWRF Discharge

As documented above, the SRWRF discharge does not appear to have any observable negative effect on the receiving waters at Station No. 4.

Recommended Management Actions

No additional management actions (relative to the SRWRF discharge) are recommended.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: GROUND WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Depth to Groundwater (ft)
101	Well MW-1 on Santa Margarita River at De Luz Road	None	01	1/5/98	101001	12.11
			02	3/6/98	101002	9.33
			03	5/27/98	101003	11.02
			04	8/5/98	101004	11.58
			05	11/10/98	101005	11.30
			06	2/12/99	101006	11.50
			07	5/12/99	101007	11.98
			08	9/30/99	101008	12.12
			09	12/7/99	101009	11.83
			10	3/14/00	101010	12.39
			11	6/2/00	101011	12.30

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: GROUND WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Depth to Groundwater (ft)
102	Well MW-2 on De Luz Creek	None	01	1/5/98	102001	19.04
			02	3/12/98	102002	7.20
			03	5/27/98	102003	7.42
			04	8/5/98	102004	7.60
			04	8/10/98	102004	7.64
			05	11/10/98	102005	7.75
			06	2/12/99	102006	7.58
			07	5/12/99	102007	7.64
			08	9/30/99	102008	25.72
			09	12/7/99	102009	31.21
			10	3/14/00	102010	7.92
			11	6/2/00	102011	8.97

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: GROUND WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Depth to Groundwater (ft)
103	Well MW-3 on Cristianitos Creek	None	01	1/5/98	103001	12.16
			02	3/6/98	103002	7.98
			03	5/27/98	103003	8.00
			04	8/5/98	103004	10.02
			05	11/10/98	103005	11.14
			06	2/12/99	103006	11.64
			07	5/12/99	103007	11.95
			08	9/29/99	103008	12.04
			09	12/7/99	103009	12.01
			10	3/14/00	103010	11.64
			11	6/2/00	103011	12.23

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: SURFACE WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Daily Mean Flow (cfs)
501	Santa Margarita River near Fallbrook	11044300	01	12/9/97	501001	27
			02	3/3/98	501002	105
			03	5/26/98	501003	34
			04	8/4/98	501004	6
			05	11/9/98	501005	31
			06	2/10/99	501006	16
			07	5/11/99	501007	5.5
			08	9/28/99	501008	7
			09	12/6/99	501009	2.2
			10	3/7/00	501010	3.1
			11	6/1/00	501011	5.5

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: SURFACE WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Daily Mean Flow (cfs)
502	Sandia Creek near Fallbrook	11044350	01	12/9/97	502001	6
			02	3/3/98	502002	47
			03	5/26/98	502003	14
			04	8/4/98	502004	3
			05	11/9/98	502005	6
			06	2/10/99	502006	6
			07	5/11/99	502007	2.3
			08	9/28/99	502008	2
			09	12/6/99	502009	1.3
			10	3/7/00	502010	2.9
			11	6/1/00	502011	3.5

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: SURFACE WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Daily Mean Flow (cfs)
503	Rainbow Creek near Fallbrook	11044250	01	12/9/97	503001	2
			02	3/3/98	503002	14
			03	5/26/98	503003	5
			04	8/4/98	503004	0
			05	11/9/98	503005	2
			06	2/10/99	503006	2
			07	5/11/99	503007	0.4
			08	9/28/99	503008	0.14
			09	12/6/99	503009	0.2
			10	3/7/00	503010	0.42
			11	6/1/00	503011	0.27

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: SURFACE WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Daily Mean Flow (cfs)
504	Santa Margarita River near Temecula	11044000	01	12/9/97	504001	6
			02	3/3/98	504002	58
			03	5/26/98	504003	11
			04	8/4/98	504004	4
			05	11/9/98	504005	5
			06	2/10/99	504006	12
			07	5/11/99	504007	2.8
			08	9/28/99	504008	3.2
			09	12/6/99	504009	0.28
			10	3/7/00	504010	8.9
			11	6/1/00	504011	3.5

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: SURFACE WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Daily Mean Flow (cfs)
505	Murrieta Creek at Temecula	11043000	01	12/9/97	505001	2
			02	3/3/98	505002	60
			03	5/26/98	505003	2
			04	8/4/98	505004	2
			05	11/9/98	505005	2
			06	2/10/99	505006	5
			07	5/11/99	505007	3.2
			08	9/28/99	505008	2.3
			09	12/6/99	505009	0.02
			10	3/7/00	505010	0.43
			11	6/1/00	505011	3.8

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: SURFACE WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Daily Mean Flow (cfs)
506	De Luz Creek near Fallbrook	11044800	01	12/9/97	506001	4
			02	3/3/98	506002	60
			03	5/26/98	506003	16
			04	8/4/98	506004	3
			05	11/9/98	506005	1
			06	2/10/99	506006	4
			07	5/11/99	506007	1.7
			08	9/28/99	506008	NA
			09	12/6/99	506009	NA
			10	3/7/00	506010	21
			11	6/1/00	506011	0.3

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: SURFACE WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Daily Mean Flow (cfs)
507	Fallbrook Creek near Fallbrook	11045300	01	12/9/97	507001	2
			02	3/3/98	507002	6
			03	5/26/98	507003	3
			04	8/4/98	507004	1
			05	11/9/98	507005	6
			06	2/10/99	507006	2
			07	5/11/99	507007	0.41
			08	9/28/99	507008	0.05
			09	12/6/99	507009	0.04
			10	3/7/00	507010	0.52
			11	6/1/00	507011	0.15

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: SURFACE WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Daily Mean Flow (cfs)
508	Santa Margarita River at Ysidora	11046000	01	12/9/97	508001	75
			02	3/3/98	508002	59
			03	5/26/98	508003	100
			04	8/4/98	508004	5
			05	11/9/98	508005	16
			06	2/10/99	508006	28
			07	5/11/99	508007	2.5
			08	9/28/99	508008	NA
			09	12/6/99	508009	NA
			10	3/13/00	508010	26
			11	6/1/00	508011	0

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: SURFACE WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Daily Mean Flow (cfs)
509	Cristianitos Creek near San Clemente	11046360	01	12/9/97	509001	NA
			02	3/3/98	509002	NA
			03	5/26/98	509003	NA
			04	8/4/98	509004	NA
			05	11/9/98	509005	NA
			06	2/19/99	509006	NA
			07	5/11/99	509007	0
			08	9/28/99	509008	NA
			09	12/6/99	509009	NA
			10	3/13/00	509010	0
			11	6/1/00	509011	0

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: SURFACE WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Daily Mean Flow (cfs)
510	San Mateo Creek at San Clemente	11046300	01	12/9/97	510001	8
			02	3/3/98	510002	167
			03	6/4/98	510003	28
			04	8/4/98	510004	3
			05	11/19/98	510005	3
			06	2/19/99	510006	5
			07	5/11/99	510007	2.1
			08	9/28/99	510008	NA
			09	12/7/99	510009	0.1
			10	3/22/00	510010	70
			11	6/1/00	510011	NA
			11	6/6/00	510011	0

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

SAMPLE IDENTIFICATION NUMBER CROSS-REFERENCE: SURFACE WATER

Location Number	Source	USGS Station	Round	Sample Date	Sample ID**	Daily Mean Flow (cfs)
511	San Mateo Creek at San Onofre	None	01	12/9/97	511001	NA
			02	3/3/98	511002	NA
			03	5/26/98	511003	NA
			04	8/4/98	511004	NA
			05	11/9/98	511005	NA
			06	2/10/99	511006	NA
			07	5/11/99	511007	NA
			08	9/29/99	511008	NA
			09	12/6/99	511009	NA
			10	3/13/00	511010	NA
			11	6/1/00	511011	NA

Notes:

** = Each six-digit sample identification number indicates the type of sample, sampling location, and sampling event.

Samples from monitoring wells have 1 as the initial digit. The next two digits indicate the monitoring well number (e.g., 01, 02, or 03). The final three digits correspond to the sequential number of the sampling event (e.g., 001, 002, etc.).

Samples from surface water sampling locations have 5 as the initial digit. The next two digits indicate the surface water sampling location. The final three digits correspond to the sequential number of the sampling event.

NA = Not Available.

From: Keri Cole
To: garyg@water.ca.gov
Date: 5/4/01 1:36PM
Subject: Monitoring Data

Hi Gary
Linda Pardy, in our office, recently forwarded me some monitoring data for the Santa Margarita River, San Diego River and Escondido Creek (see attached file). I have been unsuccessful in determining the dates of the sampling. Can you help me out? I am also interested in finding out exactly where the sampling stations are. Can you provide this to me? Do you have a map of the sampling locations? What is the frequency of this data? What purposes is it used for on your end?

The reason I am asking all of this is because we are currently soliciting for additional information and data that may support updates to our 303d list of impaired waterbodies in the region (see attached correspondence). I would be interested in looking at this monitoring data from July 1997 if it is available?

Thanks in advance for your assistance.

Keri Cole, P.E.
Water Resource Control Engineer
San Diego RWQCB
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>>> "Gary Gilbreath" <garyg@water.ca.gov> 05/04/01 09:16AM >>>
most recent and historical swq

Gary Gilbreath
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From: "Gary Gilbreath" <garyg@water.ca.gov>
To: <pardl@rb9.swrcb.ca.gov>
Date: 5/4/01 9:23AM

most recent and historical swq

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combined data

Lab_Smp_No	STA_NUM	StationName	FLIMS_Sample_No	TYPE_W	COUNTY	TIME	SAMP_C	*FLD Cloud Cover	FLD_EC (µS/cm)	DISS_O (mg/L)
	V9209500	MOJAVE R BL FORKS	LRA0400B0444	S	36	1030	5050	0	249	8.8
	V9209500	MOJAVE R BL FORKS	LRA1100B4998	S	36	1015	5050	25	376	9.3
	X2135000	S M R NR FLBRK	LRA0500B0483	S	37	1015	5050	100	1405	8.6
	X2135000	S M R NR FLBRK	LRA0599A0147	S	37	0900	5050	100	1238	8.2
LR5986	X2135000	S M R NR FLBRK	LRA0598A0941	S	37	0845	5050	90	648	8.4
2543	X2135000	S M R NR FLBRK	LRA1198A2543	S	37	1000	5050	0	1350	7.1
	X2135000	S M R NR FLBRK	LRA1100B5076	S	37	1030	5050	0	1410	10.5
	X4340005	ESCNDO nr H GRV	LRA0500B0484	S	37	1145	5050	20	1790	7.8
	X4340005	ESCNDO nr H GRV	LRA0599A0148	S	37	1045	5050	0	1787	7.4
LR5987	X4340005	ESCNDO nr H GRV	LRA0598A0942	S	37	1030	5050	80	1225	8.7
2544	X4340005	ESCNDO nr H GRV	LRA1198A2544	S	37	1120	5050	0	1850	8.7
	X4340005	ESCNDO nr H GRV	LRA1100B5077	S	37	1140	5050	0	1844	9.8
	X5123030	SD RVR @ OMD	LRA0500B0487	S	37	1315	5050	0	1906	9.7
	X5123030	SD RVR @ OMD	LRA0599A0151	S	37	1145	5050	0	1957	6
LR5990	X5123030	SD RVR @ OMD	LRA0598A0943	S	37	1200	5050	95	950	5.9
2547	X5123030	SD RVR @ OMD	LRA1198A2547	S	37	1230	5050	0	1600	4.6
	X5123030	SD RVR @ OMD	LRA1100B5080	S	37	1315	5050	0	1372	5.2
	Y2121005	CHINO CREEK	LRA0500B0481	S	36	0800	5050	100	895	6.7
	Y2121005	CHINO CREEK	LRA0599A0145	S	36	0545	5050	0	850	7

combined data

Lab_Smp_No	STA_NUM	StationName	FLOW (cfs)	FLD_PH	DEGREE	DEG_TY	*FLD Wind Velocity (mph)	DATE	HARD (mg/L)
	V9209500	MOJAVE R BL FORKS	10	8	64	F	3	05/11/00	71
	V9209500	MOJAVE R BL FORKS	15	8	56	F	3	11/06/00	111
	X2135000	S M R NR FLBRK	20	8	68	F	3	05/10/00	439
	X2135000	S M R NR FLBRK	30	7.6	64	F	0	05/12/99	402
LR5986	X2135000	S M R NR FLBRK		7.2	62	F	1	05/14/98	190
2543	X2135000	S M R NR FLBRK	30	8	56	F	3	11/12/98	473
	X2135000	S M R NR FLBRK	25	7.9	53	F	3	11/15/00	491
	X4340005	ESCNDO nr H GRV	10	8	71	F	2	05/10/00	401
	X4340005	ESCNDO nr H GRV	20	8	64	F	0	05/12/99	423
LR5987	X4340005	ESCNDO nr H GRV		7.6	58	F	0	05/14/98	
2544	X4340005	ESCNDO nr H GRV	15	8	56	F	2	11/12/98	505
	X4340005	ESCNDO nr H GRV	20	7.9	52	F	3	11/15/00	555
	X5123030	SD RVR @ OMD	15	7.8	78	F	3	05/10/00	465
	X5123030	SD RVR @ OMD	25	7.6	68	F	3	05/12/99	488
LR5990	X5123030	SD RVR @ OMD		7	62	F	3	05/14/98	
2547	X5123030	SD RVR @ OMD	25	7.1	58	F	3	11/12/98	400
	X5123030	SD RVR @ OMD	20	7.2	52	F	3	11/15/00	338
	Y2121005	CHINO CREEK	35	7.2	72	F	2	05/10/00	211
	Y2121005	CHINO CREEK	20	7	68	F	3	05/12/99	201

combined data

Lab_Smp_No	STA_NUM	StationName	Total Alkalinity as CACO3 (mg/L)	CL (mg/L)	LAB_EC (µS/cm)	B (mg/L)	CA (mg/L)	MG (mg/L)	NO3 (mg/L)
	V9209500	MOJAVE R BL FORKS	88.3	14	269	0	20	5	0
	V9209500	MOJAVE R BL FORKS	145	12	434	0.1	33	7	0.3
	X2135000	S M R NR FLBRK	172	195	1440	0.1	95	49	10
	X2135000	S M R NR FLBRK	186	162	1310	0.2	90	43	6.2
LR5986	X2135000	S M R NR FLBRK	108	79	670	0.141	43.8	19.5	8.9
2543	X2135000	S M R NR FLBRK	180	184	1400	0.1	107	50	19
	X2135000	S M R NR FLBRK	178		1450	0.2	111	52	12
	X4340005	ESCNDO nr H GRV	203.4	259	1850	0.2	60	61	21
	X4340005	ESCNDO nr H GRV	215	250	1810	0.2	64	64	26
LR5987	X4340005	ESCNDO nr H GRV		166	1320		71.6	42.6	
2544	X4340005	ESCNDO nr H GRV	300	259	1960	0.2	95	65	40
	X4340005	ESCNDO nr H GRV	282		1970	0.2	100	74	34
	X5123030	SD RVR @ OMD		347	2030		89	59	
	X5123030	SD RVR @ OMD		338	2020		95	61	
LR5990	X5123030	SD RVR @ OMD		138	980		54.1	29.7	
2547	X5123030	SD RVR @ OMD		273	1640		81	48	
	X5123030	SD RVR @ OMD			1400		70.91	39.15	
	Y2121005	CHINO CREEK		108	923		53	19	
	Y2121005	CHINO CREEK		91	849		54	16	

combined data

Lab_Smp_No	STA_NUM	StationName	K (mg/L)	Dissolved Ortho-phosphate	NA (mg/L)	SO4 (mg/L)	Ortho-phosphate	LAB_PH	*FLD Discharge (cfs)
	V9209500	MOJAVE R BL FORKS	1.3		26	21		7.65	
	V9209500	MOJAVE R BL FORKS	3		53	56		8.2	
	X2135000	S M R NR FLBRK	2.8		113	274		8.14	
	X2135000	S M R NR FLBRK	2.5		114	234		7.8	
LR5986	X2135000	S M R NR FLBRK	4.43			95		8.2	70
2543	X2135000	S M R NR FLBRK	3.6		101	258		7.8	
	X2135000	S M R NR FLBRK	3.7		122	268		8.2	
	X4340005	ESCNDO nr H GRV	2.5		211	337	0	8.179	
	X4340005	ESCNDO nr H GRV	1.8		230	307	0.061	8	
LR5987	X4340005	ESCNDO nr H GRV		0.12		209	0.02		35
2544	X4340005	ESCNDO nr H GRV	2.4		217	325	0.11	7.9	
	X4340005	ESCNDO nr H GRV	4.5		220	344	0.08	8.3	
	X5123030	SD RVR @ OMD				278			
	X5123030	SD RVR @ OMD				282			
LR5990	X5123030	SD RVR @ OMD				126			35
2547	X5123030	SD RVR @ OMD				225			
	X5123030	SD RVR @ OMD				184			
	Y2121005	CHINO CREEK				125			
	Y2121005	CHINO CREEK				106			

combined data

Lab_Smp_No	STA_NUM	StationName	GAGE_H (ft)	*FLD Odor	Dissolved Chloride	Dissolved Fluoride	Dissolved Sodium	TDS (mg/L)	TURB (N.T.U.)
	V9209500	MOJAVE R BL FORKS			1	166		0	
	V9209500	MOJAVE R BL FORKS		0		3.46		274	11.9
	X2135000	S M R NR FLBRK			0.3	932		4.5	
	X2135000	S M R NR FLBRK			0.3	812		0	
LR5986	X2135000	S M R NR FLBRK	0			0.2	74.5	405	271
2543	X2135000	S M R NR FLBRK	30		0.3			893	5.5
	X2135000	S M R NR FLBRK		0	205	0.3		935	2.8
	X4340005	ESCNDO nr H GRV			0.4	1150		2.2	
	X4340005	ESCNDO nr H GRV			0.4	1117		0	
LR5987	X4340005	ESCNDO nr H GRV	0					915	22.4
2544	X4340005	ESCNDO nr H GRV	0		0.4			1260	2.2
	X4340005	ESCNDO nr H GRV		0	271	0.5		1260	0
	X5123030	SD RVR @ OMD				1250		2.1	
	X5123030	SD RVR @ OMD				1212		4.5	
LR5990	X5123030	SD RVR @ OMD	0				–		
2547	X5123030	SD RVR @ OMD	0					983	0
	X5123030	SD RVR @ OMD	0	0	245			840	2.2
	Y2121005	CHINO CREEK				555		2.4	
	Y2121005	CHINO CREEK				518		2	

From: "Gary Gilbreath" <garyg@water.ca.gov>
To: "'Keri Cole'" <colek@rb9.swrcb.ca.gov>
Date: 6/7/01 11:54AM
Subject: RE: Monitoring Data

is santa margarita river at fallbrook out of your area, if so yes that would be it

-----Original Message-----
From: Keri Cole [mailto:colek@rb9.swrcb.ca.gov]
Sent: Thursday, June 07, 2001 11:44 AM
To: garyg@water.ca.gov
Subject: RE: Monitoring Data

thank you. yes the files opened fine. thanks for the list of all the stations. that was helpful. obviously the station numbers preceded by "X" are our Region 9 stations.

can i assume, given the file you sent me (a copy of the one i already have), that there has been no data collected for any other of the stations in our region except escondido creek, santa marg river and san diego river from 1998 -2000?

i apologize for my confusion, i am just not familiar with where and what you monitor.

>>> "Gary Gilbreath" <garyg@water.ca.gov> 06/07/01 11:15AM >>>
this might help you

-----Original Message-----
From: Keri Cole [mailto:colek@rb9.swrcb.ca.gov]
Sent: Thursday, June 07, 2001 10:51 AM
To: garyg@water.ca.gov
Cc: Linda Pardy
Subject: RE: Monitoring Data

hi gary
thanks i found the dates on those files you sent to linda pardy on 5/4/01.

can you please forward me the data files for these same stations for July 1997 to most recent. we need this information for our 303d evaluation.
thank you.

STA_NUM	StationName
X2135000	S M R NR FLBRK
X2135000	S M R NR FLBRK
X2135000	S M R NR FLBRK
X2135000	S M R NR FLBRK
X2135000	S M R NR FLBRK
X4340005	ESCNDO nr H GRV
X4340005	ESCNDO nr H GRV
X4340005	ESCNDO nr H GRV
X4340005	ESCNDO nr H GRV
X4340005	ESCNDO nr H GRV
X5123030	SD RVR @ OMD

X5123030	SD RVR @ OMD
X5123030	SD RVR @ OMD
X5123030	SD RVR @ OMD
X5123030	SD RVR @ OMD

Keri Cole, P.E.
Water Resource Control Engineer
San Diego RWQCB
9771 Clairemont Mesa Blvd., Suite A
San Diego, CA 92124
(858) 467-2798
colek@rb9.swrcb.ca.gov

>>> "Gary Gilbreath" <garyg@water.ca.gov> 05/09/01 08:44AM >>>
I see a date file in the db I sent out. all my field books are loaded up right now, I will fax you out of the books the location maps, when I finish this months sampling, these station were ampled every three months, years back, now bi-annully, but it looks like they will be dropped, as all of our surface water sampling stations will be as they (management) probably will go to ground water, a letter will be sent shortly to Linda, it is being prepared know, our old management used to go out and get work from the board, thay are gone now, and because the frequency of sampling has been dropped, management feels the data is not of much use, and it is only standard minerals, look in attached file, should be a date field. Data here is sent to various agencies and is available to the public by request GG

-----Original Message-----
From: Keri Cole [mailto:colek@rb9.swrcb.ca.gov]
Sent: Friday, May 04, 2001 1:37 PM
To: garyg@water.ca.gov
Subject: Monitoring Data

Hi Gary
Linda Pardy, in our office, recently forwarded me some monitoring data for the Santa Margarita River, San Diego River and Escondido Creek (see attached file). I have been unsuccessful in determining the dates of the sampling. Can you help me out? I am also interested in finding out exactly where the sampling stations are. Can you provide this to me? Do you have a map of the sampling locations? What is the frequency of this data? What purposes is it used for on your end?

The reason I am asking all of this is because we are currently soliciting for additional information and data that may support updates to our 303d list of impaired waterbodies in the region (see attached correspondence). I would be interested in looking at this monitoring data from July 1997 if it is available?

Thanks in advance for your assistance.

Keri Cole, P.E.
Water Resource Control Engineer

San Diego RWQCB
9771 Clairemont Mesa Blvd., Suite A
San Diego, CA 92124
(858) 467-2798
colek@rb9.swrcb.ca.gov

>>> "Gary Gilbreath" <garyg@water.ca.gov> 05/04/01 09:16AM >>>
most recent and historical swq

Gary Gilbreath
Dept. of Water Resources
Water Resources Engineering Associate
770 Fairmont Ave Ste 102
Glendale, Ca 91203-1035
WP-818-543-4653
Fax-818-543-4604
e-mail; garyg@water.ca.gov
web page; http://wwwdpla.water.ca.gov/sd

From: "Gary Gilbreath" <garyg@water.ca.gov>
To: "'Keri Cole'" <colek@rb9.swrcb.ca.gov>
Date: 5/9/01 8:51AM
Subject: RE: Monitoring Data

I see a date file in the db I sent out. all my field books are loaded up right now, I will fax you out of the books the location maps, when I finish this months sampling, these station were ampled every three months, years back, now bi-annully, but it looks like they will be dropped, as all of our surface water sampling stations will be as they (management) probably will go to ground water, a letter will be sent shortly to Linda, it is being prepared know, our old management used to go out and get work from the board, thay are gone now, and because the frequency of sampling has been dropped, management feels the data is not of much use, and it is only standard minerals, look in attached file, should be a date field. Data here is sent to various agencies and is available to the public by request GG

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To: garyg@water.ca.gov
Subject: Monitoring Data

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Thanks in advance for your assistance.

Keri Cole, P.E.
Water Resource Control Engineer
San Diego RWQCB
9771 Clairemont Mesa Blvd., Suite A
San Diego, CA 92124
(858) 467-2798
colek@rb9.swrcb.ca.gov

>>> "Gary Gilbreath" <garyg@water.ca.gov> 05/04/01 09:16AM >>>
most recent and historical swq

Gary Gilbreath
Dept. of Water Resources
Water Resources Engineering Associate

770 Fairmont Ave Ste 102
Glendale, Ca 91203-1035
WP-818-543-4653
Fax-818-543-4604
e-mail; garyg@water.ca.gov
web page; http://wwwdpla.water.ca.gov/sd

From: Linda Pardy
To: Keri Cole; Lisa Brown
Date: 3/5/01 2:52PM
Subject: Fwd: Re: Cabrillo National Monument Water Quality Data

Keri, ...the data reports for these analyses are in Lisa Brown's cube labeled Santa Margarita River Water Quality Sampling Data Summaries Part III. It is not actually in Cabrillo Monument, but in the Region 9. Park Service will put these data into STORET for us. They had asked me for everything we know about wq in a distance of 10 miles from Cabrillo Natl Park, and so I sent them several websites for reference and this 1998 data. The end of fiscal year sampling was done with whatever monies we had left in the FY budget that year and was a shotgun approach on the major river systems, we sampled where it was easy to get to (near roads).
-Linda

><> ><> ><> ><> ><> ><> ><> ><> ><> ><>
Linda Pardy, Environmental Specialist
California Regional Water Quality Control Board
San Diego Region
9771 Clairemont Mesa Blvd, Suite A
San Diego, CA 92124-1324
(858) 627-3932, fax (858) 571-6972
calnet 8-734-3932
email <PARDL@RB9.SWRCB.CA.GOV>
Internet Address <www.swrcb.ca.gov/~rwqcb9>
Primary Office Phone Number (858) 467-2952
><> ><> ><> ><> ><> ><> >>>: ><> >>>:

CC: Deborah Jayne

SANTA
MARGARITA
RIVER

From: <Tracy_Weddle@nps.gov>
To: <pardl@rb9.swrcb.ca.gov>
Date: 3/5/01 10:16AM
Subject: Cabrillo National Monument Water Quality Data

Ms. Pardy,

I am currenty establishing a baseline water quality report for Cabrillo National Monument for the National Park Service. I am taking over the work of Brett Atkinson, whom you spoke to previously. Brett prepared the data which you sent him for these reports, but there is one bit of information missing before these reports can be completed and the data uploaded to the EPA database STORET. A paragraph description is needed, describing the source of data and purpose for data collection and monitoring. I have looked on your agency's website to try and determine this, but there are so may projects that I could not determine where the data you sent came from. Could you please describe to me what the monitoring was for, the extent of monitoring, and any other information you feel is significant? I am attaching a copy of the data you sent in case you are unsure about what data I'm referring to. Thank you for your help!

Sincerely,

Tracy Weddle
Water Quality Data Analyst
National Park Service
Water Resources Division
1201 Oakridge Drive, Suite 250
Fort Collins, CO 80525
phone: (970)225-3568
fax: (970)225-9965(See attached file: Linda_Pardy.xls)

From: Linda Pardy
To: Tracy_Weddle@nps.gov
Date: 3/5/01 2:45PM
Subject: Re: Cabrillo National Monument Water Quality Data

Tracy, FYI. In reply to your email:
The source of 1998 water quality data was the San Diego Regional Water Quality Control Board (Regional Board). The Regional Board collected water samples at selected sites throughout the Region to scan sites for elevated levels of the sampled parameters. The June 1998 sampling was limited to those samples/constituents shown. The samples were delivered to the lab by the Regional Board. The contract lab which did the analyses was Truesdail Laboratories, Inc is located at 14201 Franklin Ave, Tustin, CA 92780-7008. The project manager at that time for the testing was Divina B. Pascual. Their phone number was 714 730-6239. -Linda

><> ><> ><> ><> ><> ><> ><> ><> ><> ><>
Linda Pardy, Environmental Specialist
California Regional Water Quality Control Board
San Diego Region
9771 Clairemont Mesa Blvd, Suite A
San Diego, CA 92124-1324
(858) 627-3932, fax (858) 571-6972
calnet 8-734-3932
email <PARDL@RB9.SWRCB.CA.GOV>
Internet Address <www.swrcb.ca.gov/~rwqcb9>
Primary Office Phone Number (858) 467-2952
><> ><> ><> ><> ><> ><> >>>: ><> >>>:

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways to reduce demand and cut your energy costs, see the tips at: http://www.swrcb.ca.gov/news/echallenge.html

>>> <Tracy_Weddle@nps.gov> 03/05/01 10:18AM >>>
Ms. Pardy,

I am currenty establishing a baseline water quality report for Cabrillo National Monument for the National Park Service. I am taking over the work of Brett Atkinson, whom you spoke to previously. Brett prepared the data which you sent him for these reports, but there is one bit of information missing before these reports can be completed and the data uploaded to the EPA database STORET. A paragraph description is needed, describing the source of data and purpose for data collection and monitoring. I have looked on your agency's website to try and determine this, but there are so may projects that I could not determine where the data you sent came from. Could you please describe to me what the monitoring was for, the extent of monitoring, and any other information you feel is significant? I am attaching a copy of the data you sent in case you are unsure about what data I'm referring to. Thank you for your help!

Sincerely,

Tracy Weddle
Water Quality Data Analyst
National Park Service
Water Resources Division
1201 Oakridge Drive, Suite 250
Fort Collins, CO 80525

March 9, 2001

Commanding Officer
Southwest Division
Naval Facilities Engineering Command
1220 Pacific Highway
San Diego, California 92132-5181

LAW Project No. 70300-7-0193

Attention: Ms. Mary Nguyen, P.E. (Code 5CEN.MN)
Remedial Project Manager

Subject: ***Final* Report of Water Quality Studies and Proposed Watershed Monitoring Program for Portions of San Mateo and Santa Margarita River Watersheds Marine Corps Base, Camp Pendleton, California Contract No. N68711-95-D-7573, D.O. 0021**

Dear Ms. Nguyen:

LAWCRANDALL is pleased to submit the enclosed two copies of the *Final* report for the 1999 Water Quality Studies and Proposed Watershed Monitoring Program project. Six copies have been delivered to Mr. Larry Carlson at MCB Camp Pendleton. The report was prepared in accordance with the scope of work provided for Delivery Order 0021, Work Element 2, dated 19 June 1997.

We appreciate the opportunity to be of service on this project. If you have any questions regarding the *Final* report or any other aspects of the project, please call us at 858-278-3600.

Sincerely,

LAWCRANDALL
A Division of Law Engineering and Environmental Services, Inc.

Kurt R. Myers, CEG 1790
Project Manager

Keith L. Carlson, P.E. Ch. 5021
Senior Engineer

Richard W. Shatz, CHG 84
Principal Geologist

Enclosure: 2 copies

cc: Mr. Larry Carlson, MCB Camp Pendleton (6 copies)

G:\70300-7\0193\1999 Final comprehensive Rreport.doc

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FIGURES

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APPENDICES

EXECUTIVE SUMMARY

LAW conducted water quality studies at Marine Corps Base (MCB), Camp Pendleton, California to establish a baseline for the analysis of water quality trends to be used for evaluating the long term effects to groundwater, the Base's principal drinking water supply. Figure 1, shows the location of MCB, Camp Pendleton. The work consisted of compiling historical surface water quality data, re-establishing MCB Camp Pendleton's surface water quality monitoring program, supplementing the surface water quality monitoring by installing and sampling three groundwater monitoring wells, compiling data into a database, and analyzing the water quality data using graphical and statistical methods. The results of this work were used to prepare and justify a Watershed Monitoring Program (WMP) for portions of the San Mateo and Santa Margarita River Watersheds to protect the groundwater supply at MCB Camp Pendleton. Figure 2, shows the location of these two watersheds.

The WMP developed for MCB Camp Pendleton describes the monitoring system network, identifies chemical parameters for analysis that are indicative of changes in water quality, and specifies sampling procedures and analytical methods. It also establishes upper prediction limits (UPLs) for chemical parameters to indicate when action is needed to protect the Base's drinking water supply.

Water quality in the San Mateo Watershed was evaluated at three surface water locations: Cristianitos Creek near San Clemente (Station 509); San Mateo Creek at San Clemente (Station 510); and San Mateo Creek at San Onofre (Station 511). Surface water versus groundwater quality was evaluated from monitoring well MW-3 (Station 103) located in Cristianitos Creek. Figure 3 shows the location of these surface and groundwater monitoring stations.

Significant findings for the San Mateo Watershed include a statistical difference in water quality between Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Clemente (Station 510). Water at San Mateo Creek at San Onofre (Station 511), which is a mixture from Cristianitos Creek near San Clemente (Stations 509) and San Mateo Creek at San Clemente (Station 510), shows an influence from local activities as indicated by changes in sodium and nitrate concentrations. Nitrate at San Mateo Creek at San Onofre (Station 511) has exceeded drinking water maximum contaminate levels (MCLs) at least once since 1997. Water from Cristianitos Creek near San Clemente (Station 509) strongly affects the water quality at San Mateo Creek at San Onofre (Station 511). At least once since 1997, the drinking water MCLs at one of the stations were exceeded for specific conductivity, total dissolved solids (TDS), manganese, iron, and fecal coliform. In addition, there is a significant difference in water quality between surface water at Cristianitos Creek near San Clemente (Station 509) and groundwater in MW-3 (Station 103). In general, water quality within the watershed is improving based on downward-trending data for many of the chemical parameters.

Water quality in the Santa Margarita River Watershed was evaluated at eight surface water locations. Three locations are along the Santa Margarita River: Santa Margarita River near Fallbrook (Station 501); Santa Margarita River near Temecula (Station 504); and Santa Margarita River at Ysidora (Station 508). Five locations are on tributary creeks to the Santa Margarita River: Sandia Creek near Fallbrook (Station 502); Rainbow Creek Near Fallbrook (Station 503); Murrieta Creek near Temecula (Station 505); De Luz Creek near Fallbrook (Station 506); and Fallbrook Creek near Fallbrook (Station 507). Surface water versus groundwater quality was evaluated from two monitoring wells located along the Santa Margarita River at De Luz Road (MW-1) and in De Luz Creek (MW-2). Figure 4 shows the location of these monitoring locations.

Significant findings for the Santa Margarita River Watershed include a statistical difference in water quality between tributaries of the Santa Margarita River. There is also a significant difference in water quality between surface water monitoring stations in comparison to nearby groundwater wells. Water quality is degrading in Sandia Creek near Fallbrook (Station 502) and De Luz Creek near Fallbrook (Station 506) from increasing concentrations of sodium, chloride, sulfate, and nitrate as indicated by the generally increasing trends for these parameters. Groundwater in MW-2 in De Luz Creek (Station 102) also contained nitrate at concentrations above the MCL. At least once since 1997, the drinking water MCLs was exceeded in 2 tributaries or in the Santa Margarita River for sulfate, manganese, specific conductance, and TDS. The MCL was also exceeded for nitrate in Rainbow Creek near Fallbrook (Station 503), chloride in Sandia Creek near Fallbrook (Station 502), and iron in De Luz Creek near Fallbrook (Station 506) and Sandia Creek near Fallbrook (Station 502) and in the Santa Margarita River near Fallbrook (Station 504). Water quality in the Santa Margarita River near Fallbrook (Station 501) and at Santa Margarita River at Ysidora (Station 508) is essentially the same. Water at these locations appears to be strongly influenced by water from

Sandia Creek near Fallbrook (Station 502). Overall, water quality in the Santa Margarita River Watershed is improving based upon downward-trending data. Significant improvement in water quality is seen on Rainbow Creek near Fallbrook (Station 503).

Based on the results of the present studies, we recommend that monitoring of selected surface water and groundwater quality sampling locations should be conducted quarterly. The monitoring should be conducted as part of a Watershed Monitoring Program that LAW has developed and which is presented in this report. The WMP includes UPLs, which are statistical limits that indicate whether a new sample value is elevated relative to background data. The UPLs were established based on analytical results for samples collected since 1997, when monitoring resumed. Most UPLs are below established MCLs or recommended levels for drinking water. However, UPLs for both watersheds are greater than MCLs or recommended levels for iron, manganese, total dissolved solids, and specific conductance.

We recommend that ten surface water sampling stations and three groundwater sampling stations be utilized. In the San Mateo Watershed, three surface water locations and one groundwater location should be sampled. In the Santa Margarita River Watershed, seven surface water and two groundwater locations should be sampled. Based on the statistical analyses discussed in Section 3 of this report, one surface water sampling location has been removed from the locations sampled during the 1997-1999 program. The station at Santa Margarita River at Ysidora (Station 508) was removed because its water quality is the same as that at Santa Margaret River near Fallbrook (Station 501).

For each sampling location in the San Mateo and Santa Margarita River Watersheds, we recommend the following analytical parameters be monitored: arsenic, phosphate, chloride, bicarbonate, sodium, calcium, specific conductance, fecal coliform, fluoride, lead, iron, manganese, surfactants (MBAS), methyl tert-butyl ether (MTBE), nitrate, thallium, total dissolved solids (TDS), and sulfate. These parameters were selected for at least one of the following reasons: 1) because they have maximum contaminant levels for drinking water; 2) they have historically exceeded MCLs; 3) they have exceeded the MCL at least once since 1997; 4) they are considered important indicators of water quality; and/or 5) they can give important indications of upstream contaminant release.

Analytical data gathered from implementation of the WMP should be incorporated into the database compiled for LAW's water quality studies for MCB Camp Pendleton during 1997-1999. A CD with the database is included in Appendix D of this report. The database will facilitate use of the new and existing data by subsequent users. The database is in Microsoft Access and is sufficiently versatile to allow graphical and statistical data analysis.

We recommend that, after each monitoring event, the analytical data be evaluated to identify UPL and MCL exceedances. The data should also be reported in written and electronic formats to MCB Camp Pendleton's Office of Water Resources. If a UPL for a given parameter is exceeded during a sampling event, additional investigation should be conducted. The affected sampling location should be sampled and analyzed again for the exceeded parameter as soon as practical. If the second sample also exceeds the UPL, continued monitoring at increasing frequencies (up to weekly) should be conducted, and an investigation undertaken that includes upstream sampling to determine the source of the exceedance. Detection of MTBE concentrations that exceed the MCL should be reported to the RWQCB. It is also advisable to discuss the findings with local agencies and interested parties, including the Santa Margarita River Watershed Committee.

Some of the UPLs established exceed MCLs or recommended levels for drinking water. The UPLs are based on a statistical comparison of water quality data obtained since 1997. Because the UPLs are greater than the MCLs or recommended level, it indicates that water quality in both the watersheds have repeatedly exceeded MCLs or recommended levels since 1997 for iron, manganese, TDS, and specific conductance. We recommend that an investigation be undertaken that includes upstream sampling and observation to determine the type of activity that may be creating the exceedance. Once identified discussions with local agencies and interested parties, including the Santa Margarita River Watershed Committee could potentially lead to modification of practices to reduce or eliminate the source.

The WMP approach and monitoring parameters should be re-evaluated about every three years, and no less frequently than every five years. UPLs should, according to statistical convention, be re-calculated after every monitoring event to maintain their currency. However, since this monitoring is not a part of a regulatory mandated monitoring program, which would require recalculation after every monitoring event. In our opinion, the UPLs could be recalculated annually to reduce cost.

1.0 INTRODUCTION

This report presents the results of water quality studies conducted at Marine Corps Base (MCB), Camp Pendleton, California to establish a baseline for the analysis of the water quality trends to be used for evaluating the long term effects to groundwater, the Base's principal drinking water supply. The work consisted of compiling historic surface water quality data, re-establishing MCB Camp Pendleton's surface water quality monitoring program, supplementing the surface water quality monitoring program by installing and sampling three groundwater monitoring wells, compiling historic water quality records into a database, and analyzing the water quality data using graphical and statistical methods.

The results of this work were used to prepare and justify a Watershed Monitoring Program for portions of the San Mateo and Santa Margarita River Watersheds to protect the groundwater supply at MCB Camp Pendleton. The Watershed Monitoring Program describes the monitoring system network, identifies chemical parameters for analysis that are indicative of changes in water quality, and specifies sampling procedures and analytical methods. It also establishes upper prediction limits (UPLs) for chemical parameters to indicate when action is needed to protect the Base's drinking water supply.

1.1 SITE DESCRIPTION

MCB Camp Pendleton is located in northern San Diego County, California and comprises approximately 140,000 acres or 219 square miles (Figure 1). The Base is the Marine Corps' premier amphibious training facility. It is the only Marine Corps facility where amphibious training operations can be combined with elements of Marine Corps aviation and other supporting combat arms to develop, evaluate, and exercise the Marine Corps combat doctrine to the fullest extent.

MCB Camp Pendleton relies entirely on local groundwater resources for its drinking water. It is derived from the basins of four principal stream systems that flow through the Base and recharge the groundwater system before flowing into the Pacific Ocean. These basins are the San Mateo, the San Onofre, the Las Flores, and the Santa Margarita River basins. The groundwater system beneath MCB Camp Pendleton is recharged from local runoff into these basins and from an enhanced recharge area at the Lake O'Neill diversion works. This project only assessed portions of the San Mateo and Santa Margarita River watersheds because their tributary area extends beyond the Base, where urban, rural, industrial, and agricultural activities are not controlled by MCB Camp Pendleton. A description of these two watersheds, potential sources of pollutants, and pertinent water quality information are presented in the following subsections.

1.1.1 San Mateo Watershed

The San Mateo Watershed covers 137 square miles of land a portion of which is located in the northwestern portion of MCB Camp Pendleton. Figure 2 shows the extent of the San Mateo Watershed. It extends about 22 miles inland from its discharge point into the Pacific Ocean. Its tributary area encompasses the west slope of the Santa Ana Mountains. San Mateo Creek drains the eastern portion of the watershed, and Cristianitos Creek drains the western portion. The two creeks merge on MCB Camp Pendleton in a narrow sediment-filled valley. MCB Camp Pendleton's water supply wells are located downstream of the confluence of these two creeks.

Recharge to groundwater in the San Mateo Watershed occurs primarily through direct infiltration of precipitation and surface runoff. Near the confluence of San Mateo and Cristianitos Creeks, MCB Camp Pendleton operates Sewage Treatment Plant No. 12. Treated wastewater is recharged through oxidation ponds into groundwater.

Most of the watershed is undeveloped. However, residential developments and portions of the City of San Clemente are located within the watershed outside of MCB Camp Pendleton.

Regular sampling of surface water in San Mateo and Cristianitos Creeks had been conducted by MCB Camp Pendleton's Natural Resources Office or affiliates for about 30 years, up until 1992. This current study resumed sampling at three locations beginning in December 1997. Figure 3 shows the locations of the monitoring stations. Previous studies have concluded the following in regard to water quality in this watershed:

- At San Mateo Creek at San Onofre (Station 511), TDS concentrations are high probably due to surface runoff and subsurface discharge from nearby agricultural areas (Leighton, 1987).

- At San Mateo Creek at San Clemente (Station 510), dissolved constituent concentrations are relatively consistent, except during periods of lower than average rainfall and during heavy seasonal precipitation. Dissolved constituent concentrations increase once per year coincident with the winter or wet months (Leighton, 1987).

- At the station designated as Cristianitos Creek near San Clemente (Station 509) the water has a relatively high TDS in comparison to San Mateo Creek at San Clemente (Station 510) (Leighton, 1987).

1.1.2 Santa Margarita River Watershed

The Santa Margarita River Watershed covers 742 square miles of land east of Lake Elsinore between the San Jacinto Mountains and Palomar Mountain, extending southwestward to the Pacific Ocean near Oceanside, California. Figures 2 and 4 show the extent of the watershed. The Santa Margarita River originates at the confluence of Temecula Creek and Murrieta Creek near the city of Temecula. Temecula Creek begins on the eastern slope of the Palomar Mountains and flows first generally northwest and then southwest through a series of valleys around the northeastern slope of these mountains until it joins with Murrieta Creek. Murrieta Creek begins on the northern slope of the Santa Rosa Plateau and flows generally southeastward through a wide valley near the foot of the east-facing plateau until it joins with Temecula Creek. The combined drainage area for Temecula and Murrieta Creeks is about 588 square miles.

From this confluence, the Santa Margarita River flows 27 miles to the Pacific Ocean. The river first descends through a twisting course for about six miles in the bottom of Temecula Canyon (the gorge), a steep-walled canyon cut through the Santa Margarita Mountains. Near the downstream mouth of this canyon, Rainbow Creek flows into the river from the east; about two miles further downstream Sandia Creek flows into the river from the north. Further downstream, De Luz Creek also flows into the Santa Margarita River from the north. The river then flows into a broad sediment-filled valley within MCB Camp Pendleton, where percolation through the coarse-grained soils recharges the groundwater. Finer-grained sediments that limit recharge from the river to the underlying sediments are present south of Basilone Road (Worts, 1954). MCB Camp Pendleton obtains its drinking water from wells in the alluvium in this valley. Most of the wells are not influenced by surface water, with the possible exceptions of Well Nos. 2673, 33924, and 33926 (MacDonald-Stephens, 1993).

The water in the Santa Margarita River originates from rainfall in the watershed, from discharges at Lake Skinner and Vail Lake, and from discharges from non-point sources.

There are four major population areas within the watershed. Two areas, the cities of Temecula and Murrieta, are located above the gorge, and two areas, the town of Fallbrook and MCB Camp Pendleton, are located below the gorge. Large agricultural areas are present near Fallbrook and Temecula. Avocados and citrus are the primary crops grown near Fallbrook. Outside of Temecula and Murrieta, grapes, sod, and various other dry farm crops are cultivated. In the mid-1980s, development in the Rainbow Creek area included several large nurseries, along with single family residences, irrigated orchards, field crops, and pastures (Cadmus, 1994). Sandia and De Luz Creeks also experienced agricultural and housing development in the mid-1980s (Harris, 1992).

In the Temecula and Murrieta areas, there are several water reclamation facilities. Reclaimed wastewater is used for irrigation at golf courses and sod farms, and spread in percolation ponds. Wastewater from Fallbrook is treated at a water reclamation plant and discharged to a land outfall that is connected to the City of Oceanside's ocean outfall outside the Santa Margarita River Watershed (NBS/Lowry, 1994).

Septic disposal systems are widespread throughout unincorporated areas of the watershed. Private landowners and larger facilities, such as recreational vehicle parks and campgrounds, discharge to on-site systems.

Surface water quality in the Santa Margarita River and its tributaries has been monitored at multiple locations for several decades by agencies such as the United States Geological Survey (USGS), California Department of Water Resources, and MCB Camp Pendleton, among others. Resurrection of MCB Camp Pendleton's surface water quality monitoring program for this study involved sampling at eight of these USGS existing stations. Figure 4 shows the location of the monitoring stations. Previous water quality investigations noted changes in water quality in this watershed as summarized in the following:

- Water quality from De Luz Creek near Fallbrook (Station 506) has exceeded basin plan objectives for total dissolved solids (750 mg/L) since 1973. At times boron and sulfate have also exceeded basin standards (0.75 and 250 mg/L, respectively) (Leedshill-Herkenhoff, 1989). During the drought of 1974-77, concentrations of most parameters studied were higher.

- Water quality data from Fallbrook Creek near Fallbrook (Station 507) indicate TDS, sulfate, and boron frequently exceed basin standards. Nitrate concentrations increased during the drought of 1974-77. The City of Fallbrook discharged wastewater effluent into the Creek prior to 1983 (Leedshill-Herkenhoff, 1989).

- Data from the Santa Margarita River near Temecula (Station 504) and the Santa Margarita River near Fallbrook (Station 501) indicate that the water quality consistently meets the basin plan objectives except for TDS. Water quality appears to degrade between the Temecula and Fallbrook Stations. During the drought of 1974-77, TDS values were very high. Nitrate concentrations have increased rapidly since about 1978 (Leedshill-Herkenhoff, 1989).

- Water quality characterization by the California Department of Water Resources (1956) indicated Murrieta Creek near Temecula (Station 505) had sodium chloride water; De Luz Creek near Fallbrook (Station 506) had sodium bicarbonate water; Rainbow Creek near Fallbrook (Station 503) had no predominant character; the Santa Margarita River (Stations 501 and 504) and Sandia Creek near Fallbrook (Station 502) had a mixed sodium-calcium bicarbonate-chloride character; and Fallbrook Creek near Fallbrook (Station 507) had mixed sodium-calcium chloride-sulfate character.

- Agricultural activities around Rainbow Creek near Fallbrook (Station 503), upstream from Station 503 (Rainbow Creek near Fallbrook), have substantially elevated phosphate and nitrate concentrations since at least the mid-1980s (Cadmus, 1994). A Rainbow Creek Non-Point Source Nitrate Reduction Project was developed by the Mission Resource Conservation District.

- Very low levels of some BTXE (benzene, toluene, total xylene, and ethylbenzene) components were detected in 1992 at sampling locations in the Santa Margarita River Watershed (Law/Crandall, Inc., 1995).

- Low levels of Dieldrin and phthalate were detected at Fallbrook Creek in 1991 but may have been introduced in the laboratory (Law/Crandall, Inc., 1995).

- Low concentrations of bromoform were detected at Santa Margarita River at Temecula Gorge in 1992. Also hexachlorobenzene and dibromochloromethane were detected at the Rancho California 3cfs Meter Gorge that year (Law/Crandall, Inc., 1995).

- Vail Lake (Rancho California Water District) and Skinner Reservoir (Metropolitan Water District) discharge into Temecula Creek and a tributary of Murrieta Creek, respectively (Cadmus, 1994).

1.2 WATER QUALITY REGULATIONS

MCB Camp Pendleton relies solely on groundwater for its drinking water. Because surface water recharges the groundwater, surface water quality should meet drinking water standards, with a few exceptions such as turbidity and coliform, which can be removed during percolation through sediments.

California Department of Health Services (DHS) has established primary and secondary drinking water standards for all water served by water purveyors in California (California Code of Regulations (CCR), Title 22, Division 4, Chapter 15). Tables 1 through 5 list existing drinking water standards.

Several additional chemicals have recently become regulated or may become regulated in the near future. These include methyl tert-butyl ether (MTBE), perchlorate, arsenic, radon, and sulfate. The regulatory status for each of these chemicals is briefly described in the following paragraphs. MTBE, a volatile organic chemical used as an oxygenate in the blending of gasoline, is currently listed as an "unregulated chemical" for which monitoring is required, but no maximum contaminant level (MCL) applies. DHS recently developed a secondary standard (5 micrograms per liter (µg/L)) and has begun a process to develop a primary drinking water standard for MTBE. A proposed primary standard is planned for release for public comment in 1999. DHS will utilize the 14 µg/L Public Health Goal for developing the primary standard.

Perchlorate is used in the manufacture of solid rocket propellant, munitions, and fireworks. DHS proposed identifying perchlorate as an "unregulated chemical" in July 1998 and established an action level of 18 µg/L. The regulation identifying perchlorate as an "unregulated chemical" is anticipated to be in place in 1999.

In accordance with the Safe Drinking Water Act (SDWA) Amendments of 1996, USEPA must develop arsenic, sulfate, and radon national primary drinking water regulations. The arsenic regulation must be proposed by January 2000 and finalized by January 2001. Prior to regulating sulfate, USEPA must conduct a study of sulfate in drinking water. USEPA has 30 months after the enactment of the SDWA amendments to propose a maximum contaminant level goal and regulation for radon. The final rule must be promulgated one year thereafter.

Water quality objectives for surface water and groundwater have been developed by the San Diego Regional Water Quality Control Board (RWQCB). The San Diego Water Quality Control Plan (the Basin Plan) water quality objectives generally mimic drinking water standards but include a limit for boron, a common constituent of soap. Table 6 lists the Basin Plan objectives, which are not as extensive as parameters contained in the drinking water regulations.

1.3 PROJECT OBJECTIVES

The objectives of this project were to 1) develop a baseline analysis of the quality of surface water and groundwater near the upstream boundaries of MCB Camp Pendleton to be used for the interpretation of future water quality trends, 2) to establish upper prediction limits (UPLs) for water quality parameters to evaluate potential long-term impacts to the water supply, and 3) to develop a Watershed Monitoring Program for future implementation to continue to protect MCB Camp Pendleton's groundwater drinking water supply.

1.4 PROJECT APPROACH

Our approach to meet the project objectives was to compile a water quality database representative of the water quality in the watersheds, statistically and graphically analyze the data, and evaluate and interpret the results. Historical data were supplemented by surface water data collected quarterly from December 1997 to May 1999. Groundwater samples were collected from three monitoring wells installed by LAW in December 1997 to evaluate the quality of water in the sediments and the relationship of surface water quality to groundwater quality.

After compiling the water quality database, the data were analyzed using both graphical and statistical methods to determine:

- Both long term and short term trends in surface water quality;
- Whether the stations sampled were representative of surface water quality without redundancy;
- If surface water quality is representative of groundwater quality;
- Chemical parameters indicative of potential changes in water quality or pollution;
- Upper prediction limits for selected chemical parameters to identify when further action is needed to protect the Base's groundwater drinking water supply.

The results of the analysis were evaluated and used to prepare and justify a Watershed Monitoring Program for portions of the Santa Margarita River and San Mateo Watersheds to protect groundwater supplies at MCB Camp Pendleton. The Watershed Monitoring Program describes the monitoring system network, outlines sampling procedures, identifies chemical parameters for analysis that are indicative of changes in water quality, details sampling procedures, and documents analytical methods. It also establishes UPLs for chemical parameters to indicate when action is needed to protect the Base's drinking water supply.

2.0 WATER QUALITY CHARACTERIZATION ACTIVITIES

This section discusses the work performed, data collection and sampling locations, and methods and procedures used for this water quality evaluation. Summary tables of data gathered during this work were compiled.

2.1 PRECIPITATION STATIONS

MCB Camp Pendleton has a precipitation gauging station located at Marine Corps Air Station (MCAS) Camp Pendleton. A 10-year precipitation record (1989-1999) with daily measurements was obtained from the Air Station. In addition, monthly data from several precipitation stations off Base were used. The other stations used, along with the period of record, are San Clemente Dam (1940-1997), Oceanside Harbor (1955-1997), Escondido (1931-1979), and Escondido 2 (1979-1997). These measurements were used for the statistical analysis to assess if there was a correlation between water quality and rainfall amount. Appendix A contains the precipitation records.

2.2 STREAM GAUGING STATIONS

The USGS has developed an extensive network of stream gauging stations to measure the flow in the Santa Margarita River and its tributaries, and in Cristianitos and San Mateo Creeks. LAW selected the San Mateo Creek at San Onofre (Station 511) and Santa Margarita River near Fallbrook (Station 501) gauging stations to represent flow conditions within the San Mateo and Santa Margarita River Watersheds, respectively. These stations were selected to be representative because they: had a long period of record; were down stream of as many tributaries and creeks as possible to account for the total flow available for groundwater recharge, and if possible before significant percolation could occur that would reduce the surface water flow.

The stream gauge measurements were used during the statistical analysis to test for a correlation between stream flow and water quality. A direct correlation could provide support for a defensible monitoring frequency to be specified in the Watershed Monitoring Program. These gauging stations were also used as locations for surface water quality sampling. The locations of these stations are shown on Figures 3 and 4. The stream gauging records are in Appendix B.

2.3 STREAM SAMPLING STATIONS

LAW sampled eleven surface water locations along the Santa Margarita River and its tributaries, and along San Mateo and Cristianitos Creeks. The locations were selected by MCB Camp Pendleton staff based on the locations being representative of water quality in the river, creek, or major tributary; having a historic record of water quality data; and accessibility of the location. Table 7 lists the stations monitored during this study. This table also correlates LAW's station identification numbers with those of other agencies. Figures 3 and 4 show the locations of the sampling stations.

2.4 MONITORING WELL INSTALLATION

Three groundwater monitoring wells were installed by LAW adjacent to the Santa Margarita River (MW-1), De Luz Creek (MW-2), and Cristianitos Creek (MW-3) in December 1997 for groundwater quality sampling. Locations for these wells were selected as near surface water sampling locations as practical so a comparison of surface water and groundwater quality would be realistic. The wells were constructed of inert casing materials that were unlikely to affect the water quality. Figures 3 and 4 show the locations of the wells. Appendix C contains a description of the monitoring wells including lithologic logs and well construction details.

2.5 SURFACE AND GROUNDWATER SAMPLING AND ANALYSIS

LAW collected surface water and groundwater samples between December 1997 and May 1999 to document the current water quality at selected locations on San Mateo and Cristianitos Creeks, and the Santa Margarita River and its tributaries. MCB Camp Pendleton last conducted surface water quality sampling in 1992. This monitoring program resumed major portions of the previous sampling program.

LAW used a numerical scheme for identifying the discrete location and time frame in which a particular sample was collected. Each sample was assigned a six digit numerical code. The first digit was either a 1 (for a monitoring well) or a 5 (for a surface water location). The next two digits identified the station location number, which ranged from 01 to 03 for monitoring wells and from 01 to 11 for surface water locations (Table 7). The final three digits identified the sampling event number, which for this project ranged from 001 to 007.

The following sections describe the procedures used to collect samples.

2.5.1 Groundwater Sampling

Groundwater samples were collected from each of the three-groundwater monitoring wells (sampling locations 101, 102, and 103) during seven sampling events. The sampling events were in December 1997 (semi-annual sampling), March 1998 (quarterly sampling), May 1998 (semi-annual), August 1998 (quarterly), November 1998 (semi-annual), February 1999 (quarterly), and May 1999 (semi-annual). Groundwater was sampled in accordance with the County of San Diego Site Assessment and Mitigation (SAM) Manual guidelines for sampling groundwater monitoring wells. The SAM Manual describes wells as either fast recharging or slow recharging. A fast recharging well recovers to 80 % or more of its static condition within two hours of purging. A slow recharging well recovers to 80 % of its static condition more than 2 hours after purging. According to these criteria, all three monitoring wells are fast recharging wells.

For sampling, each well was purged of three (3) borehole volumes of water using a bailer. The depth to the water level surface was measured before and after purging to determine the well drawdown. Once the water surface had recovered to at least 80% of the static condition, the well was sampled.

Groundwater samples were collected in disposable bailers. Water was poured directly from the bailer into laboratory prepared sample containers, which were then capped and placed in an ice chest. Samples for general minerals and metals were collected into plastic bottles while glass bottles were used for coliform and nitrate. A field test sample was collected into a disposable cup and tested at the well head for pH, specific conductance, and temperature using a Myron-L meter. Care was exercised to avoid personal contact, even with protective gloves, with the sampled water as such contact may impact certain analyses.

2.5.2 Surface Water Sampling

Surface water samples were collected at eleven surface water sampling locations (sampling locations 501 through 511) during seven sampling events. The sampling events took place in December 1997 (semi-annual sampling), March 1998 (quarterly sampling), May 1998 (semi-annual), August 1998 (quarterly), November 1998 (semi-annual), February 1999 (quarterly), and May 1999 (semi-annual).

Each sample was collected from a mid-stream area to represent cross-sectional homogeneity, not where the channel is constricted. The sampler entered the water downstream of the sample location and proceeded upstream to the sampling location. Surface water samples were collected facing the upstream direction to allow water to flow directly into the sample containers from the top six inches of flow. Floating debris such as leaves was avoided. The samples were collected directly into laboratory prepared bottles. Samples for general minerals and metals were collected into plastic bottles while samples for coliform and nitrate were collected into glass bottles. A sample of the water was also collected into a disposable cup for field parameters including pH, temperature, and specific conductance. These field test parameters were measured using a calibrated Myron-L meter.

Surface water samples could not be collected at Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Clemente (Station 510) during January 1998 due to lack of flow. Cristianitos Creek near San Clemente (Station 509) also could not be sampled during November 1998 due to lack of flow.

2.5.3 Sample Analysis

The surface water and groundwater samples were collected in laboratory-provided containers by LAW personnel. The samples were placed in an insulated cooler containing ice to keep the temperature of the samples at 4 ± 2 C until receipt at the State of California-certified laboratory. All sampling and sample handling was performed under chain-of-custody protocol. Water samples collected from the wells and the surface water locations were analyzed for those parameters identified in Tables 8 and 9. Except for coliform analysis, all samples were analyzed by Law Environmental National Laboratories (LENL) of Pensacola, Florida. Coliform analysis was performed by Environmental Engineering Laboratories (EEL) of San Diego, California (Sampling Events 1 - 6) and Pat Chem Laboratories (PCL) of San Diego, California (Sampling Events 6 and 7). Appendix D-2 contains tabulated analytical data from the seven sampling events.

2.5.4 Quality Assurance/Quality Control

The project followed the protocols set forth in the project Work Plan (WP) and its associated quality assurance/quality control (QA/QC) protocol. The WP contains procedures for training, documentation, observations, methods of sample collection and containment, and sample custody. The subcontractor laboratory was responsible for internal quality control checks including documentation of instrumentation, standards and data, calibration and check standards, and control samples.

To assure that analytical data collected and reported from monitoring activities is scientifically valid, accurate, and consistent, the following steps were taken:

- Accuracy was assessed by comparing reported data to "true" values using calibration standards, reference samples, and spiked samples. The criterion for an accurate result for an analyte was its percent recovery being within control limits. There were no analytes identified in the laboratory QA/QC Reports with recoveries outside control limits.

- Precision was assessed at a frequency of 10 percent of the monitoring locations sampled through the collection and analysis of duplicate samples. The results of the duplicate samples were compared to the original sample to estimate a relative percent difference (RPD) between the two samples. The parameter-specific relative percent differences are in Appendix H. These values are viewed as a goal rather than a requirement due to the inherent variation in surface and ground water samples. The goals were met for 92% of all analytes.

- Representativeness of the proper design of the sampling program in terms of the selection of the sample locations and the adequacy of the number of samples collected met the requirements of the Work Plan.

2.6 WATER QUALITY DATABASE

Surface water quality data have been collected within the San Mateo and Santa Margarita River Watersheds since the 1960s. Many of the sampling stations are clearly documented; however, many samples were collected at locations that are poorly defined. Only data from those stations that were clearly identifiable, had a period of record greater than three years, and corresponded to the stations used during sampling for this project were included in the database. Chemical data were collected from:

- USGS published reports;
- California Department of Water Resources reports;
- MCB Camp Pendleton, Office of Water Resources files;
- LAW's current surface and groundwater sampling program;
- Rancho California Water District; and
- Eastern Municipal Water District.

Over 32,000 water quality results were inputted into the database. Table 7 lists the stations with water quality data contained in the database. The locations of these stations are shown on Figures 3 and 4. Appendix D-1 contains a compact disc (CD) with the database compiled in ACCESS. Appendix D-3 lists other sources of available water quality data that were not included in the database because the location was not well defined, the sampling station had a short period of record, or the station was not on the Santa Margarita River, San Mateo Creek, or Cristianitos Creek. Figure D-1 shows the known locations of some of these samples.

2.7 DATA ANALYSIS

The goals of the analysis of the water quality data were to justify the selection of monitoring locations and chemical parameters to detect trends in water quality and to establish UPLs for water quality parameters to indicate when water supplies at MCB Camp Pendleton may be threatened and warrant further investigation or action. This information was used to prepare the Watershed Monitoring Program. Both graphical and statistical data analysis methods were chosen and are described in the following subsections.

2.7.1 Graphical Analysis

The data collected were graphed prior to statistical analyses to visually evaluate the data for trends and to evaluate the relationship of surface water and groundwater quality. The EPA technical guidance document states that visually observing data for trends is an appropriate method, especially when the data are non-parametric.

2.7.1.1 Trend Graphs

LAW plotted the water quality data collected for the eleven surface water and three groundwater monitoring stations in the San Mateo and Santa Margarita River Watersheds to graphically display the concentrations for each analytical parameter over time. The graphs were used to visually evaluate the data for trends and to relate significant changes in water quality to potential sources. The graphs also served to provide a visual examination of the changes in water quality to verify the results of the statistical analysis. Where a constituent was not detected with repeat sampling, the graphs also were used to justify elimination of that parameter from sampling in the Watershed Monitoring Program.

Trend plots were developed for each surface water and groundwater monitoring station for each chemical parameter with sufficient data. Some parameters had been sampled infrequently in the past and contained very few data points. The parameters graphed are:

- Major anions including bicarbonate, carbonate, chloride, and sulfate (HCO_3, CO_3, Cl, and SO_4);
- Major cations including calcium, sodium, magnesium, and potassium (Ca, Na, Mg, K);
- TDS, pH, hardness, and specific conductance;
- Nitrate as nitrogen, and phosphorus converted from phosphate;
- Metals including copper, iron, lead, mercury, manganese, and zinc (Cu, Fe, Pb, Hg, Mn, Zn).

Appendix E contains the graphs of these plots for each monitoring location shown on Figures 3 and 4.

2.7.1.2 Piper Diagrams

Graphs of water quality can be used to interpret whether water is from the same source, from a different source, or is mixed. LAW used Piper diagrams to assess whether groundwater and surface water have similar quality to help justify the monitoring locations for the Watershed Monitoring Program. Appendix F contains Piper diagrams for each monitoring location.

To create a trilinear plot, the percentage of each major ion is calculated based on the total cations or anions. The percentage of major cations and percentage of major anions are then potted onto the two lower triangles on the diagram. The apex of these triangles represents a 100% concentration of each major anion and cation. The cation point from the lower left triangle is projected onto the diamond area of the diagram parallel to the magnesium axis and the anion point is projected onto the diamond area of the diagram parallel to the sulfate axis until the lines intersect. This point represents the distribution of the major ions in the water sample.

LAW used the analytical results from 1997 though 1999 to compare surface water and groundwater quality. This period was selected for analysis because LAW installed the monitoring wells in 1997 and since then, surface water sampling and groundwater sampling has occurred concurrently. Separate graphs were initially prepared for each monitoring location to evaluate if the quality of water varies by season. Surface water monitoring stations were also plotted with nearby monitoring wells to evaluate if the waters have similar quality. Piper Diagrams using the historical data were prepared for each station with the exception of stations 502,504,and 508 that did not have ion data sets for trilinear plots. These diagrams are located in appendix F.

2.7.2 Statistical Analysis

Environmental data is often difficult to interpret because the analytical results often contain "less than" values (non-detectable concentrations), results that are extremely high and anomalous to the rest of the data (outliers), and is often influenced by natural factors that produce cyclic variations (climatic factors such as recharge from rain). Over the last twenty years use of statistics to interpret environmental data has been refined and has gained more acceptance. USEPA has led this effort to establish standard methods for the evaluation of data from contaminated sites. Statistical methods provide a defensible, standardized approach of interpreting the data to provide a yes/no response as to whether a current analytical result is significantly different than previous analyses and whether any corrective action is required. LAW used statistical methods to analyze water quality data gathered between 1997 and 1999 to establish a current baseline for water quality in the Santa Margarita River and San Mateo River watersheds.

In general, the methods used can be divided into two categories, data management and statistical evaluations. During the data management phase the analytical data set is evaluated for anomalous results, the number of non-detectable results and detection limits. Using approved methods the data set is then manipulated to establish a data set suitable for statistical evaluation. The data set is then checked to determine if the data is normal (produces a bell shaped curve), log normal (where the logarithm of the data is analyzed) or non-parametric (the data set does not conform to a general linear model). Based on these categories the data is then analyzed using the appropriate equations to determine whether there are significant differences in the data and to define an UPL. The UPL is a concentration that, if exceeded, indicates the water quality has degraded from the baseline.

LAW used these methods to determine:

- If there is a statistically significant difference between monitoring stations within each watershed, with the purpose of deciding which monitoring points should be included in the Watershed Monitoring Program.
- If the analyses are affected by weather or seasonal variations, with the purpose of deciding the frequency of monitoring.
- UPLs for chemical parameters, with the purpose of establishing concentration limits to indicate when MCB Camp Pendleton needs to take action to protect its groundwater supplies.

LAW used SYSTAT™ and Microsoft Excel™ software to evaluate surface and groundwater data from monitoring locations in the San Mateo and Santa Margarita River Watersheds. The following sub-sections describe the methods used for data management (Sections 2.7.2.1 and 2.7.2.2) and for statistical analysis (Sections 2.7.2.3 through 2.7.2.7).

2.7.2.1 Outlier Analysis

Outliers are measurements that are extremely large or small relative to the rest of the data and, therefore, are suspected of misrepresenting the population from which they were collected. Outliers may result from transcription errors, data-coding errors, or measurement system problems such as instrument breakdown. However, outliers may also represent true extreme values of a distribution (for instance, a spill into the waterway) and indicate more variability in the population than was expected. Not removing true outliers and removing false outliers both lead to a distortion of estimates of the population parameters.

For this analysis potential outliers were identified graphically using trend plots (described in Section 2.7.1.1). Each suspected outlier was compared to its original data source and corrected or discarded if incorrect. No outliers were discarded solely for their extreme value.

2.7.2.2 Sorting by Frequency of Non-Detection

The statistical method used to compute control limits was largely dependent on the frequency of non-detects of a given parameter. A non-detect result implies some uncertainty of the concentration of that result because the true value is somewhere between zero and the sample-specific detection limit (DL). The handling of non-detects is paramount to the statistical procedures for determining control limits. Furthermore, as the proportion of non-detects in a data set increases, so does the uncertainty in the summary statistics computed for the data set. For this reason, the USEPA recommends segregating data into four classes based on the percentage of non-detects (USEPA, 1998). For the purposes of this report data sets are referred to as types A through D, as described below:

Data Set Type	Percent Non-Detect Values	Statistical Analysis Method
A	0%	No adjustment
B	0% to <15%	Replace non-detects with one-half the detection limit
C	15% to 50%	Cohen's Adjustment or Trimmed Mean

D	>50%	Non-parametric

Each parameter's data type is listed in Tables 10 and 11.

2.7.2.3 Data Normality Analysis

After outliers were deselected, the surface water and groundwater data were plotted for each parameter using normal, log transform, and exponential distribution probability plots with the SYSTAT™ statistical software program. Probability plots using each method are in Appendix G. These plots identified parameters as normally distributed or non-parametric. The results of normality analysis are presented in Tables 10 and 11. Normal data are listed as "N" and non-parametric data are listed as "NP."

Mean

The mean is the average of the values in the data set. It was calculated using the formula:

$$\bar{x} = \sum_{i=1}^{n} \left(\frac{x_i}{n} \right)$$

where

$\bar{x}$ = The mean of the data set
x_i = An individual data point within the data set
n = The total number of points in the data set

Means were computed for data set types A, B, and C.

a. Variance

The variance of a data set is the mean square deviation from the data set mean. Variances were calculated for type A, B, and C data sets using the formula:

$$s^2 = \sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{(n-1)}$$

where

s^2	=	The variance of the data set
$\overline{x}$	=	The mean of the data set
x_i	=	An individual data point within the data set
n	=	The total number of points in the data set

Standard Deviation

The standard deviation (s) of a data set is the square root of the variance (described in the preceding equation). Standard deviations were calculated for data set types A, B, and C.

b.

c.Upper Prediction Limits - Normal Distribution

For data sets with a normal distribution, a parametric upper prediction limit (UPL) that achieved 95 percent coverage was constructed using methods outlined by the USEPA (1992). A UPL is a statistical limit that indicates whether a new sample value is elevated relative to background data. In order to construct a parametric UPL that satisfies USEPA criteria, the USEPA recommends a minimum of eight data points (USEPA, 1992). For the San Mateo Watershed, each parameter data set has 25 data points; for the Santa Margarita River Watershed, each parameter data set has 70 data points. The parametric UPL was constructed using the formula:

$$\text{UPL} = \overline{x} + t(\nu,\alpha) \cdot s \cdot \sqrt{1+\frac{1}{n}}$$

where

UPL	=	the parametric upper prediction limit for a parameter
$\overline{x}$	=	The mean of the background data set
t	=	The 95th percentile of the Bonferroni t-statistic as a function of degrees of freedom (ν), and total probability of a type I error (α)
n	=	The number of data points in a background data set
ν	=	The degrees of freedom in the background data set
α	=	The probability of a type I error (false positive), for this project, $\alpha = 0.05$
s	=	The standard deviation of the background data set

The 95th percentile Bonferroni t-statistic values that were used in the UPL calculations are presented in Table A-1 in published literature (USEPA, 1998).

Upper Prediction Limit - Non-Parametric Distribution

For data sets that were neither normally nor log-normally distributed, type D data sets, a non-parametric UPL was constructed using the maximum contaminant level (MCL) divided by two or the detection limit (DL), whichever is larger.

2.7.2.4 Cohen's Adjustment

For Type C data, where non-detects were 15% to 50% of the total data set, Cohen's adjustment method was used to compensate for non-detects that are real values that exist below the DL and that have been censored at their detection limit.

Cohen's adjustment technique adjusts the mean and standard deviation by the following procedures. First, the mean and variance ($\overline{x}_d$ and V_d,) of the detected values greater than or equal to the DL were calculated. Then two parameters (h and γ) were calculated as follows (USEPA 1998):

$$h = \frac{(n-m)}{n}$$

$$\gamma = \frac{V_d}{(\overline{x}_d - SQL)^2}$$

where

n	=	The total number of points in the data set (including non-detects)
m	=	The number of detects in the data set
$\overline{x}_d$	=	Mean of values greater than or equal to the SQL
V_d	=	The coefficient of variation of values greater than or equal to the SQL
SQL	=	The non-varying sample quantitation limit
h	=	h Cohen's Adjustment parameter
γ	=	γ Cohen's Adjustment parameter

The values h and γ were used to determine the value of λ from published literature (Table A-10, Appendix A of USEPA 1998). Double linear interpolation was used when exact tabulated values for h and γ were not available. The calculations for h, γ, and λ are included in Appendix G.

The adjusted mean for detect values ($\overline{x}'_d$) was calculated by the formula:

$$\overline{x}'_d = \overline{x}_d - \lambda(\overline{x}_d - DL)$$

The adjusted standard deviation for detect values (s'_d) was calculated by the formula:

$$s'_d = \sqrt{s_d^2 + \lambda(\overline{x}_d - DL)^2}$$

where

$\overline{x}'_d$	=	The adjusted mean of detect values
s'_d	=	The adjusted standard deviation of detect values
$\overline{x}_d$	=	The mean of the detect values
s_d	=	The standard deviation of detect values
DL	=	The non-varying sample detection limit

If the calculated γ for the use of Cohen's adjustment was beyond the range of Table A-10 (>1.00), the Trimmed Mean adjustment was used.

2.7.2.5 Trimmed Mean

Trimming discards the data in the tail ends of a data set to develop an unbiased estimate of the population mean. For environmental data, non-detects usually occur in the left tail of the data distribution. Therefore, trimming the data can be used to adjust the data set to account for non-detects when estimating the mean. Developing a 100p% trimmed mean involves trimming p% of the data in both the lower and upper tails. The trimmed mean is calculated using the following steps:

p	=	the percent of non-detects in the data set
n	=	the total number of points in the data set

t = the integer part of the product np

Delete the t smallest values of the data set and t largest values of the data set.

Compute the mean of the remaining n-2t values using the equation above.

2.7.2.6 Analysis of Variance

Analysis of variance (ANOVA) was performed on parameters from the water quality data set using the SYSTAT™ software. The purpose of performing the ANOVA was to evaluate if there were significant differences between the water quality at sampling locations within each watershed. Least Squares Means plots for various analytical parameters are included in Appendix G. These plots show the mean values of the parameter on the y-axis for each monitoring location on the x-axis. For each sample station (SID$) a confidence interval is displayed in the vertical direction. When these intervals overlap it indicates there is no significant difference between means.

2.7.2.7 Pearson Correlation

Pearson correlation was used to measure the linear relationship between two sets of data. The Pearson correlation coefficient (r) is calculated using the following formula:

where

X = label for a variable from one data set

Y = label for the same variable from the other data set

N = number of data pairs

3.0 WATER QUALITY EVALUATION RESULTS

The evaluation of the relationship of surface water quality and groundwater quality in regard to protecting MCB Camp Pendleton's groundwater drinking water supply was accomplished using a variety of graphical and statistical methods. The relationships of surface water quality and groundwater quality were assessed using data from the monitoring wells installed for this project and data from surface water sampling locations. The results of the evaluation were incorporated into the Watershed Monitoring Program.

3.1 SAN MATEO WATERSHED

This section discusses the analysis of water quality data from three surface water monitoring stations and one groundwater monitoring well for the San Mateo Watershed. Figure 3 shows the location of the monitoring stations. Included in the analysis is a comparison of rainfall and gauging station measurements to water quality parameters to assess their relationships to water quality.

3.1.1 Trend Analysis

Trend plots from the database were generated for each of the chemical parameters analyzed. Appendix E contains these trend graphs. The plots were visually evaluated to:

- Detect obvious trends in chemical parameter concentrations over time, either short term or long term;
- Determine if parameters exceeded the drinking water maximum contaminant level (MCL) or basin plan objectives; and
- Assess if high concentrations could be traced to a tributary or creek, an indicator parameter.

A variety of patterns were observed, ranging from a scattering of data without a definite pattern to clearly identifiable trends. Table 8 provides a summary of these trends which are described below.

- Several constituents, such as cyanide and biochemical oxygen demand (BOD), had less than five measurements. Trends could not be discerned with these few measurements.

- Over 20 samples for the four monitoring locations in the San Mateo watershed were submitted for analysis of mercury content. Mercury was not detected in these samples. Cyanide was also not detected, although very few samples were analyzed for cyanide for each monitoring location.

- Flat trending data were observed for cyanide, hydroxide, iron, lead, manganese, mercury, potassium and sulfate; however, some higher concentrations were observed.

- Downward trends, which suggest an improvement in water quality, were observed for calcium, carbonate, chloride, specific conductance, copper, hardness, magnesium, potassium, sodium, and TDS.

- An apparent cyclic trend (potentially seasonal) was observed for TDS and pH.

- Historic increasing trends were observed from 1967 through 1976 for calcium, hardness, sulfate, and TDS. Since 1976, a downward trend is observed in the data. The downward trend suggests an improvement in the water quality over time.

- Different concentrations were observed for arsenic and phosphate among surface water sampling locations and between surface water and groundwater samples.

The trend analysis data were also evaluated to check the results for constituents that exceeded the drinking water MCLs. MCLs were exceeded in the historic record for:

- Nitrate, TDS, sulfate, manganese, iron, and specific conductance at Cristianitos Creek near San Clemente, San Mateo Creek at San Clemente, and San Mateo Creek at San Onofre (Stations 509, 510, and 511);

- Chloride and copper at Cristianitos Creek near San Clemente (Station 509);

- Fluoride at Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Clemente (Station 510);

- MBAS at San Mateo Creek at San Onofre (Station 511);

- Arsenic and lead at San Mateo Creek at San Clemente (Station 510) and at San Onofre (Station 511).

The analytical data collected since 1997 show MCLs were exceeded at least once for:

- TDS and specific conductance at Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Onofre (Station 511);

- Nitrate at San Mateo Creek at San Onofre (Station 511);
- Manganese and iron at Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Onofre (Station 511);
- Fecal coliform at Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Clemente (Station 510);
- Lead in groundwater at MW-3 (Station 103).

A statistical approach was taken to evaluate the trend data. Least squares linear regressions were fitted to some of the data to develop an equation for forecasting water quality. However, because the data sets have large standard deviations the use of these trend lines is not recommended for forecasting water quality.

Based on the trend analysis and a comparison of the analytical results to MCLs, parametric intra-monitoring point, parametric statistical comparison to gauging station measurements, and statistical historical versus current data (1997 to 1999) were performed for the six parameters that currently exceed the MCLs. These analyses were also performed for arsenic, calcium, bicarbonate, chloride, sodium, and phosphate, which had different concentrations in the monitoring well samples and surface water samples as identified in the trend graphs and Piper diagrams.

The historical data was reviewed, and it was found that the concentrations of the following metals were below their regulated MCLs: antimony, barium, beryllium, cadmium, chromium, mercury, nickel, and selenium.

3.1.2 Piper Diagrams

Piper diagrams were used to evaluate if the surface water monitoring locations in the San Mateo Watershed had similar or dissimilar water quality from 1997 to 1999 and to determine if the water quality of the groundwater is similar or dissimilar to surface water. Appendix F contains the Piper diagrams for each monitoring location.

The surface water quality in Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Clemente (Station 510) is dissimilar. Figure 5 shows the water quality for Cristianitos

Creek (Station 509) plots in a fairly tight grouping. The water is characterized as a calcium chloride water. In comparison the water in San Mateo Creek (Station 510) is a calcium bicarbonate water as indicated by the tight grouping to the left of the samples from Cristianitos Creek (Station 509). The tight groupings of each plot show that the water quality varies very little between winter and summer and that the sources of the water are constant.

Figure 6 shows that water from Cristianitos Creek (Station 509) and San Mateo Creek (Station 510) mix below the confluence of these streams at San Mateo Creek at San Onofre (Station 511). The plot shows that the water at Station 511 is predominantly from Cristianitos Creek, with very little influence from San Mateo Creek. However, during March 1998 water at Station 511 (sample 511002) had a plot that was more similar to water from San Mateo Creek. This difference appears to be related to the above average precipitation recorded that year during March and the preceding months. This relationship suggests that either the flow in Cristianitos Creek is greater than flow in San Mateo Creek or that most of the water in San Mateo Creek percolates into the subsurface. In August of 1998, Station 511 (sample 511004) had a water quality different than that of either San Mateo or Cristianitos Creeks. It appears that sodium, in a source of flow on the Base, contributed water to the creek down gradient of Stations 509 and 510.

Groundwater monitoring well MW-3 (Station 103) is located within the Cristianitos Creek drainage area, upstream from the surface water sampling location at Station 509. As shown on Figure 7, the water in Station 103 is a calcium chloride water, which is similar in composition to the surface water at Station 509. However, in March 1998 (sample 103002), the water quality in monitoring well MW-3 was characterized as calcium bicarbonate, different than the water in Cristianitos Creek.

The plots of the historical data (Appendix F) show a similar relationship as described above with waters form Cristianitos Creek having the most influence on the water quality at Station 511.

3.1.3 Statistical Analysis

The following subsections discuss the statistical methods used, the statistical results, and the upper prediction limits for use in future monitoring.

3.1.3.1 Statistical Approach

The chemical data set for the San Mateo Watershed was evaluated to select the appropriate method for statistical analysis. A summary of the statistics for the San Mateo Watershed is presented in Table 10. Values were calculated for each of 33 water quality parameters for the period from 1997 to 1999 based on data type (described in Section 2.7.2.2) and on probability plots. Data were tested using normal, log-transformed normal, exponential, and chi-squared probability plots. These plots are included in Appendix G. The statistical distributions selected are as follows:

Non-parametric	Normal	Log Transformed Normal
Arsenic	Alkalinity	Phosphorus
Biochemical Oxygen Demand	Bicarbonate	Potassium
Copper	Boron	
Cyanide	Calcium	
Fecal Coliform	Carbonate	
Hydroxide	Chloride	
Lead	Conductivity	
Mercury	Fluoride	
Nitrate	Hardness	
Nitrogen	Iron	
Oil &Grease	Magnesium	
Surfactants	Manganese	
Total Coliform	pH	
Zinc	Sodium	
	Sulfate	
	Total Dissolved Solids	
	Total Organic Carbon	

The Cohen adjustment was used on the boron, carbonate, and total organic carbon (TOC) data sets and the Trimmed Mean adjustment was used on the iron, manganese, phosphorus, and potassium data sets. The statistical parameters - mean, standard deviation, variance, and upper prediction limit - were calculated from the adjusted data sets.

3.1.3.2 Statistical Relationships

Statistical analysis was used to evaluate if variations in the chemical parameters were related to rainfall or stream gauge measurements and whether the analyses were significantly different between monitoring points. The goals of the statistical analysis were to define the frequency and sample locations of future monitoring events.

Precipitation and daily stream flow values were plotted over a time scale from October 1993 through September 1997 to evaluate their correlation. The rain events were recorded daily at the Marine Corps Air Station, Camp Pendleton and the flow data was from the U.S. Geological Survey gauging station (No.11046360) at Cristianitos Creek near San Clemente. Figure 8a shows the entire time span and Figures 8b and 8c show expanded portions of the data to provide more details. The Pearson correlation coefficient is 0.445. This is a poor correlation and probably results from several rain events occurring after a dry period and the ground absorbing the water with no runoff to the creek. Figure 8c shows 13 rain days when there was no additional flow recorded in the creek. The figures also show that stream flow increased several times during the year when there was no rainfall, probably due to discharges from unknown sources that may have contained poor quality water. This also affected the correlation. This occurred on 12/31/97, 4/26/98, 7/5/98, 7/10/98, and 7/26/98. Because of the poor correlation to rainfall and the apparent unscheduled discharges (other than from rainfall) that appear to occur, the frequency of monitoring cannot be limited to just certain portions of the year.

Gauging station measurements were plotted over time from 1997 through 1999 to evaluate if chemical concentrations correlated with stream gauge measurements. Previous authors evaluation suggested some seasonal cyclic variations in TDS. Trend plots evaluated for this project also suggested an apparent cyclic nature possibly seasonal for TDS and pH. However, plots (included in Appendix E) of stream flow and TDS for each monitoring location do not show a consistent correlation for all monitoring stations. Therefore, statistically there is no correlation.

Analysis of variance (ANOVA) least squares means was used to evaluate if there was a statistical difference between the monitoring stations for those chemical parameters that had a normal distribution, had established water quality goals, and were suggested by other methods to possibly be statistically different. The ANOVA set the baseline conditions for the watershed for comparison of future results. The plots for bicarbonate, calcium, chloride, conductance, fluoride, iron, magnesium, manganese, pH, phosphorus, sulfate, sodium, and TDS are in Appendix G. These plots show significant differences between surface water monitoring Stations 509 and 510. Station 511 is located downstream from the confluence of San Mateo Creek and Cristianitos Creek and, as expected, the results fall between the results of Stations 509 and 510 except for nitrate and fluoride. The plots for iron, magnesium, manganese, and pH indicate surface water quality is not the only factor in the quality of groundwater measured at Station 103. The nonparametric constituents had too few data points for statistical calculations.

3.1.3.3 Upper Prediction Limits

Upper prediction limits (UPLs) were statistically calculated for 31 chemical parameters contained within the chemical database. UPLs were not calculated for total or fecal coliform because results for those parameters are reported by the laboratory as a statistical "most probable number" which is a step function. Calculating a UPL from a step function is not appropriate. Exceeding the UPL for a parameter in a future sampling event would indicate that, the water quality in the San Mateo Watershed is degraded compared to the baseline calculated in this report. UPLs from Table 10 are presented below. It should be noted that UPLs for conductance, iron, manganese, and TDS exceed MCLs.

Parameter	**UPL**	**Units**	**Parameter**	**UPL**	**Units**
Alkalinity	223	mg/L	Lead	0.0075	mg/L
Arsenic	0.025	mg/L	Magnesium	39	mg/L
Bicarbonate	220	mg/L	Manganese	1.7*	mg/L
BOD	2	mg/L	Mercury	0.001	mg/L
Boron	0.5	mg/L	Nitrate	23	mg/L
Calcium	116	mg/L	Nitrogen	5	mg/L
Carbonate	5.5	mg/L	Oil & Grease	1	mg/L
Chloride	151	mg/L	pH	9	pH
Conductivity	1244**	µmhos/cm	Phosphorus	0.4	mg/L
Copper	0.5	mg/L	Potassium	5.0	mg/L
Cyanide	0.1	mg/L	Sodium	116	mg/L
Fluoride	0.5	mg/L	Sulfate	230	mg/L

Parameter	UPL	Units	Parameter	UPL	Units
Hardness	434	mg/L	Surfactants	0.25	mg/L
Hydroxide	0.5	mg/L	TDS	778**	mg/L
Iron	23*	mg/L	TOC	7.4	mg/L
			Zinc	2.5	mg/L

Notes:

*- Exceeds MCL for Drinking Water

** - Exceeds Recommended Levels for Drinking Water

3.2 SANTA MARGARITA RIVER WATERSHED

This section discusses the analyses of water quality data from eight surface water monitoring stations and two groundwater monitoring wells for the Santa Margarita River Watershed. Figure 4 shows the location of the monitoring locations. Included in the analysis is a comparison of rainfall and gauging station measurements to water quality parameters to assess their relationships to water quality.

3.2.1 Trend Analysis

The chemical database was used to generate trend plots for each of the chemical parameters that were analyzed. Appendix E contains the trend graphs. The plots were visually evaluated to:

- Detect obvious trends in chemical parameter concentrations over time, either short term or long term;
- Determine if parameters exceeded the drinking water maximum contaminant level (MCL) or basin plan objectives; and
- Assess if high concentrations could be traced to a tributary or creek.

A variety of trends were observed, ranging from a scattering of data without a definite pattern to clearly identifiable trends. Table 9 provides a summary of these trends, which are described below.

- Several constituents, such as cyanide, had less than five measurements. Trends could not be discerned with these few measurements.

- Over 20 samples for the three monitoring locations in the Santa Margarita River Watershed were submitted for analysis of mercury. Mercury was not detected in the samples.

- Flat trending data was observed for arsenic, hydroxide, iron, lead, manganese, mercury, and potassium; however, some high concentrations were observed.

- Downward trends, which suggest an improvement in water quality, were observed for bicarbonate, boron, carbonate, copper, fluoride, and nitrate. Nitrate may be increasing at Sandia Creek near Fallbrook (Station 502) and De Luz Creeks near Fallbrook (Station 506).

- A cyclic (seasonal) trend was observed for alkalinity and chloride.

- Increasing trends were observed for bicarbonate and hardness on Rainbow Creek near Fallbrook (Station 503) and Fallbrook Creek near Fallbrook (Station 507).

- Increasing trends were observed for sodium and sulfate on Sandia Creek near Fallbrook (Station 502) and De Luz Creek near Fallbrook (Station 506).

- Increasing trends were observed for calcium and manganese.

- TDS and specific conductance have varying patterns. Increasing trends for TDS and specific conductance were seen at De Luz near Fallbrook (Station 506) and Rainbow Creek near Fallbrook (Station 503).

- Historical increasing trends were observed from 1961 through 1983 for specific conductance and TDS in Murrieta Creek near Temecula (Station 505) and in Rainbow Creek near Fallbrook (Station 503) between 1961 through 1987. Since then, the levels dropped and have maintained a relatively constant value. However, some are still above the MCL

- Bicarbonate, calcium, magnesium, hardness, and phosphate all were showing increasing trends.

- Different water quality was observed for arsenic in the surface water samples and in surface water versus groundwater.

Historically, the following parameters have exceeded the MCL at least once:

- MBAS at Rainbow Creek near Fallbrook (Station 503);

- Nitrate at Santa Margarita River near Fallbrook (Station 501), Sandia Creek near Fallbrook (Station 502), Rainbow Creek near Fallbrook (Station 503), Murrieta Creek at Temecula (Station 505), De Luz Creek near Fallbrook (Station 506), Fallbrook Creek near Fallbrook (Station 507), and the Santa Margarita River at Ysidora (Station 508);

- Sulfate in groundwater at DeLuz Creek near Fallbrook (Station 506), Santa Margarita River near Fallbrook (Station 501), Sandia Creek near Fallbrook (Station 502), Rainbow Creek near Fallbrook (Station 503), Murrieta Creek near Temecula (Station 505), and Fallbrook Creek near Fallbrook (Station 507);

- Manganese at Fallbrook Creek near Fallbrook (Station 507), De Luz Creek near Fallbrook (Station 506), and Rainbow Creek near Fallbrook (Station 503);

- Chloride at Murrieta Creek at Temecula (Station 505), Fallbrook Creek near Fallbrook (Station 507), and DeLuz Creek near Fallbrook (Station 506);

- Conductivity, TDS, and iron at all stations;

- Fluoride at the Santa Margarita River near Fallbrook (Station 501), Rainbow Creek near Fallbrook (Station 503), the Santa Margarita River near Temecula (Station 504), Murrieta Creek at Temecula (Station 505), De Luz Creek near Fallbrook (Station 506), and Fallbrook Creek near Fallbrook (Station 507);

- Arsenic at the Santa Margarita River near Fallbrook (Station 501), Rainbow Creek near Fallbrook (Station 503), and De Luz Creek near Fallbrook (Station 506);

- Fecal coliform at the Santa Margarita River near Temecula (Station 501), Sandia Creek near Fallbrook (Station 502), Rainbow Creek near Fallbrook (Station 503), Santa Margarita River near Temecula (Station 504), Murrieta Creek at Temecula (Station 505), De Luz Creek near Fallbrook (Station 506), Fallbrook Creek near Fallbrook (Station 507), and the Santa Margarita River at Ysidora (Station 508); and

- Lead at the Santa Margarita River near Fallbrook (Station 501), Murrieta Creek at Temecula (Station 505), De Luz Creek near Fallbrook (Station 506), and Fallbrook Creek near Fallbrook (Station 507).

Review of the trend analyses data also showed that the MCL is currently being exceeded for:

- Nitrate at Rainbow Creek near Fallbrook (Station 503);

- Sulfate, iron, manganese, TDS and specific conductance at all surface water monitoring stations;

- Chloride at Sandia Creek near Fallbrook (Station 502);

- Lead at Rainbow Creek near Fallbrook (Station 503), the Santa Margarita River near Temecula (Station 504), De Luz Creek near Fallbrook (Station 506), Fallbrook Creek near Fallbrook (Station 507), and in both MW-1 and MW-2 (Stations 101 and 102); and

- Nitrate in groundwater at MW-2, the De Luz Creek well (Station 102).

A statistical approach was taken to evaluate the trend data. Least squares linear regressions were fitted to some of the data to develop an equation for forecasting water quality. However, because the data sets have large standard deviations the use of these trend lines are not recommended for forecasting water quality.

Based on the trend analysis and a comparison of the analytical results to MCLs, parametric intra-monitoring point, parametric statistical comparison to gauging station measurements and statistical historical versus current data (1997 to 1999) were performed for the seven parameters that currently exceed the MCLs. These analyses were also performed for arsenic, calcium, carbonate, sodium, and chloride, which had different concentrations in the monitoring well samples and surface water samples as identified in the trend graphs and Piper diagrams.

3.2.2 Piper Diagrams

Piper diagrams were used to evaluate if the surface water monitoring locations in the Santa Margarita River Watershed had similar or dissimilar water quality from 1997 to 1999 and to determine if the water quality of the groundwater and surface water is similar or dissimilar. Appendix F contains the Piper diagrams for each monitoring location.

Water in the upper portion of the Santa Margarita River is from Murrieta Creek (Station 505), Temecula Creek (Station 504 combined with flow from 505), and several tributaries including Sandia Creek (Station 502) and Rainbow Creek (Station 503). Water in these creeks and tributaries mixes and is monitored at Station 501, Santa Margarita River near Fallbrook. Figure 9 shows the plot of the water quality at these stations during August 1998. The plot shows the water from Murrieta Creek (Station 505) is a sodium chloride water. Temecula Creek does influence the water quality in the Santa Margarita River (Station 504) as shown by a slight decrease in sodium. Water from Sandia Creek is different and is a calcium chloride water. Graphs in Appendix F show the water in Murrieta and Temecula Creeks varies throughout the year. However, the water from Sandia Creek is consistent with little to no seasonal change. Figure 9 shows that at Station 501 (Santa Margarita River near Fallbrook), which is downstream from these other sources which has waters from the creeks and tributaries have mixed resulting in a calcium chloride water. This suggests that Sandia Creek (Station 502) has a larger flow and hence a strong influence on the water quality in the Santa Margarita River or those geologic materials containing calcium has affected the water quality.

The surface water quality in the lower portion of the Santa Margarita River is measured at two locations along the river - one on the Base (Santa Margarita River at Ysidora [Station 508]) and one in the river at the Fallbrook Public Utilities District (FPUD) sump (Santa Margarita River near Fallbrook [Station 501]). Figure 10 shows the water quality at the two stations is calcium chloride in character. The water at these two locations is almost identical, except in May 1999 (sample 508007) when water from a different source must have increased the sodium content at Station 508. Figure 11 shows the water quality at the monitoring stations upstream of Station 508 for May 1999. Sodium is present in water samples from both Murrieta and Temecula Creeks (Stations 504 and 505); however, these stations are upstream of Station 501. Station 501 is a mixture of water from these two stations, yet it does not compare with sample 508007. De Luz Creek (Station 506), which merges with the Santa Margarita River downstream of Station 501, Santa Margarita River near Fallbrook, could have an effect on the water quality seen at Station 508, Santa Margarita River near Ysidora. As shown on Figure 11, water from De Luz Creek is calcium chloride in character and is not the source of sodium measured at Station 508. Both Stations 501 and 101, Santa Margarita River near Fallbrook and MW-1, have sodium chloride water. Monitoring well MW-1 (Station 101), which is downstream of Station 501, contains sodium bicarbonate water. It appears that the source of the sodium water is from Fallbrook Creek (Station 507) or less likely from groundwater MW-1 (Station 101) that emerges as surface water. Low flows in the Santa Margarita River and releases from Lake O'Neill appear to have affected surface water quality at Station 508, Santa Margarita River at Ysidora, during May 1999. Otherwise, water samples collected at either Station 501 or 508 are representative of water in the Santa Margarita River.

Groundwater monitoring well MW-1 (Station 101) is located near surface water monitoring Station 501, Santa Margarita River near Fallbrook. As shown on Figure 12, the water in MW-1 is usually a calcium bicarbonate water, which is different than the calcium chloride water in the Santa Margarita River at Station 501 (Figure 13). Only once, in March 1998 at Stations 101 and 501, was the water in a monitoring well nearly identical in character to water in the Santa Margarita River. This suggests there is little, if any recharge to groundwater from the river in the gorge. The plot does suggest that some water from the river mixed with the groundwater during June and November 1998 and February and May 1999. In February and August 1998, the river did not appear to affect groundwater quality. Because there does not appear to be a relationship to seasonal changes it is our opinion that either:

- Sediment thickness within the river channel and fluctuating depth to groundwater affect how much the river recharges the groundwater and affects its water quality, or
- Fine-grained sediment accumulation in the river channel reduces recharge through the coarser-grained sediments unless high flows remove the fine-grained sediments blocking the pore spaces.

In contrast to MW-1, MW-2 (Station 102) shows a strong relationship of water quality with surface water Station 506 (De Luz Creek near Fallbrook). Figure 13 shows this relationship. However, the water quality of a few groundwater samples does not relate directly with the quality of surface water samples. This occurred during the first and second sampling rounds when surface and groundwater sampling events were separated by about 7 to 14 days. Based on estimated groundwater velocities and travel times through sand and gravel, a particle of water would take about 3 to 14 days to travel from the creek to the groundwater well. In March 1998, dissimilar water quality was noted when the surface and groundwater samples where collected within only one day of each other. This disparity could be caused by a change in surface water that occurred days prior to sampling the surface water or by groundwater with different water quality.

Piper Diagrams of the historical data indicate the water quality has remained consistent for Stations 501 Santa Margarita River near Fallbrook, 505 Murrieta Creek near Temecula, and 507 Fallbrook Creek near Fallbrook. There has been a shift in anions at Station 503 Rainbow Creek near Fallbrook from bicarbonate to sulfate. At Station 506 Del Luz Creek near Fallbrook the anion shift was from bicarbonate to chloride.

3.2.3 Statistical Analyses

This sections discusses the results of the statistical methods used, statistical results, and provides upper predictive limits for use in future monitoring for the Santa Margarita River Watershed.

3.2.3.1 Statistical Approach

The chemical data set for the Santa Margarita Watershed was evaluated to select the appropriate method for statistical analysis. The summary statistics for the Santa Margarita Watershed are presented in Table 11. Values were calculated for each of 33 water quality parameters based on the data type (as described in Section 2.7.2.2) and on probability plots. Data were tested using normal, log transformed normal, exponential, and chi-squared probability plots. These plots are included in Appendix G. The statistical distributions selected are as follows:

Non-Parametric	Normal	Log Transformed Normal
Arsenic	Alkalinity	Bicarbonate
Biochemical Oxygen Demand	Boron	Fluoride
Copper	Calcium	Iron
Cyanide	Carbonate	Phosphorus
Fecal Coliform	Chloride	Potassium
Hydroxide	Conductivity	
Lead	Hardness	
Mercury	Magnesium	
Nitrogen	Manganese	
Oil &Grease	Nitrate	
Surfactants	pH	
Total Coliform	Sodium	
Zinc	Sulfate	
	Total Dissolved Solids	
	Total Organic Carbon	

The Cohen adjustment was used on the boron and carbonate data sets. The statistical parameters, mean, standard deviation variance, and upper prediction limit were calculated from the adjusted data sets.

3.2.3.2 Statistical Relationships

Statistical analysis was used to evaluate if variations in the chemical parameters where related to rainfall or stream gauge measurements and whether the analyses were significantly different between monitoring points. The goals of the statistical analysis were to define when to monitor and where to monitor.

Precipitation and daily stream flow values were plotted over a time scale from October 1993 through September 1997 to evaluate their correlation. The rain events were recorded daily at the Marine Corps Air Station, Camp Pendleton and the flow was from the U.S. Geological Survey gauging station located on the Santa Margarita River near Fallbrook (USGS No.11044330). Figure 14a shows the entire time span and Figures 14b and 14c show expanded portions of the data to provide more details. The Pearson correlation coefficient is 0.665. This is a poor correlation and probably results from several rain events occurring after a dry period and the ground absorbing the water with no runoff to the river. Figures 14b and 14c show periods when the stream flow peaks prior to the peak in precipitation (for example on 3/25/98 and 5/5/98). This anomaly is probably due to the timing of flow measurements taken relative to the rain event and the fast surface drainage from the watershed. Figure 14b also shows at least four increases in flow during a period with no recorded rain events (6/23/98, 7/1/98, 7/5/98, and 7/11/98), indicating non-weather related releases occurred upstream. Because of the poor correlation to rainfall and the fact that discharges other than from rainfall are randomly occurring, the frequency of monitoring cannot be limited to just certain portions of the year.

Gauging station measurements were plotted over time from 1997 through 1999 to evaluate if chemical concentrations correlated with stream gauge measurements. Evaluation by previous authors suggested some seasonal cyclic variations in TDS; however, plots (included in Appendix E) of stream flow and TDS for each monitoring location do not show a consistent correlation for all monitoring stations. Therefore, statistically there is no correlation.

Analysis of variance (ANOVA) least squares means was used to evaluate if there was a statistical difference between the monitoring stations for those chemical parameters that had a normal distribution, had established water quality goals, and suggested by other methods to have a statistical difference. The ANOVA set the baseline conditions for the watershed for comparison of future results. The plots for bicarbonate, calcium, chloride, conductance, fluoride, iron, manganese, nitrate, pH, sulfate, sodium, and TDS are in Appendix G. These plots show significant differences between monitoring well MW-1 (Station 101) and surface water in the Santa Margarita River near Fallbrook (Station 501) for chloride, fluoride, iron, manganese, and sulfate. Also statistically different water quality was observed between monitoring well MW-2 (Station 102) and surface water in De Luz Creek near Fallbrook (Station 506) for iron, nitrate, manganese, and sulfate. There is possibly a significant difference for TDS; however, the specific conductance, which directly relates to TDS does not show a difference. Monitoring locations on Murrieta Creek near Temecula (Station 505) and the Santa Margarita River near Temecula (Station 504) displayed no significant differences, except for calcium. Monitoring locations on De Luz Creek (Station 506), Fallbrook Creek (Station 507), Santa Margarita River near Fallbrook (Station 501), and the Santa Margarita River at Ysidora (Station 508) displayed no significant differences. The nonparametric constituents had too few data points for statistical calculations.

3.2.3.3 Upper Prediction Limits

Upper prediction limits (UPLs) were statistically calculated for 31 chemical parameters contained within the chemical database. UPLs were not calculated for total or fecal coliform because results for those parameters are reported by the laboratory as a statistical "most probable number" which is a step function. Calculating a UPL from a step function is not appropriate. Exceeding the UPL for a parameter in a future sampling event would indicate that the Santa Margarita River Watershed water quality is degraded compared to the baseline calculated in this report. UPLs from Table 11 are presented below. It should be noted that UPLs for conductance, iron, manganese, sulfate, and TDS exceed MCLs.

Parameter	UPL	Units	Parameter	UPL	Units
Alkalinity	365	mg/L	Lead	0.0075	Mg/L
Arsenic	0.025	mg/L	Magnesium	62	Mg/L
Bicarbonate	362	mg/L	Manganese	0.91*	Mg/L
BOD	2	mg/L	Mercury	0.001	Mg/L
Boron	0.39	mg/L	Nitrate	14	Mg/L
Calcium	132	mg/L	Nitrogen	5	Mg/L

Parameter	UPL	Units	Parameter	UPL	Units
Carbonate	4.6	mg/L	Oil & Grease	1	Mg/L
Chloride	230	mg/L	pH	8.6	pH
Conductivity	1595**	µmhos/cm	Phosphorus	1.0	Mg/L
Copper	0.5	mg/L	Potassium	9.1	Mg/L
Cyanide	0.1	mg/L	Sodium	144	Mg/L
Fluoride	0.99	mg/L	Sulfate	343**	Mg/L
Hardness	597	mg/L	Surfactants	0.25	Mg/L
Hydroxide	0.5	mg/L	TDS	1027**	Mg/L
Iron	17*	mg/L	TOC	22	Mg/L
			Zinc	2.5	Mg/L

- Exceeds MCL

** - Exceeds Recommended MCL

4.0 WATERSHED MONITORING PROGRAM

The Watershed Monitoring Program (WMP) is designed to monitor the surface water sources that recharge the groundwater used by MCB Camp Pendleton. It is based on information presented in the preceding sections of this report. The purpose of the WMP is to indicate to the Base when a water quality parameter exceeds an upper prediction limit (UPL), indicating that the water quality has degraded below the baseline conditions and that action should be taken to identify and mitigate the source of the problem. This WMP is for portions of the San Mateo and Santa Margarita River Watersheds located on or adjacent to MCB Camp Pendleton.

4.1 MONITORING STATION LOCATIONS

We recommend that ten surface water sampling stations and three groundwater sampling stations be utilized. In the San Mateo Watershed, three surface water locations and one groundwater location should be sampled. In the Santa Margarita River Watershed, seven surface water and two groundwater locations should be sampled. Based on the statistical analyses discussed in Section 3 of this report, one surface water sampling location has been removed from the locations sampled during the 1997-1999 program. Station 508, Santa Margarita River at Ysidora, was removed because its water quality is the same as that of Station 501, Santa Margarita River near Fallbrook. Justification for selecting the surface water and groundwater sampling locations for each watershed is presented in the following subsections.

4.1.1 San Mateo Watershed

The results of the trend analysis, Piper diagrams and statistical analysis were used to decide which monitoring stations in the San Mateo Watershed are representative of the water quality.

The trend analyses showed most parameters were either flat lying or are currently decreasing. There were no increasing trends in this watershed. There were recognizable differences in quality between surface water stations and also between surface water and groundwater. Water quality differences were observed for:

- Arsenic historically has been detected at San Mateo Creek at San Clemente (Station 510), and San Mateo Creek at San Onofre (Station 511), but not at Cristianitos Creek near San Clemente (Station 509). Since 1997 arsenic was not detected in any surface water stations but was detected in the groundwater monitoring well MW-3 (Station 103).

- Phosphate historically has had higher concentrations in San Mateo Creek at San Clemente (Station 510) and San Mateo Creek at San Onofre (Station 511) than at Cristianitos Creek near San Clemente (Station 509). Phosphate is currently higher in groundwater, MW-3 (Station 103) than at any surface water station monitored in this watershed.

The review of the trend analyses also showed that the MCL has been exceeded at least once since 1997 for:

- TDS and specific conductance at Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Onofre (Station 511);
- Nitrate at San Mateo Creek at San Onofre (Station 511);
- Manganese and iron at Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Onofre (Station 511);
- Fecal coliform at Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Clemente (Station 510);
- Lead in groundwater at MW-3 (Station 103).

The Piper diagrams showed:

- The water in Cristianitos Creek near San Clemente (Station 509) is a calcium chloride water and the water in San Mateo Creek at San Clemente (Station 510) is calcium bicarbonate.

- Water in San Mateo Creek at San Onofre (Station 511) is a mixture of water from these creeks, but at times is affected by activities that occur downstream from Stations 509 and 510.

- Groundwater quality in MW-3 (Station 103) is different than surface water quality at Station 509, Cristianitos Creek near San Clemente.

The results of the statistical analysis showed:

- The statistical analysis for variance using the least square means method confirmed that there is a statistical difference in water quality between Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Clemente (Station 510).

- . There is a statistical difference in the water quality at San Mateo Creek at San Onofre (Station 511) compared to Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Clemente (Station 510) for fluoride and nitrate.

- There is a statistical difference in water quality between groundwater at MW-3 in Cristianitos Creek (Station 103) and surface water at Cristianitos Creek near San Clemente (Station 509), as indicated by iron, magnesium, manganese, and pH concentrations.

- Water at San Mateo Creek at San Onofre (Station 511), being a mixture of Stations 509 and 510, usually is not statistically different.

The recommended surface water sampling stations in the San Mateo Watershed are based on the trend analysis, Piper diagrams and the statistical analysis. The statistical analysis detected significant differences between Cristianitos Creek near San Clemente (Station 509); San Mateo

Creek at San Clemente (Station 510) and MW-3 (Station 103). The Piper diagrams also showed a similar relation as indicated by the statistical analyses but also showed water at San Mateo Creek at San Onofre (Station 511) is being locally affected by agricultural sources. Evaluation of the trend graphs and the data show that current MCLs are at times exceeding drinking water standards for fecal coliform, lead, iron, manganese, nitrate (as nitrogen), specific conductance, and TDS at different locations throughout the watershed at the different stations. It also showed a difference between arsenic and phosphate.

Based on these results, the recommended surface water monitoring stations in the San Mateo Watershed are Cristianitos Creek near San Clemente (Station 509), San Mateo Creek at San Clemente (Station 510) and San Mateo Creek at San Onofre (Station 511). We also recommend sampling groundwater at MW-3, the Cristianitos Creek well (Station 103).

4.1.2 Santa Margarita River Watershed

The results of the trend analysis, Piper diagrams and statistical analysis were used to decide which monitoring stations in the Santa Margarita Watershed are representative of the water quality.

The trend analyses showed recognizable differences in quality between surface water stations and also between surface water and groundwater. Historical water quality trends were observed at:

- Sandia (Station 502) and De Luz (Station 506) Creeks where sodium, chloride, sulfate, and nitrate are increasing;
- Rainbow Creek (Station 503) and Fallbrook Creek (Station 507) where bicarbonate are increasing;
- Temecula (Station 504) and Murrieta (Station 505) Creeks, where phosphate is currently increasing;
- Temecula (Station 504) and Murrieta (Station 505) Creeks, where TDS and specific conductance have increased in the past; and
- Rainbow Creek (Station 503), where nitrate was increasing but has since declined.

The review of the trend analyses data also showed that the MCL is currently being exceeded for:

- Nitrate at Rainbow Creek (Station 503),;

- Sulfate, iron, manganese, TDS and specific conductance at all surface water monitoring stations; and

- Chloride at Sandia Creek (Station 502).

The Piper diagrams showed that:

- Similar water quality (calcium chloride in nature) was observed at the Santa Margarita River near Fallbrook (Station 501) and at the Santa Margarita River at Ysidora (Station 508). Water quality at Station 508 is affected by water quality discharging from Fallbrook Creek (Station 507) and when water is released from Lake O'Neill. Station 507 has sodium chloride water.

- Water quality from De Luz Creek near Fallbrook (Station 506), which joins the Santa Margarita River between Stations 501 and 508, has similar water quality to Station 508.

- The Santa Margarita River near Fallbrook (Station 501) is a mixture of water from Sandia Creek near Fallbrook (Station 502), Rainbow Creek near Fallbrook (Station 503), Murrieta Creek near Temecula (Station 505), and from Temecula Creek. The water from these creeks has different water quality ranging from calcium chloride to sodium chloride water. The water in the Santa Margarita River near Fallbrook at Station 501 is strongly influenced by Sandia Creek (Station 502).

- Groundwater at MW-1 (Station 101) is different than surface water in the Santa Margarita River at nearby surface water sampling Station 501. The water in the monitoring well is calcium bicarbonate and the surface water is calcium chloride. The river has only minor influence on the groundwater quality.

- Groundwater in MW-2 (Station 102) is similar to that in De Luz Creek as observed at nearby surface water sampling Station 506. However, when surface and groundwater sampling times were separated by several days, the water quality was different.

The results of the statistical analysis showed there were statistically significant differences in water quality at the following locations:

- Between monitoring well MW-1 (Station 101) and surface water in the Santa Margarita River near Fallbrook (Station 501) for bicarbonate, chloride, fluoride, iron, manganese, sodium, and sulfate.

- Between monitoring well MW-2 (Station 102) and surface water in De Luz Creek near Fallbrook (Station 506) for iron, nitrate, manganese, and sulfate. There is possibly a significant difference for TDS; however, specific conductance, which is a parameter with a direct relationship to TDS, does not correlate.

- Monitoring locations on Murrieta Creek near Temecula (Station 505) and the Santa Margarita River near Temecula (Station 504) displayed no significant differences except for calcium.

- Rainbow Creek near Fallbrook (Station 503) showed a significant difference for phosphate compared to the rest of the monitoring stations.

- Monitoring well MW-1 (Station 101) showed a statistical difference for sodium compared to the rest of the monitoring stations.

- Sandia Creek near Fallbrook (Station 502) and MW-1 (Station 101) showed a significant difference for chloride compared to the rest of the stations.

- Fallbrook Creek near Fallbrook (Station 507) and MW-1 (Station 101) showed a significant difference for bicarbonate compared to the rest of the stations.

- De Luz Creek near Fallbrook (Station 506), Fallbrook Creek near Fallbrook (Station 507), the Santa Margarita River near Fallbrook (Station 501), and the Santa Margarita River at Ysidora (Station 508) displayed no significant differences.

The recommended surface water sampling stations in the Santa Margarita River Watershed are based on the trend analysis, Piper diagrams and the statistical analysis. The statistical analysis detected significant differences in the surface water quality for bicarbonate, calcium, chloride, sodium, and phosphate. The Piper diagrams also showed that water quality was different within the Santa Margarita River and its tributaries for bicarbonate, calcium, chloride, and sodium. Evaluation of the trend graphs and the data show that current concentrations are at times exceeding drinking water standards for chloride, specific conductance, iron, manganese, nitrate (as nitrogen), sulfate, and TDS at different locations throughout the watershed.

Because some of these parameters exceed the MCLs and there are statistical differences in water quality at all monitoring stations; all stations except one should be included in future monitoring efforts. However, as shown by both the Piper diagrams and statistical analysis, water quality at Stations 501 and 508, Santa Margarita River near Fallbrook and Santa Margarita River at Ysidora, respectively, is nearly identical. There was only one time when parameter concentrations at Station 508 differed from Station 501, and it was probably due to an influence from Fallbrook Creek

(Station 507). Because of the similarity of water quality and the fact that Station 507 is being monitored, we recommend that Station 508, Santa Margarita River at Ysidora, be deleted from the WMP. This approach will still enable tracking of increasing trends for sodium, chloride, and sulfate on Sandia Creek near Fallbrook (Station 502) and De Luz Creek near Fallbrook (Station 506). Weak trends are also present for nitrate on both of these watersheds.

We also recommend sampling groundwater at MW-1, the Santa Margarita River at De Luz Road well (Station 101), and MW-2, the De Luz Creek well (Station 102). At times, these monitoring stations have different water quality than in nearby surface water stations. Interpretation of both Piper diagrams and statistical analysis results substantiated the difference in water quality. The locations of these wells, adjacent to important surface waterways near the Base boundaries, are ideal for the proposed monitoring.

4.2 MONITORING FREQUENCY

Based on the results of this study, we recommend quarterly monitoring of the surface water and groundwater quality. Attempts to correlate the water quality to rainfall and stream gauge measurements did not produce a high enough confidence level to reduce the monitoring frequency to specific times of the year, such as during the spring, summer, and fall. Discharges occur within both watersheds that cannot be predicted; therefore, we recommend quarterly sampling.

4.3 ANALYTICAL PARAMETERS

Based upon the results of our analysis, the following analytical parameters should be analyzed for stations in the San Mateo and Santa Margarita River Watersheds: arsenic, bicarbonate, calcium, chloride, sodium, specific conductance, fecal coliform, fluoride, lead, iron, manganese, methyl tert-butyl ether (MTBE), nitrate, phosphate, sodium, specific conductance, sulfate, surfactants (MBAS), thallium, and total dissolved solids (TDS). Table 12 lists the analytical parameters, along with the EPA methods, detection limits, and general QA/QC requirements.

Because many of the parameters are components of a general mineral analysis, it will be more cost-effective to specify the general mineral analysis rather than request selected parameters. The general mineral analysis can vary from laboratory to laboratory, but typically includes the following:

Bicarbonate
Carbonate
Hydroxide
Alkalinity (as $CaCO_3$)
Chloride
Conductivity
Fluoride
Hardness
Nitrate (as Nitrogen)
pH
Sodium
Sulfate
Surfactants (MBAS)
Total Dissolved Solids (TDS)
Aluminum
Calcium
Copper
Iron
Magnesium
Manganese
Potassium
Zinc

The following subsections provide the justification for selection of the monitoring parameters.

4.3.1 San Mateo Watershed

The analytical parameters selected for monitoring in the San Mateo Watershed were selected for at least one of the following reasons:

- Concentrations have historically exceeded the MCL for drinking water;
- Concentrations have exceeded the MCL for drinking water at least once since monitoring resumed in 1997;
- It is considered an important indicator of water quality; or
- It can indicate an upstream contaminant release.

The trend analysis indicated MCLs were exceeded in the historical record for:

- Nitrate, TDS, sulfate, manganese, iron, and specific conductance at Cristianitos Creek near San Clemente, San Mateo Creek at San Clemente, and San Mateo Creek at San Onofre (Stations 509, 510, and 511);

- Chloride and copper at Cristianitos Creek near San Clemente (Station 509);
- Fluoride at Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Clemente (Station 510);
- MBAS and lead at San Mateo Creek at San Onofre (Station 511); and
- Arsenic at San Mateo Creek at San Clemente (Station 510) and at San Mateo Creek at San Onofre (Station 511).

The analytical data collected since 1997 show MCLs were exceeded at least once for:

- TDS and specific conductance at Cristianitos Creek near San Clemente (Station 509) and at San Mateo Creek at San Onofre (Station 511);
- Nitrate at San Mateo Creek at San Onofre (Station 511);
- Manganese at Cristianitos Creek near San Clemente (Station 509);
- Iron at Cristianitos Creek near San Clemente (Station 509), San Mateo Creek at San Clemente (Station 510), and San Mateo Creek at San Onofre (Station 511);
- Fecal coliform at Cristianitos Creek near San Clemente (Station 509) and San Mateo Creek at San Clemente (Station 510); and
- Lead in groundwater at MW-3 (Station 103).

Trend analysis, Piper diagrams, and statistical analysis showed differences in water quality exist in the watershed. The differences in water quality are most noticeable for arsenic, phosphate, chloride, bicarbonate, calcium, bicarbonate, sodium, specific conductance, fluoride, TDS, and sulfate.

MTBE has typically not been analyzed in surface water collected from the San Mateo Watershed. It is highly soluble in water and would be detected before other constituents of gasoline. Although it is presently considered an "unregulated chemical," we included MTBE because it is a growing concern in surface water and groundwater quality. DHS plans to propose a primary drinking water standard for MTBE in the near future. The continued use of this compound in gasoline is being debated. Based on its doubtful future use in gasoline this monitoring parameter should only be evaluated annually to determine if monitoring is still warranted.

Based upon the results of this study, the following parameters should be monitored in the San Mateo Watershed: arsenic, bicarbonate, calcium, chloride, sodium, specific conductance, fecal coliform, fluoride, lead, iron, manganese, methyl tert-butyl ether (), nitrate, phosphate, sodium, specific conductance, sulfate, surfactants (MBAS), thallium, and total dissolved solids (TDS).

We do not recommend monitoring for the following parameters that were monitored during 1997-1999: boron, cyanide, mercury, oil and grease, biochemical oxygen demand (BOD), and total organic carbon (TOC). These parameters were excluded for one of the following reasons:

- It has no MCL for drinking water; and
- It was consistently not detected or detected at such low levels that it does not appear to be a significant concern.

Volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and radiological constituents are all regulated. These chemicals have apparently not been tested in surface water in the San Mateo Watershed. VOCs are unlikely to be present due to their high volatility and the fact that natural streams aerate the water. Naturally occurring organic carbon in the water and plant life tend to absorb SVOCs. We do not recommend including these parameters for routine watershed monitoring. Radiological parameters are also not recommended for monitoring due to their unlikely occurrence.

4.3.2 Santa Margarita River Watershed

The analytical parameters selected for monitoring in the Santa Margarita River Watershed were selected for at least one of the following reasons:

- Concentrations have historically exceeded the MCL for drinking water;
- Concentrations have exceeded the MCL for drinking water at least once since sampling resumed in 1997;
- It is considered an important indicator of water quality; or
- It can indicate an upstream contaminant release.

Historical water quality trends were observed at:

- Sandia Creek (Stations 502), where, chloride (from 1981 to 1991), sodium, and sulfate are increasing;
- De Luz Creek (Station 506), where sodium,(from 1979 to 1989), chloride, and sulfate are increasing;
-
- Rainbow Creek (Stations 503), where bicarbonate after 1987 is increasing;
- Fallbrook Creek (Stations 503), where sodium (from 1983 to 1987) and bicarbonate (from 1973 to 1987) are increasing;
- Murrieta Creek near Temecula (Station 505), where TDS and specific conductance have increased in the past; and
- Rainbow Creek near Fallbrook (Station 503) where nitrate was increasing but has since declined.

Historically, the following parameters have exceeded the MCL at least once:

- MBAS at Rainbow Creek near Fallbrook (Station 503);
- Nitrate at Santa Margarita River near Fallbrook (Station 501), Sandia Creek near Fallbrook (Station 502), Rainbow Creek near Fallbrook (Station 503), Murrieta Creek at Temecula (Station 505), De Luz Creek near Fallbrook (Station 506), Fallbrook Creek near Fallbrook (Station 507), and the Santa Margarita River at Ysidora (Station 508);
- Sulfate in groundwater at DeLuz Creek near Fallbrook (Station 506), Santa Margarita River near Fallbrook (Station 501), Sandia Creek near Fallbrook (Station 502), Rainbow Creek near Fallbrook (Station 503), Murrieta Creek near Temecula (Station 505), and Fallbrook Creek near Fallbrook (Station 507);
- Manganese at Fallbrook Creek near Fallbrook (Station 507), De Luz Creek near Fallbrook (Station 506), and Rainbow Creek near Fallbrook (Station 503);
- Chloride at Murrieta Creek at Temecula (Station 505), Fallbrook Creek near Fallbrook (Station 507), and DeLuz Creek near Fallbrook (Station 506);
- Conductivity, TDS, and iron at all stations;

- Fluoride at the Santa Margarita River near Fallbrook (Station 501), Rainbow Creek, the Santa Margarita River near Temecula, Murrieta Creek, De Luz Creek, and Fallbrook Creek near Fallbrook;

- Arsenic at the Santa Margarita River near Fallbrook (Station 501), Rainbow Creek near Fallbrook (Station 503), De Luz near Fallbrook (Station 506);

- Fecal coliform at the Santa Margarita River near Temecula (Station 501), Sandia Creek near Fallbrook (Station 502), Rainbow Creek near Fallbrook (Station 503), Santa Margarita River near Temecula (Station 504), Murrieta Creek near Temecula (Station 505), De Luz Creek near Fallbrook (Station 506), Fallbrook Creek near Fallbrook (Station 507), and the Santa Margarita River at Ysidora (Station 508);

- Lead at the Santa Margarita River near Fallbrook (Station 501), Murrieta Creek near Temecula (Station 505), De Luz Creek near Fallbrook (Station 506), and Fallbrook Creek near Fallbrook (Station 507).

- Thallium at the Santa Margarita River near Fallbrook and Temecula (Stations 501 and 504).

Review of the trend analyses data also showed that the MCL is currently being exceeded for:

- Nitrate at Rainbow Creek near Fallbrook (Station 503);

- Sulfate, iron, manganese, TDS and specific conductance at all surface water monitoring stations;

- Chloride at Sandia Creek near Fallbrook (Station 502);

- Lead at Rainbow Creek near Fallbrook (Station 503), the Santa Margarita River near Temecula (Station 504), De Luz Creek near Fallbrook (Station 506), Fallbrook Creek near Fallbrook (Station 507), and in both MW-1 and MW-2 (Stations 101 and 102); and

- Nitrate in groundwater at MW-2, the De Luz Creek well (Station 102).

Trend analysis, Piper diagrams, and statistical analysis show differences in water quality within the watershed. Arsenic, chloride, bicarbonate, sodium, calcium, and phosphate concentrations vary among sampling locations.

MTBE has typically not been analyzed in surface water collected from the Santa Margarita River Watershed. In comparison to BTEX, MTBE is more soluble in water, is not significantly affected by adsorption or biodegradation, and does not readily volatilize once in contact with water. Because of these characteristics MTBE would be detected before other gasoline parameters. In 1992, gasoline constituents were detected in the Santa Margarita River, apparently as a result of contaminated groundwater seeping into Murrieta Creek. Although it is presently considered an "unregulated chemical," we included MTBE because it is a growing concern in surface water and groundwater quality and components of gasoline have been detected in the past. DHS plans to propose a primary drinking water standard for MTBE in the near future. The continued use of this compound in gasoline is being debated. Based on its doubtful future use in gasoline, it should only be evaluated annually to determine if monitoring is still warranted.

As mentioned previously, components of gasoline (benzene, toluene, total xylenes, and ethylbenzene [BTXE]) were detected in the Santa Margarita River in 1992. Because MTBE analysis is being recommended, and it is more soluble than BTEX compounds, BTXE is not recommended as a routine monitoring parameter. Should MTBE be detected, confirmation sampling should include an analysis for BTEX as described in Section 4.7.

Based upon the results of this study, the following parameters should be monitored in the Santa Margarita River Watershed: arsenic, bicarbonate, calcium, chloride, sodium, specific conductance, fecal coliform, fluoride, lead, iron, manganese, methyl tert-butyl ether (MTBE), nitrate, phosphate, sodium, specific conductance, sulfate, surfactants (MBAS), thallium, and total dissolved solids (TDS).

We do not recommend monitoring for the following parameters that were monitored during 1997-1999: boron, cyanide, mercury, oil and grease, biochemical oxygen demand (BOD), and total organic carbon (TOC). These parameters were excluded for one of the following reasons:

- It has no MCL for drinking water; or
- It was consistently not detected or detected at such low levels that it does not appear to be a significant concern.

Volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and radiological constituents are all regulated. These chemicals, except for radiological constituents were tested in 1991 and 1992 for surface water in the Santa Margarita River Watershed. Other than for low levels of a few unregulated chemicals, and some BTXE chemicals associated with gasoline contaminated groundwater discharge, VOCs and SVOCs were not found. This is expected as volatile organic compounds are unlikely to be present due to their high volatility and the fact that natural streams aerate the water. Naturally occurring organic carbon in the water and plant life tend to absorb SVOCs, herbicides, and pesticides. We do not recommend including these parameters for routine watershed monitoring. Radiological constituents, which have been detected at concentrations that were below MCLs in water supply wells within the watershed, are not recommended for routine monitoring.

4.4 MONITORING TECHNIQUES

Monitoring proposed for the WMP includes sampling of groundwater and surface water. The groundwater sampling should be performed in accordance with the current County of San Diego Site Assessment and Mitigation Manual guidelines (the SAM Manual). The SAM Manual describes well purging and sampling procedures for fast and slow recharging wells. The three groundwater monitoring wells installed by LAW are fast recharging wells, meaning each well recovers to 80 % or more of its static condition within two hours after purging.

Groundwater samples should be collected in disposable decontaminated bailers after purging. The bailer is lowered into the well and allowed to fill. The contents of the bailer are used to fill each sample container. The water in the bailer should be poured directly into laboratory-prepared bottles, which are then capped. Appendix H lists the sizes and types of bottles, along with preservatives that should be in the bottles. Care should be taken to avoid personal contact with the sampled water, even when wearing protective gloves, as such contact may affect certain analyses.

When sampling surface water, the sample should be collected from an area exhibiting cross-sectional homogeneity, not where the channel is constricted. The sampler should enter the stream or creek downstream of the sample location and proceed upstream to the sample location. The sampler should face the upstream direction to collect the sample and the sample should be collected directly into the sample containers from the top six inches of flow. The container should be capped immediately after it is filled. As with the ground water sampling, care should be taken to avoid personal contact with the sampled water, even when wearing protective gloves, as such contact may affect certain analyses. Collection of floating debris, such as leaves, should be avoided. The samples for metals should be collected in laboratory-prepared bottles that do not contain preservatives. Appendix H lists the types and sizes of bottles to be used. The laboratory should be instructed to filter the samples before preserving to eliminate detections caused by particulate matter and sediments.

A numerical scheme for identifying the discrete location and time frame in which a particular sample was collected and was developed for this project and should be used in the future when collecting samples. Each sample should be assigned a six digit numerical code. The first digit will be either a 1 (for a monitoring well) or a 5 (for a surface water location). The next two digits will identify the station location number, which will range from 01 to 03 for monitoring wells and from 01 to 11 for surface water locations (Table 7). The final three digits identified will be the sampling event number, which for this project ranged to begin at 008 and continue consecutively.

The water samples should be collected in appropriate sample containers. After being filled, the sample container should be placed in a clean, insulated cooler chest containing ice to keep the temperature at 4± 2 C during transfer to a California-certified laboratory. All sampling and sample handling should be performed under chain-of-custody protocol.

Water samples collected from the monitoring wells and the surface water locations should be analyzed for those parameters identified in Section 4.3.

4.5 QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance/Quality Control is an essential element of the sampling program. The goal is to provide that sampling and analytical data collected and reported are scientifically valid, verifiable, and consistent.

Chain-of-custody forms are contained in Appendix H.

A Data Quality Assessment (DQA) will be performed after analytical data has been collected and analyzed. A DQA assists in evaluating whether analytical procedures, sampling procedures, and field measurements meet the project objectives and represent actual field conditions. The DQA will consist of calculating precision and accuracy.

4.6 DATA MANAGEMENT

Analytical data from the WMP should be incorporated into the database compiled for MCB Camp Pendleton during this study. A copy of that database on compact disc is included in Appendix D. This will facilitate use of the new and existing data by subsequent users. The database, which is in Microsoft Access, can be used for data analysis such as data plots of trends or statistical comparison between multiple sampling locations.

We recommend that the analytical data generated from each monitoring event be reported in both written and electronic formats to MCB Camp Pendleton's Office of Water Resources. Results of each monitoring event should be evaluated to identify UPL and MCL exceedances. This degree of awareness and review will maximize protection of MCB Camp Pendleton's groundwater supply.

4.7 UPPER PREDICTION LIMITS

This study developed upper prediction limits (UPLs) for target parameters proposed for monitoring in both the San Mateo and Santa Margarita River Watersheds. The UPLs developed by LAW in this study are presented below. They are intended to represent threshold levels that, if exceeded, would indicate a change from baseline conditions and a potential impact to MCB Camp Pendleton's drinking water supply. The UPLs were also set with the intention that they could provide an "early warning" of changed, and potentially adverse, water quality conditions before the Base drinking water supply was put at risk.

SAN MATEO WATERSHED UPLs					
Parameter	**UPL**	**Units**	**Parameter**	**UPL**	**Units**

SAN MATEO WATERSHED UPLs					
Parameter	**UPL**	**Units**	**Parameter**	**UPL**	**Units**
Alkalinity	223	mg/L	Lead	0.0075	mg/L
Arsenic	0.025	mg/L	Magnesium	39	mg/L
Bicarbonate	220	mg/L	Manganese*	1.7	mg/L
BOD	2	mg/L	Mercury	0.001	mg/L
Boron	0.5	mg/L	Nitrate	23	mg/L
Calcium	116	mg/L	Nitrogen	5	mg/L
Carbonate	5.5	mg/L	Oil & Grease	1	mg/L
Chloride	151	mg/L	pH	9	pH
Conductivity	1244*	µmhos/cm	Phosphorus	0.4	mg/L
Copper	0.5	mg/L	Potassium	5.0	mg/L
Cyanide	0.1	mg/L	Sodium	116	mg/L
Fluoride	0.5	mg/L	Sulfate	230	mg/L
Hardness	434	mg/L	Surfactants	0.25	mg/L
Hydroxide	0.5	mg/L	TDS*	778	mg/L
Iron	23*	mg/L	TOC	7.4	mg/L
			Zinc	2.5	mg/L

* - Exceeds MCL.

SANTA MARGARIATA WATERSHED UPLs					
Parameter	**UPL**	**Units**	**Parameter**	**UPL**	**Units**
Alkalinity	365	mg/L	Lead	0.0075	mg/L
Arsenic	0.025	mg/L	Magnesium	62	mg/L
Bicarbonate	362	mg/L	Manganese	0.91*	mg/L
BOD	2	mg/L	Mercury	0.001	mg/L
Boron	0.39	mg/L	Nitrate	14	mg/L
Calcium	132	mg/L	Nitrogen	5	mg/L
Carbonate	4.6	mg/L	Oil & Grease	1	mg/L
Chloride	230	mg/L	pH	8.6	pH
Conductivity	1595*	µmhos/cm	Phosphorus	1.0	mg/L
Copper	0.5	mg/L	Potassium	9.1	mg/L
Cyanide	0.1	mg/L	Sodium	144	mg/L
Fluoride	0.99	mg/L	Sulfate	343*	mg/L
Hardness	597	mg/L	Surfactants	0.25	mg/L
Hydroxide	0.5	mg/L	TDS	1027*	mg/L
Iron	17*	mg/L	TOC	22	mg/L
			Zinc	2.5	mg/L

* - Exceeds MCL.

The UPLs were established based on analytical results for samples collected since 1997, when monitoring resumed. Most UPLs are below established MCLs or recommended levels for drinking water. However, UPLs for both watersheds are greater than MCLs or recommended levels for iron, manganese, total dissolved solids, and specific conductance.

4.8 ADDITIONAL INVESTIGATION

After a monitoring event is completed and the laboratory analytical results are received, the data should be reviewed for UPL exceedances. If a UPL for a given parameter is exceeded, the following investigative steps should be taken.

The affected sampling location should be re-sampled as soon as practical and the sample analyzed for the parameter exceeded. If the second sample also exceeds the UPL, a preliminary investigation should be initiated as described below. If necessary, the monitoring frequency for the parameter that exceeded the UPL should be increased (up to weekly).

The investigation should also include upstream sampling and observation of the drainage area to determine the source or potential cause of the parameter exceedance. Depending upon the source and type of contaminant detected, it may be advisable to report the findings to the RWQCB and to discuss the issue with local agencies and interested parties, including the Santa Margarita River Watershed Committee. If MTBE concentrations are detected that exceed the UPL, MCL, or San Diego Basin Objectives, the findings should be reported to the RWQCB and testing initiated for benzene, toluene, total xylenes, and ethylbenzene (BTXE).

The WMP approach and monitoring parameters should be re-evaluated about every three years, but no less frequently than every five years. Upper prediction limits (UPLS) according to statistical convention should be re-calculated after every monitoring event to keep them current. However, since this monitoring is not part of a regulatory mandated program, which would require recalculation after every monitoring event, it is our opinion the UPLs could be re-calculated annually to reduce costs.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The results of this evaluation indicate that statistically significant differences in water quality exist within the San Mateo and Santa Margarita River Watersheds. After proving that different water quality exists through trend analysis, Piper diagrams, and statistical methods, the baseline water quality data were used to develop upper prediction limits (UPLs) to indicate when MCB Camp Pendleton should take action to protect their groundwater supplies. Overall, the water quality is improving for many of the water quality parameters in the watersheds but there are several parameters that are exceeding MCLs or are showing trends of increasing concentrations.

Significant findings for the San Mateo Watershed include a statistical difference in water quality between San Mateo Creek at San Clemente (Station 510) and Cristianitos Creek near San Clemente (Station 509). Water at San Mateo Creek at San Onofre (Station 511) which is a mixture from Stations 509 and 510, shows an influence from local activities as indicated by changes in sodium and nitrate concentrations. Nitrate at Station 511 has exceeded drinking water MCLs at least once since 1997. Water from Cristianitos Creek strongly affects the water quality at Station 511. At least once since 1997, the drinking water MCLs were exceeded for specific conductance, TDS, manganese, iron, and fecal coliform. In addition, there is a significant difference in water quality between surface water at Cristianitos Creek near San Clemente (Station 509) and groundwater in MW-3 (Station 103).

Significant findings for the Santa Margarita River Watershed include a statistical difference in water quality between tributaries of the Santa Margarita River. There is also a significant difference in water quality between surface water monitoring stations in comparison to nearby groundwater wells. Water quality is degrading in Sandia and De Luz Creeks from increasing concentrations of sodium, chloride, sulfate, and nitrate as indicated by the generally increasing trends for these parameters. Land use changes in these two tributary areas should be monitored to prevent further degradation of the water quality. Groundwater in MW-2 (Station 102) near De Luz Creek also contained nitrate at concentrations above the MCL. At least once since 1997, the drinking water MCLs were exceeded in all tributaries or in the Santa Margarita River for sulfate, manganese, specific conductance, and TDS. The MCL was also exceeded for nitrate in Rainbow Creek, chloride in Sandia Creek, and iron in De Luz and Sandia Creeks and in the Santa Margarita River near Fallbrook (Station 501). Water quality in the Santa Margarita River at Fallbrook (Station 501) and at Ysidora (Station 508) is essentially the same. Water at these locations appears to be strongly influenced by water from Sandia Creek.

The WMP developed for MCB Camp Pendleton describes the monitoring system network, identifies chemical parameters for analysis that are indicative of changes in water quality, and specifies the sampling procedures and analytical methods to be used. It also identifies upper prediction limits (UPLs) for chemical parameters to indicate when action is needed to protect the Base's drinking water supply.

We recommend that ten surface water sampling stations and three groundwater sampling stations be utilized. In the San Mateo Watershed, three surface water locations and one groundwater location should be sampled. In the Santa Margarita River Watershed, seven surface water and two groundwater locations should be sampled. Based on the statistical analyses discussed in Section 3 of this report, one surface water sampling location has been removed from the locations sampled during the 1997-1999 program. Santa Margarita River at Ysidora (Station 508) was removed because its water quality is the same as that at Station 501, Santa Margarita River near Fallbrook.

Based on the results of the present studies, we recommend that monitoring of selected surface water and groundwater quality sampling locations should be conducted quarterly.

For each sampling location in the San Mateo and Santa Margarita River Watersheds, we recommend the following analytical parameters be monitored: arsenic, phosphate, chloride, bicarbonate, sodium, calcium, specific conductance, fecal coliform, fluoride, lead, iron, manganese, surfactants (MBAS); thallium, methyl tert-butyl ether (MTBE), nitrate, total dissolved solids (TDS), and sulfate. These parameters were selected for at least one of the following reasons: 1) because they have maximum contaminant levels for drinking water; 2) they have historically exceeded MCLs; 3) they have exceed the MCL at least once since 1997; 4) they are considered important indicators of water quality; and 5) they can give important indications of upstream contaminant release.

Analytical data gathered from implementation of the WMP should be incorporated into the database compiled for LAW's water quality studies for MCB Camp Pendleton during 1997-1999. A CD with the database is included in Appendix D of this report. The database will facilitate use of the new and existing data by subsequent users. The database is in Microsoft Access and is sufficiently versatile to allow graphical and statistical data analysis.

We recommend that after each monitoring event, the analytical data be evaluated to identify UPL and MCL exceedances. The data should be reported in written and electronic formats to MCB Camp Pendleton's Office of Water Resources. If a UPL for a given parameter is exceeded during a sampling event, additional investigation should be conducted. The affected sampling location should be re-sampled and analyzed for the exceeded parameter as soon as practical. If the second sample also exceeds the UPL, continued monitoring at increasing frequencies (up to weekly) should be conducted, and an investigation undertaken that includes upstream sampling and observations to determine the source of the exceedance. Detection of MTBE concentrations that exceeded the UPL, MCL, or San Diego Basin Plan Objectives should be reported to the RWQCB. It also may be advisable to discuss the findings with local regulatory agencies.

Some of the UPLs established exceed MCLs or recommended levels for drinking water. The UPLs are based on a statistical comparison of water quality data obtained since 1997. Because the UPLs are greater than the MCLs or recommended level, it indicates that water quality in both the watersheds have repeatedly exceeded MCLs or recommended levels for iron, manganese, total dissolved solids, and specific conductance. We recommend that an investigation be undertaken that includes upstream sampling and observation to determine the type of activity that may be creating the exceedance. Once identified discussions local agencies and interested parties, including the Santa Margarita River Watershed Committee, which could potentially lead to modification of practices to reduce or eliminate the source.

The WMP approach and monitoring parameters should be re-evaluated about every three years, and no less frequently than every five years. Upper prediction limits (UPLs), according to statistical convention, should be re-calculated after every monitoring event to maintain their currency. . However, since this monitoring is not part of a regulatory mandated program, which would require re-calculation after each monitoring event, it is our opinion the UPLs could be re-calculated annually to reduce costs.

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TABLE 1
MAXIMUM CONTAMINANT LEVELS FOR VOLATILE ORGANIC CHEMICALS

Chemical	MCL (mg/L)*
Benzene	0.001
Carbon Tetrachloride	0.0005
1,2-Dichlorobenzene	0.600
1,4-Dichlorobenzene	0.005
1,1-Dichloroethane	0.005
1,2-Dichloroethane	0.0005
1,1-Dichloroethylene	0.006
cis-1,2-Dichloroethylene	0.006
trans-1,2-Dichloroethylene	0.010
Dichloromethane	0.005
1,2-Dichloropropane	0.005
1,3-Dichloropropene	0.0005
Ethylbenzene	0.700
Monochlorobenzene	0.070
Styrene	0.100
1,1,2,2-Tetrachloroethane	0.001
Tetrachloroethylene	0.005
Toluene	0.150
1,2,4-Trichlorobenzene	0.070
1,1,1-Trichloroethane	0.200
1,1,2-Trichloroethane	0.005
Trichloroethylene	0.005
Trichlorofluoromethane	0.150
1,1,2-Trichloro-1,2,2-Trifluoroethane	1.200

Reference:
22 CCR 64444 and 22 CCR 64445.1

Notes:
*Primary MCLs for Drinking Water
MCL – Maximum Contaminant Level
mg/L – Milligrams per liter

TABLE 2
MAXIMUM CONTAMINANT LEVELS FOR NON-VOLATILE SYNTHETIC ORGANIC CHEMICALS

Chemical	MCL (mg/L)*
Alachlor	0.002
Atrazine	0.003
Bentazon	0.018
Benzo (a) pyrene	0.0002
Carbofuran	0.018
Chlordane	0.0001
2,4-D	0.07
Dalapon	0.2
Dibromochloropropane	0.0002
Di (2-ethylhexyl) adipate	0.4
Di (2-ethylhexyl) phthalate	0.004
Dinoseb	0.007
Diquat	0.02
Endothall	0.1
Endrin	0.002
Ethylene Dibromide	0.0005
Glyphosate	0.7
Heptachlor	0.00001
Heptachlor Epoxide	0.00001
Hexachlorobenzene	0.001
Hexachlorocyclopentadiene	0.05
Lindane	0.0002
Methoxychlor	0.04
Molinate	0.02
Oxamyl	0.2
Pentachlorophenol	0.001
Picloram	0.5
Polychlorinated Biphenyls	0.0005
Simazine	0.004
Thiobencarb	0.07
Toxaphene	0.003
2,3,7,8-TCDD (Dioxin)	3×10^{-8}
2,4,5-TP (Silvex)	0.05

Reference:
22 CCR 64444 and 22 CCR 64445.1

Notes:
*Primary MCLs for Drinking WaterMCL – Maximum Contaminant Level
mg/L – Milligrams per liter

TABLE 3
MAXIMUM CONTAMINANT LEVELS FOR INORGANIC CHEMICALS

Chemical	MCL (mg/L)*
Aluminum	1.00
Antimony	0.006
Arsenic	0.05
Asbestos	7 MFL
Barium	1.00
Beryllium	0.004
Cadmium	0.005
Chromium	0.05
Cyanide	0.20
Fluoride	2.00
Mercury	0.002
Nickel	0.10
Nitrate (as NO_3)	45.00
Nitrate + Nitrite (sum as Nitrogen)	10.00
Nitrite (as Nitrogen)	1.00
Selenium	0.50
Thallium	0.002

Reference:
22 CCR 64431 and 22 CCR 64432

Notes:
*Primary MCLs for Drinking WaterMFL = million fibers per liter; MCL for fibers exceeding 10 μm in length.
MCL – Maximum Contaminant Level
mg/L – Milligrams per liter

TABLE 4
MAXIMUM CONTAMINANT LEVELS FOR GENERAL PHYSICAL/MINERAL PARAMETERS

Parameter	MCL*
Aluminum	0.2 mg/L
Copper	1.0 mg/L
Corrosivity	Non-corrosive
Foaming Agents (MBAS)	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor – Threshold	3 Units
Silver	0.1 mg/L
Thiobencarb	0.001 mg/L
Turbidity	5 Units
Zinc	5.0 mg/L
Specific Conductivity	900 µmhos**
Total Dissolved Solids	500 mg/L**
Chloride	250 mg/L**
Sulfate	250 mg/L**
Bicarbonate	None
Carbonate	None
Hydroxide Alkalinity	None
Calcium	None
Magnesium	None
Sodium	None
Total Hardness	None
MTBE	0.005 mg/L

Reference:
22 CCR 64449

Notes:
*Primary MCLs for Drinking Water, Unless Noted Otherwise
** Secondary Recommended Level for Drinking Water
MBAS – Methylene blue active substance
MCL – Maximum Contaminant Level
MTBE – Methyl tert-Butyl Ether

TABLE 5
UNREGULATED ORGANIC CHEMICALS

Chemical	Synonyms
1,1,1,2-Tetrachloroethane	
1,1-Dichloropropene	
1,2,3-Trichlorobenzene	1,2,3-TCB
1,2,3-Trichloropropane	Allyl Trichloride
1,2,4-Trimethylbenzene	Pseudocumene
1,3,5-Trimethylbenzene	Mesitylene
1,3-Dichlorobenzene	m-Dichlorobenzene
1,3-Dichloropropane	
1-Phenylpropane	n-Propylbenzene
2,2-Dichloropropane	
2-Chlorotoluene	o-Chlorotoluene
3-Hydroxycarbofuran	
4-Chlorotoluene	p-Chlorotoluene
Aldicarb	
Aldicarb Sulfone	
Aldicarb Sulfoxide	
Aldrin	Aldrec, Aldron
Bromacil	HYVAR X, HYVAR XL
Bromobenzene	Monobromobenzene
Bromochloromethane	Chlorobromomethane
Bromodichloromethane	Dichlorobromomethane
Bromoform	Tribromomethane
Bromomethane	Methyl Bromide
Butachlor	Butanex, Lambast, Machete
Carbaryl	Sevin
Chlorodibromomethane	Dibromochloromethane
Chloroethane	Ethyl Chloride
Chloroform	Trichloromethane
Chloromethane	Methyl Chloride
Chlorothalonil	BRAVO
Dibromomethane	Methylene Bromide
Dicamba	Banex, Banvel, Dianat
Dichlorodifluoromethane	Difluorodichloromethane
Dieldrin	
Dimethoate	CYGON
Diuron	KARMEX, KROVAR
Hexachlorobutadiene	Perchlorobutadiene
Isopropylbenzene	Cumene
Methomyl	Lannate
Methyl tert-Butyl Ether	MTBE

TABLE 5 (continued)
UNREGULATED ORGANIC CHEMICALS

Chemical	Synonyms
Metolachlor	Metelilachlor
Metribuzin	Lexone, Sencor, Sencoral
Naphthalene	Naphtalin
n-Butylbenzene	1-Phenylbutane
p-Isopropyltoluene	p-Cymene
Prometryn	CAPAROL
Propachlor	Albrass, Ramrod
sec-Butylbenzene	2-Phenylbutane
tert-Butylbenzene	2-Methyl-2-phenylpropane
tert-Amyl Methyl Ether	TAME

Reference:
22 CCR 64450

TABLE 6
RWQCB WATER QUALITY OBJECTIVES – INLAND SURFACE WATER

Inland Surface Water	Station	Hydrologic Unit Basin Number	Constituent (mg/L)							
			TDS	Cl	SO4	Fe	Mn	MBAS	B	F
Santa Margarita Hydrologic Unit		**902.00**								
Gavilan HSA										
Santa Margarita River near Fallbrook	501	2.22	750	250	250	0.3	0.05	0.5	0.75	1.10
Sandia Creek near Fallbrook	502	2.22	750	250	250	0.3	0.05	0.5	0.75	1.10
Rainbow Creek near Fallbrook	503	2.22	750	250	250	0.3	0.05	0.5	0.75	1.10
Wolf HSA										
Santa Margarita River near Temecula	504	2.52	750	250	250	0.3	0.05	0.5	0.75	1.10
Murrieta HA										
Murrieta Creek at Temecula	505	2.30	750	300	300	0.3	0.05	0.5	0.75	1.10
De Luz Creek HSA										
De Luz Creek near Fallbrook	506	2.21	750	250	250	0.3	0.05	0.5	0.75	1.10
Ysidora HA										
Fallbrook Creek near Fallbrook	507	2.10	750	300	300	0.3	0.05	0.5	0.75	1.10
Santa Margarita River at Ysidora	508	2.10	750	300	300	0.3	0.05	0.5	0.75	1.10
San Juan Hydrologic Unit		**901.00**								
San Mateo Canyon HA										
Cristianitos Creek near San Clemente	509	1.40	500	250	250	0.3	0.05	0.5	0.75	1.0
San Mateo Creek at San Clemente	510	1.40	500	250	250	0.3	0.05	0.5	0.75	1.0
San Mateo Creek at San Onofre	511	1.40	500	250	250	0.3	0.05	0.5	0.75	1.0

Reference:
San Diego Regional Water Quality Control Board's "Water Quality Control Plan for the San Diego Basin" dated September 1994

Notes:
TDS – Total dissolved solids
Cl – Chloride
SO_4 – Sulfate
Fe – Iron
Mn – Manganese
MBAS – Methylene blue active substance
B – Baron
F – Fluoride
HA – Hydrologic Area
HSA – Hydrologic Sub Area (Lower case letters indicate endnotes following the table.)

TABLE 7
WATER QUALITY SAMPLING LOCATIONS

LAW Station No.	USGS Station No.	Station Name	Latitude	Longitude	Period of Record
501	X-2-1350.00 11044300	Santa Margarita River near Fallbrook	332449	1171425	1961-1993 and 1997-1999
502	11044350	Sandia Creek near Fallbrook	332528	1171454	1982-1993 and 1997-1999
503	11044250	Rainbow Creek near Fallbrook	332427	1171200	1970-1993 and 1997-1999
504	X-2-1425.00 11044000	Santa Margarita River near Temecula	332826	1170829	1983-1994 and 1997-1999
505	11043000	Murrieta Creek near Temecula	332847	1170835	1965-1993 and 1997-1999
506	X-2-1235.50 11044900	De Luz Creek near Fallbrook(1)	332511	1171915	1968-1993 and 1997- 1999
507	11045300	Fallbrook Creek near Fallbrook	332049	1171901	1965-1993 and 1997-1999
508	11046000	Santa Margarita River at Ysidora	331413	1172314	1997-1999
509	11046360	Cristianitos Creek near San Clemente	332541	1173403	1967-1987 and 1997-1999
510	11046300	San Mateo Creek at San Clemente	332815	1172820	1969-1988 and 1997-1999
511	11046370	San Mateo Creek at San Onofre	332400	1173509	1970-1988 and 1997-1999
101	None	MW-1 Santa Margarita River at De Luz Road	332400	1171541	1997-1999
102	None	MW-2 De Luz Creek	332426	1171904	1997-1999
103	None	MW-3 Cristianitos Creek	332704	1173405	1997-1999

Notes:
(1) Historical data from "De Luz Creek at McDowell" used.

APPENDIX A

PRECIPITATION RECORDS

APPENDIX B

STREAM GAUGING STATION RECORDS

APPENDIX C

MONITORING WELL CONSTRUCTION

APPENDIX C-1

MONITORING WELL COMPLETION REPORT

APPENDIX C-1

MONITORING WELL COMPLETION REPORT

Permitting and Drilling Site Clearance

For the installation of the three ground water monitoring wells, LAW obtained a drilling permit from the County of San Diego (Appendix C-2). The proposed drilling sites were marked in the field and scanned for utility clearance by Underground Service Alert, by the Base utility locating office, and by URS, a private utility locating company. In addition, the proposed drilling sites were observed for surficial indications of historical and cultural artifacts by Mr. Stan Berryman, an archaeologist with the MCB Camp Pendleton Assistant Chief of Staff, Environmental Security (AC/S, ES). Mr. Berryman did not identify artifacts at the surface but based on previous investigations in the vicinity, recommended observation of the initial 10 feet of drilling in monitoring well MW-3 by an observer trained in archaeological excavation. A representative of KEA Environmental provided the requested archaeological monitoring, and reported that no such artifacts were observed.

MCB Camp Pendleton prepared a PED (Preliminary Environmental Data) and a Clean Water Act (CWA) Section 404 nation wide 5 (NW5) permit application. The PED was used by ES to prepare a "Categorical eXclusion" (Cat-X) which resolved National Environmental Protection Act concerns. Then ES used the NW5 application to apply for that permit from the Army Corps of Engineers, Los Angeles District (ACE). Once the ACE was satisfied with the Cat-X and NW5 application, they approved it pending certification under Section 401, which is an action by the Regional Water Quality Control Board.

Drilling

The borings for the wells were drilled using truck-mounted hollow-stem augers and air rotary drilling equipment. All down-hole drilling equipment was steam-cleaned prior to each use. Each boring was logged during drilling.

Monitoring Well Construction and Development

Monitoring well construction was performed in accordance with the SAMD Site Assessment and Mitigation Manual (the SAM Manual) guidelines and the drilling permit issued for the work. The wells were constructed with 4-inch diameter schedule 40 PVC casing and screen. The well screen had a slot-size of 0.020 inches. Blank casing was placed from the top of the screen to the ground surface. The wells were constructed with Monterey No. 3 sand for gravel pack. An outer steel casing rising out of the concrete pad was installed, with a locking "J-plug" in the top of the casing and a locking outer well cap to protect the well at the surface. Lithologic logs and well construction details are presented in Appendix C-3.

Each well was developed to establish hydraulic continuity with the aquifer. Development consisted of mechanically surging each well for at least fifteen (15) minutes using a surge block. Each well was then purged of approximately two (2) to three (3) well volumes of water (as defined in the SAM Manual) in order to remove fine-grained sediments from the well.

Waste Management

Soil cuttings and waste water derived from drilling, development and purging the monitoring wells, and from decontamination of field equipment, were disposed in a manner identified in the environmental documentation prepared by the Base's Environmental Security Office. All liquids were disposed within the project's "footprint" at each well site. All soil cuttings were used to level areas within the footprints.

APPENDIX C-3

LITHOLOGIC LOGS AND WELL CONSTRUCTION DETAILS

APPENDIX D

WATER QUALITY DATA

APPENDIX D-1

COMPACT DISC (CD) OF WATER QUALITY DATABASE

APPENDIX D-2

WATER QUALITY ANALYTICAL RESULTS 1997-1999

APPENDIX D-3

OTHER SOURCES OF WATER QUALITY DATA

APPENDIX E

TREND GRAPHS

NOTES ON TREND GRAPHS

1. Graphs are organized alphabetically by analyte. Analytes are separated by blue pages.
2. Units for all analytes (except conductivity and pH) are milligrams per liter (mg/L).
3. Units for conductivity are micromhos per centimeter (umhos/cm).
4. Units for pH are pH units.

INDEX TO STATIONS

SURFACE WATER MONITORING LOCATIONS	
Station 501	Santa Margarita River near Fallbrook
Station 502	Sandia Creek near Fallbrook
Station 503	Rainbow Creek near Fallbrook
Station 504	Santa Margarita River near Temecula
Station 505	Murrieta Creek near Temecula
Station 506	De Luz Creek near Fallbrook
Station 507	Fallbrook Creek near Fallbrook
Station 508	Santa Margarita River at Ysidora
Station 509	Cristianitos Creek near San Clemente
Station 510	San Mateo Creek at San Clemente
Station 511	San Mateo Creek at San Onofre

GROUNDWATER MONITORING LOCATIONS	
MW-1	Santa Margarita River at De Luz Road
MW-2	De Luz Creek
MW-3	Cristianitos Creek

OTHER SURFACE WATER ANALYTICAL DATA AVAILABLE FROM MCB, CAMP PENDLETON
OFFICE OF WATER RESOURCES

Brood Mare Pond, Surface Water Analytical Data 1955-1985.

California State Water Quality Samples, Off and On Base Sites, Surface Water Analytical Data 1975-1979.

Case Springs, Surface Water Analytical Data 1959-1987.

De Luz Road at SMR (Off Base), Surface Water Analytical Data 1991-1993.

Depot Lake N.W.S., Surface Water Analytical Data 1971-1975.

Fallbrook Creek at N.W.S., Surface Water Analytical Data 1982-1993.

Group 12 Lake N.W.S. (9/433M), Surface Water Analytical Data 1971-1975.

Group 12 Lakes N.W.S. (9/428P), Surface Water Analytical Data 1971-1975.

Historical-Fallbrook Creek at N.W.S., Surface Water Analytical Data 1965-1982.

Historical-San Onofre Ford at Basilone Road, Surface Water Analytical Data 1974-1980.

Historical-Sewage Effluent by Day, Plant #1, 16 Nov 54 to 14 Oct 81, Surface Water Analytical Data 1954-1981.

Historical-Sewage Effluent by Day, Plant #2, 16 Oct 54 to 14 Nov 81, Surface Water Analytical Data 1955-1981.

Historical-Sewage Effluent by Plant/by Month, Surface Water Analytical Data 1965-1981.

Historical-Temecula Creek at Interstate 15, Surface Water Analytical Data 1961-1982.

Jacinto Pond, Surface Water Analytical Data 1971.

Lake O'Neill, Surface Water Analytical Data 1952-1987.

Las Flores Pond, Surface Water Analytical Data 1961-1987.

Las Pulgas, Surface Water Analytical Data 1980-1986.
II.
III.Little Case Springs, Surface Water Analytical Data 1985-1987.

Miscellaneous, Surface Water Analytical Data 1952-1987.

Miscellaneous, Surface Water Analytical Data 1977.
Pilgrim Pond, Surface Water Analytical Data 1986.

Plant #1 Outfall – Urine Pond (Lake), Surface Water Analytical Data 1955-1986.

Plant #2 – Pond #2, Surface Water Analytical Data 1985-1987.

Sewage Effluent Flow-by Day, Plant 1, Surface Water Analytical Data 1981-1992.

SMR at De Luz Road, Surface Water Analytical Data 1986-1988.

SMR-Up Rainbow Creek, Surface Water Analytical Data 1991-1993.

Surface Water Analysis Impoundment Structures – Camp Pendleton Fallbrook N.W.S., Miscellaneous Surface Water Analytical Data 1977-1982.

Temecula Creek at Interstate 15, Surface Water Analytical Data 1982-1993 and 1961-1987 (two separate sets of data).

Wild Cat #1 and #2, Surface Water Analytical Data 1973.

APPENDIX F

PIPER DIAGRAMS

APPENDIX G

STATISTICAL ANALYSIS

APPENDIX H

QUALITY ASSURANCE/QUALITY CONTROL OBJECTIVES

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: GROUND WATER: MONITORING WELL MW-1
SANTA MARGARITA RIVER AT DE LUZ ROAD

Analyte	Det. Limit	Units	MCL	Analytical Results										
				1/5/98	3/6/98	5/27/98	8/5/98	11/10/98	2/12/99	5/12/99	9/30/99	12/7/99	3/14/00	6/2/00
Alkalinity (CaCO3)	1	mg/L	None	148	328	380	502	418	434	394	340	332	348	344
Arsenic	0.005	mg/L	0.05	ND	ND	0.033	ND	ND	ND	ND	ND	ND	ND	ND
Bicarbonate	1	mg/L	None	148	319	380	500	417	433	393	340	332	348	344
Biochemical Oxygen Demand	2	mg/L	None	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS
Boron	0.1	mg/L	None	NS	ND	ND	0.224	0.282	0.237	0.272	0.2	ND	0.3	0.3
Calcium	0.1	mg/L	None	102	61	94.4	72.4	107	107	119	123	116	114	120
Carbonate	0.5	mg/L	None	ND	8.65	ND	1.45	1.13	1.15	1.17	ND	ND	ND	ND
Chloride	1	mg/L	250	168	28.1	139	52.3	120	133	133	188	199	177	192
Conductivity	10	mg/L	900	1140	734	990	907	1380	1450	1470	1610	1610	1,500	1,570
Copper	0.005	mg/L	1.0	0.04	0.016	0.054	0.0191	0.017	0.0136	0.0146	ND	0.04	0.015	ND
Cyanide (Total)	0.01	mg/L	0.2	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS
Fecal Coliform	2	MPN/100 mL	None	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	ND
Fluoride	0.1	mg/L	None	0.304	1.36	1.17	1.21	1.07	0.908	0.867	0.8	0.8	0.8	0.7
Hardness (CaCO3)	2	mg/L	None	418	229	305	287	480	486	450	496	500	476	508
Hydroxide	0.5	mg/L	None	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	0.05	mg/L	0.3	48.7	8.76	23.7	8.51	4.74	5.22	5.56	ND	ND	0.036J	ND
Lead	0.005	mg/L	0.015	0.052	ND	0.00247	ND	0.00175	ND	0.00104	ND	ND	ND	ND
Magnesium	0.2	mg/L	None	50.3	24.3	38.1	27.7	42.4	42.6	46.2	46.5	43.0	43.0	44.3
Manganese	0.01	mg/L	0.05	0.612	0.391	1.16	0.592	0.458	1.12	0.897	0.25	0.55	0.06	0.41
Mercury	0.0002	mg/L	0.002	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: GROUND WATER: MONITORING WELL MW-1
SANTA MARGARITA RIVER AT DE LUZ ROAD

Analyte	Det. Limit	Units	MCL	Analytical Results										
				1/5/98	3/6/98	5/27/98	8/5/98	11/10/98	2/12/99	5/12/99	9/30/99	12/7/99	3/14/00	6/2/00
Nitrate-N	0.1	mg/L	45	ND	1.31	1.43	0.88	0.177	ND	ND	ND	ND	0.9	ND
Nitrogen	0.1	mg/Kg	10	0.125	NS	ND	NS	0.456	NS	0.227	0.3	NS	0.2	NS
Oil and Grease	1.0	mg/L	None	ND	ND	ND	ND	ND	ND	1.13	ND	ND	ND	ND
pH	1.00	mg/L	None	7.1	7.81	7.08	7.46	NS	7.33	7.24	7.15	7.08	7.28	7.58
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	0.3	0.4	ND	ND
Potassium	1.0	mg/L	None	11	3.92	5.17	2.66	3.31	3.4	3.59	2.2	2.9	2.9	3.1
Sodium	0.3	mg/L	None	85.3	100	127	120	150	146	143	159	144	144	147
Sulfate	10	mg/L	250	205	50.5	101	68	201	168	189	208	225	196	217
Surfactants (MBAS)	0.05	mg/L	0.5	0.109	ND	ND	ND	ND	ND	ND	0.06	ND	ND	ND
Total Coliform	2	MPN/100 mL	None	280	4	<2	<2	7	<2	<2	<2	<2	<2	ND
Total Dissolved Solids	10	mg/L	500	687	524	665	650	869	846	916	1010	1030	953	971
Total Organic Carbon	0.5	mg/L	None	4.18	ND	6.33	ND	2.54	ND	9.62	8.5	1.7	7.3	87
Zinc	0.02	mg/L	5	0.13	0.025	0.063	0.0163	0.015	0.0114	ND	ND	ND	0.03	ND

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: GROUND WATER: MONITORING WELL MW-2
DE LUZ CREEK

Analyte	Det. Limit	Units	MCL	Analytical Results										
				1/5/98	3/12/98	5/27/98	8/5/98	11/10/98	2/12/99	5/12/99	9/30/99	12/7/99	3/14/00	6/2/00
Alkalinity (CaCO3)	1	mg/L	None	388	141	124	144	141	171	164	192	NS	180	164
Arsenic	0.005	mg/L	0.05	ND	0.028	0.027	ND	ND	ND	ND	ND	NS	ND	ND
Bicarbonate	1	mg/L	None	384	140	124	143	141	171	166	192	NS	180	164
Biochemical Oxygen Demand	2	mg/L	None	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS
Boron	0.1	mg/L	None	NS	ND	ND	0.0276	0.162	0.142	0.133	0.1	NS	0.1	0.2
Calcium	0.1	mg/L	None	130	97	62.8	67.4	83.6	86.3	84.3	92.6	NS	91.9	107
Carbonate	0.5	mg/L	None	3.96	1.34	ND	0.575	ND	ND	ND	ND	NS	ND	ND
Chloride	1	mg/L	250	175	150	83.6	117	149	149	134	148	NS	148	184
Conductivity	10	mg/L	900	1470	1080	702	873	1110	1450	1120	1140	NS	1,130	1,310
Copper	0.005	mg/L	1.0	0.03	ND	0.011	0.0097	ND	ND	ND	ND	NS	ND	ND
Cyanide (Total)	0.01	mg/L	0.2	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS
Fecal Coliform	2	MPN/100 mL	None	<2	<2	<2	<2	<2	<2	<2	<2	NS	2	ND
Fluoride	0.1	mg/L	None	0.745	0.3	0.321	0.263	0.343	0.279	0.27	0.3	NS	0.4	0.5
Hardness (CaCO3)	2	mg/L	None	518	385	252	287	393	421	364	388	NS	412	460
Hydroxide	0.5	mg/L	None	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Iron	0.05	mg/L	0.3	9.1	4.16	15.8	12.2	1.6	2.83	1.05	ND	NS	ND	ND
Lead	0.005	mg/L	0.015	0.021	0.00182	0.00541	0.0045	0.00862	0.00254	0.00306	ND	NS	ND	ND
Magnesium	0.2	mg/L	None	47.7	39.7	28.4	30.7	38	40.1	39.4	40.7	NS	40.5	46.5
Manganese	0.01	mg/L	0.05	2.33	0.043	0.182	0.162	0.029	0.0343	0.0132	ND	NS	ND	ND
Mercury	0.0002	mg/L	0.002	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: GROUND WATER: MONITORING WELL MW-2
DE LUZ CREEK

Analyte	Det. Limit	Units	MCL	Analytical Results										
				1/5/98	3/12/98	5/27/98	8/10/98	11/10/98	2/12/99	5/12/99	9/30/99	12/7/99	3/14/00	6/2/00
Nitrate-N	0.1	mg/L	45	0.131	40	2.08	1.7	0.301	2.22	1.93	0.8	NS	7.1	2.5
Oil and Grease	1.0	mg/L	None	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
pH	1.00	mg/L	None	7.41	7.22	6.91	7.21	NS	7.37	7.24	7.06	NS	7.14	7.70
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	0.5	NS	0.3	ND
Potassium	1.0	mg/L	None	4.71	2.48	3.65	3.82	2.18	2.44	1.89	1.8	NS	2.5	2.6
Sodium	0.3	mg/L	None	152	78.8	61.3	66	80	82.4	77.9	85.3	NS	82.4	92.6
Sulfate	10	mg/L	250	191	510	99.9	136	226	185	194	155	NS	182	235
Surfactants (MBAS)	0.05	mg/L	0.5	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Total Coliform	2	MPN/100 mL	None	2	17	<2	<2	<2	27	14	<2	NS	14	ND
Total Dissolved Solids	10	mg/L	500	897	741	509	582	699	695	701	733	NS	745	835
Total Organic Carbon	0.5	mg/L	None	8.65	ND	7.03	1.77	2.29	1.34	ND	9.4	NS	5.9	37
Zinc	0.02	mg/L	5	0.039	0.011	0.035	0.0276	0.016	ND	ND	ND	NS	0.017J	ND

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: GROUND WATER: MONITORING WELL MW-3
CRISTIANITOS CREEK

Analyte	Det. Limit	Units	MCL	Analytical Results										
				1/5/98	3/6/98	5/27/98	8/5/98	11/10/98	2/12/99	5/12/99	9/29/99	12/7/99	3/14/00	6/2/00
Alkalinity (CaCO3)	1	mg/L	None	184	191	166	209	168	171	189	238	252	150	240
Arsenic	0.005	mg/L	0.05	ND	ND	0.045	0.0991	ND	ND	ND	ND	ND	ND	ND
Bicarbonate	1	mg/L	None	184	188	166	209	168	171	188	238	252	150	240
Biochemical Oxygen Demand	2	mg/L	None	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS
Boron	0.1	mg/L	None	NS	ND	ND	0.256	0.268	0.268	0.322	0.4	0.4	0.4	0.4
Calcium	0.1	mg/L	None	96.5	62	73.8	94.4	89.3	83.3	94.8	118	107	65.1	121
Carbonate	0.5	mg/L	None	ND	2.8	ND	ND	ND	ND	1.14	ND	ND	ND	ND
Chloride	1	mg/L	250	142	30.4	93.6	65.2	120	111	112	163	170	113	174
Conductivity	10	mg/L	900	1030	508	544	679	952	915	1070	1330	1370	870	1,370
Copper	0.005	mg/L	1.0	0.026	0.062	0.036	0.0825	0.014	0.0192	0.0302	ND	0.03	ND	ND
Cyanide (Total)	0.01	mg/L	0.2	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS
Fecal Coliform	2	MPN/100 mL	None	ND	80	<2	<2	<2	30	<2	<2	<2	<2	ND
Fluoride	0.1	mg/L	None	0.471	0.459	0.361	0.378	0.265	0.267	0.322	0.5	0.5	0.5	0.6
Hardness (CaCO3)	2	mg/L	None	344	202	241	322	357	318	347	418	426	270	464
Hydroxide	0.5	mg/L	None	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	0.05	mg/L	0.3	31.1	78	45.1	104	14.5	18.3	34	ND	ND	ND	ND
Lead	0.005	mg/L	0.015	0.026	0.02	0.0123	0.0354	0.0037	0.00635	0.0119	ND	ND	ND	ND
Magnesium	0.2	mg/L	None	30.3	31.7	28.4	45.8	28.6	27.9	33.4	32.8	29.1	17.9	32.4
Manganese	0.01	mg/L	0.05	6.01	8.04	6.91	11.8	2.53	3.83	5.64	0.51	0.42	0.03	0.40
Mercury	0.0002	mg/L	0.002	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: GROUND WATER: MONITORING WELL MW-3
CRISTIANITOS CREEK

Analyte	Det. Limit	Units	MCL	Analytical Results										
				1/5/98	3/6/98	5/27/98	8/5/98	11/10/98	2/12/99	5/12/99	9/29/99	12/7/99	3/14/00	6/2/00
Nitrate-N	0.1	mg/L	45	ND	ND	ND	ND	ND	ND	ND	0.2	ND	1.3	ND
Oil and Grease	1.0	mg/L	None	NS	ND	ND	ND	ND	ND	1.22	ND	ND	ND	ND
pH	1.00	mg/L	None	6.89	7.56	6.65	7.25	NS	6.99	6.85	6.88	6.87	7.12	7.31
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	0.3	0.4	0.7	ND
Potassium	1.0	mg/L	None	7.67	16.2	9.08	18.6	4.94	5.5	7.37	2.0	2.7	1.8	2.7
Sodium	0.3	mg/L	None	104	58.5	48.4	55.1	67.2	77.6	90	134	119	88.9	108
Sulfate	10	mg/L	250	139	31.6	71.1	80.4	137	146	180	196	212	126	233
Surfactants (MBAS)	0.05	mg/L	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Coliform	2	MPN/100 mL	None	ND	80	70	<2	2	900	2	4	23	<2	ND
Total Dissolved Solids	10	mg/L	500	618	461	393	454	611	585	676	846	856	548	874
Total Organic Carbon	0.5	mg/L	None	3.34	5.97	7.1	5.17	ND	ND	1.7	2.3	7.2	6.7	71
Zinc	0.02	mg/L	5	0.113	0.25	0.14	0.307	0.046	0.0596	0.109	ND	ND	0.03	ND

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 501 902.22
SANTA MARGARITA RIVER NEAR FALLBROOK
NEAR USGS GAUGING STATION 11044300

Analyte	Det. Limit	Units	MCL	Analytical Results											
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00	
Alkalinity (CaCO3)	1	mg/L	None	116	157	178	196	180	186	185	172	194	118	180	
Arsenic	0.005	mg/L	0.05	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	
Bicarbonate	1	mg/L	None	115	155	176	192	178	183	183	172	194	118	180	
Biochemical Oxygen Demand	2	mg/L	None	2.5	NS	ND	NS	2.14	NS	ND	ND	NS	ND	NS	
Boron	0.2	mg/L	None	ND	ND	ND	0.219	0.244	0.19	0.215	0.2	ND	ND	0.3	
Calcium	0.5	mg/L	None	71.4	90	92.3	99.7	118	89.1	87.4	81.4	120	61.4	92.0	
Carbonate	0.5	mg/L	None	ND	2.3	1.94	3.53	1.43	2.55	1.84	ND	ND	ND	ND	
Chloride	1	mg/L	250	147	120	189	162	176	136	135	147	188	102	176	
Conductivity	10	mg/L	900	849	1016	1070	1280	1410	1180	1230	1230	1510	842	1,350	9/11
Copper	0.02	mg/L	1.0	0.007	ND	ND	ND	ND	NS	ND	ND	0.03	ND	ND	
Cyanide (Total)	0.01	mg/L	0.2	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS	
Fecal Coliform	2	MPN/100 mL	None	>1600	140	60	110	>1600	900	>23	130	30	240	130	
Fluoride	0.1	mg/L	None	ND	0.29	0.301	0.319	0.336	0.297	0.326	0.4	0.4	0.4	0.6	
Hardness (CaCO3)	2	mg/L	None	259	348	344	483	570	460	376	400	564	278	424	
Hydroxide	0.5	mg/L	None	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	
Iron	0.05	mg/L	0.3	9.89	0.9	0.134	0.149	1.48	0.932	ND	ND	0.06	ND	ND	4/11
Lead	0.05	mg/L	0.015	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	
Magnesium	0.5	mg/L	None	27.3	34	40.8	49	50.9	40.7	38.9	37.5	56.9	25.2	44.1	
Manganese	0.01	mg/L	0.05	0.252	0.06	0.024	0.0776	0.143	0.0454	0.0274	0.02	0.04	0.03	0.04	4/11
Mercury	0.0002	mg/L	0.002	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS	

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

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COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 501
SANTA MARGARITA RIVER NEAR FALLBROOK
NEAR USGS GAUGING STATION 11044300

Analyte	Det. Limit	Units	MCL	Analytical Results											
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00	
Nitrate-N	0.1	mg/L	45	1.94	3.6	4.58	2.27	4.2	4.76	1.83	1.7	3.2	15.5	1.5	
Oil and Grease	1.0	mg/L	None	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	
pH	1.00	mg/L	None	7.85	8.19	8.07	8.29	NS	8.09	7.95	8.05	7.83	8.02	7.31	
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	ND	ND	1.2	ND	
Potassium	1.0	mg/L	None	6.47	4	4.75	4.47	7.14	4.63	3.26	3.9	3.5	4.0	3.7	
Sodium	0.5	mg/L	None	62.4	100	99.9	108	111	92.3	106	94.2	101	59.7	109	
Sulfate	10	mg/L	250	131	179	197	292	294	222	247	214	285	117	231	3/11
Surfactants (MBAS)	0.05	mg/L	0.5	ND	0.112	ND	ND	ND	NS	0.116	ND	ND	ND	ND	
Total Coliform	2	MPN/100 mL	None	>1600	>1600	>1600	>1600	>1600	>1600	>23	900	1600	>1,600	1,600	
Total Dissolved Solids	10	mg/L	750 500	432	680 x	764	846	963	771	787	785	1010	538 x	877	8/11
Total Organic Carbon	0.5	mg/L	None	6.21	5.87	8.06	2.87	5.85	6.37	2.13	20.3	0.9	7.7	5.8	
Zinc	0.03	mg/L	5	0.037	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 502 902.22
SANDIA CREEK NEAR FALLBROOK
NEAR USGS GAUGING STATION 11044350

Analyte	Det. Limit	Units	MCL	Analytical Results											
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00	
Alkalinity (CaCO3)	1	mg/L	None	154	135	159	177	158	172	166	160	168	158	166	
Arsenic	0.005	mg/L	0.05	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	
Bicarbonate	1	mg/L	None	151	133	157	175	156	168	164	140	156	158	146	
Biochemical Oxygen Demand	2	mg/L	None	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS	
Boron	0.1	mg/L	None	ND	ND	ND	0.161	0.197	0.141	ND	0.1	ND	0.1	0.2	
Calcium	0.1	mg/L	None	141	110	95.3	108	112	104	108	99.1	114	110	112	
Carbonate	0.5	mg/L	None	2.83	1.98	1.99	2.32	2.32	3.71	1.77	20	12	ND	20	
Chloride	1	mg/L	250	267	158	225	227	192	179	175	219	215	224	230	1/11
Conductivity	10	mg/L	900	1620	1155	1150	1290	1370	1300	1360	1430	1430	1,520	1,490	11/11
Copper	0.005	mg/L	1.0	ND	ND	ND	ND	ND	NS	ND	ND	0.03	ND	ND	
Cyanide (Total)	0.01	mg/L	0.2	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS	
Fecal Coliform	2	MPN/100 mL	None	300	110	220	170	1600	220	>23	130	2	1,600	50	
Fluoride	0.1	mg/L	None	ND	0.273	0.316	0.307	0.298	0.283	0.285	0.4	0.4	0.4	0.6	
Hardness (CaCO3)	2	mg/L	None	555	442	442	525	551	559	466	506	514	554	542	
Hydroxide	0.5	mg/L	None	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	
Iron	0.05	mg/L	0.3	0.257	5.5	0.765	0.103	0.451	0.336	ND	ND	0.06	ND	ND	4/11
Lead	0.005	mg/L	0.015	ND	ND	ND	ND	ND	NS	ND	ND	ND	0.011	ND	
Magnesium	0.2	mg/L	None	61.9	48	50.6	52.5	55	52	51.6	47.5	54.0	53.8	54.7	
Manganese	0.01	mg/L	0.05	0.051	0.12	0.028	0.0153	0.0282	0.0118	ND	ND	0.03	0.03	ND	2/11
Mercury	0.0002	mg/L	0.002	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS	

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 502
SANDIA CREEK NEAR FALLBROOK
NEAR USGS GAUGING STATION 11044350

Analyte	Det. Limit	Units	MCL	Analytical Results										
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00
Nitrate-N	0.1	mg/L	45	4.92	7.63	5.56	4.36	5.33	5.15	2.77	2.4	2.6	30.1	5.0
Oil and Grease	1.0	mg/L	None	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND
pH	1.00	mg/L	None	8.21	8.2	8.13	8.15	NS	8.33	8.24	8.32	8.14	8.28	7.36
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	ND	ND	0.8	ND
Potassium	1.0	mg/L	None	3.35	3	3.09	3.08	3.35	2.72	2.47	3.6	2.8	3.4	3.3
Sodium	0.3	mg/L	None	96.7	99	87.5	96.4	98.3	90.3	87.8	87.2	93.3	96.0	95.1
Sulfate	10	mg/L	250	239	222	249	265	296	240	262	218	224	262	273 5h
Surfactants (MBAS)	0.05	mg/L	0.5	ND	ND	ND	ND	ND	NS	0.116	ND	ND	ND	ND
Total Coliform	2	MPN/100 mL	None	≥1600	>1600	1600	>1600	>1600	500	>23	300	900	≥1,600	240
Total Dissolved Solids	10	mg/L	* 500 750	1010	786	814	850	925	854	879	913	908	966	1,030 "/"
Total Organic Carbon	0.5	mg/L	None	4.27	5.04	3.03	1.66	2.66	1.53	1.5	1.5	0.5	5.6	6.0
Zinc	0.02	mg/L	5	0.017	ND	ND	ND	ND	0.0111	ND	ND	ND	ND	ND

Notes:
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ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 503
RAINBOW CREEK NEAR FALLBROOK 90 2.23
NEAR USGS GAUGING STATION 11044250

Analyte	Det. Limit	Units	MCL	Analytical Results											
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00	
Alkalinity (CaCO3)	1	mg/L	None	162	79.5	114	242	163	174	222	234	238	172	216	
Arsenic	0.005	mg/L	0.05	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	
Bicarbonate	1	mg/L	None	160	78.7	104	240	162	172	221	234	238	168	204	
Biochemical Oxygen Demand	2	mg/L	None	ND	NS	4.02	NS	ND	NS	ND	ND	NS	ND	NS	
Boron	0.2	mg/L	None	ND	ND	ND	0.125	0.2	0.173	ND	0.1	ND	0.1	0.2	
Calcium	0.5	mg/L	None	122	46	65.6	114	112	91	112	114	113	116	141	
Carbonate	0.5	mg/L	None	1.73	0.757	0.642	1.92	1.13	2.18	1.04	ND	ND	4	12	
Chloride	1	mg/L	250	213	70.7	128	189	169	136	166	188	192	197	208	
Conductivity	10	mg/L	900	1470	641	848	1400	1460	1240	1420	1420	1390	1,610	1,650	9/11
Copper	0.02	mg/L	1.0	ND	ND	0.008	0.0063	0.0058	0.00511	ND	ND	0.03	ND	ND	
Cyanide (Total)	0.01	mg/L	0.2	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS	
Fecal Coliform	2	MPN/100 mL	None	1600	220	1600	900	≥1600	≥1600	>23	80	900	1,600	130	
Fluoride	0.1	mg/L	None	ND	0.203	0.325	0.239	0.35	0.294	0.242	0.3	0.3	0.4	0.5	
Hardness (CaCO3)	2	mg/L	None	515	208	354	564	562	445	492	532	530	568	600	
Hydroxide	0.5	mg/L	None	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	
Iron	0.05	mg/L	0.3	0.047	0.7	0.486	ND	0.156	0.214	ND	ND	0.06	ND	ND	2/11
Lead	0.05	mg/L	0.015	0.027	ND	0.00106	ND	ND	NS	ND	ND	ND	0.018	ND	2/4
Magnesium	0.5	mg/L	None	51.1	20	29.1	55.4	51.5	43.8	53.6	56.2	56.1	54.0	64.2	
Manganese	0.01	mg/L	0.05	0.027	0.05	0.055	0.0329	0.048	0.0168	ND	ND	0.03	0.01	ND	1/11
Mercury	0.0002	mg/L	0.002	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS	

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 503
RAINBOW CREEK NEAR FALLBROOK
NEAR USGS GAUGING STATION 11044250

Analyte	Det. Limit	Units	MCL	Analytical Results											
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00	
Nitrate-N	0.1	mg/L	45	1.3	4.95	10.3	4.54	13.2	9.34	8.6	4.1	4.8	62.9	15.0	1/11
Oil and Grease	1.0	mg/L	None	ND	ND	ND	ND	ND	0.98	0.962	ND	ND	ND	ND	
pH	1.00	mg/L	None	7.98	8.12	7.78	7.93	NS	8.06	7.98	7.91	7.62	8.25	7.39	
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	1.3	1.1	2.0	1.1	
Potassium	1.0	mg/L	None	10.8	3	7.21	5.38	9.35	7.56	5.06	4.6	3.4	9.8	7.9	
Sodium	0.5	mg/L	None	103	69	83.2	NS	120	102	96	91.9	85.6	122	125	
Sulfate	10	mg/L	250	269	108	134	252	326	250	254	196	187	290	314	6/11
Surfactants (MBAS)	0.05	mg/L	0.5	ND	ND	ND	ND	0.113	NS	ND	ND	ND	0.06	ND	
Total Coliform	2	MPN/100 mL	None	>1600	>1600	>1600	>1600	>1600	>1600	>23	300	1600	>1,600	>1,600	
Total Dissolved Solids	10	mg/L	750 500 *	910	453	662 X	884	1010	806	848	964	879	1,060	1,190	9/11
Total Organic Carbon	0.5	mg/L	None	11.1	8.45	10.3	3.42	58.9	7.31	5.77	7.0	1.4	8.1	13	
Zinc	0.03	mg/L	5	0.015	ND	ND	ND	ND	NS	ND	ND	ND	0.019J	ND	

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 504
SANTA MARGARITA RIVER NEAR TEMECULA 902.52
NEAR USGS GAUGING STATION 11044000

Analyte	Det. Limit	Units	MCL	Analytical Results										
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00
Alkalinity (CaCO3)	1	mg/L	None	164	173	211	205	159	154	237	164	288	134	188
Arsenic	0.005	mg/L	0.05	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND
Bicarbonate	1	mg/L	None	163	170	195	203	158	153	235	164	288	134	180
Biochemical Oxygen Demand	2	mg/L	None	2.38	NS	ND	NS	6.72	NS	ND	ND	NS	ND	NS
Boron	0.2	mg/L	None	ND	ND	ND	0.228	0.377	0.345	0.197	0.2	ND	0.3	0.2
Calcium	0.5	mg/L	None	85.3	85	97.9	83.4	61.3	47.9	105	63.4	112	47.7	66.0
Carbonate	0.5	mg/L	None	1.08	2.48	0.862	1.7	ND	1.09	2.11	ND	ND	ND	8
Chloride	1	mg/L	250	148	115	197	98.3	109	96.6	95.1	81	147	99	99
Conductivity	10	mg/L	900	934	983	1120	977	860	776	1140	821	1250	728	873	11/11
Copper	0.02	mg/L	1.0	ND	ND	ND	ND	ND	0.005	ND	ND	0.03	ND	ND
Cyanide (Total)	0.01	mg/L	0.2	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS
Fecal Coliform	2	MPN/100 mL	None	>1600	300	1600	17	≥1600	1600	>23	<2	80	>1600	13
Fluoride	0.1	mg/L	None	ND	0.32	1.12	0.353	0.352	0.292	0.281	0.5	0.4	0.5	0.5
Hardness (CaCO3)	2	mg/L	None	247	320	310	295	230	192	353	236	400	186	242
Hydroxide	0.5	mg/L	None	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND
Iron	0.05	mg/L	0.3	3	1.4	0.447	0.221	0.564	3.46	0.0668	ND	0.11	0.035J	ND	5/11
Lead	0.05	mg/L	0.015	0.019	ND	ND	ND	ND	0.00107	0.00286	ND	ND	0.025	ND	2/11
Magnesium	0.5	mg/L	None	18.7	28	32.2	24.2	16.7	14.7	22.4	17.5	27.4	13.2	17.7
Manganese	0.01	mg/L	0.05	0.251	0.1	0.075	0.108	0.0656	0.0786	0.0417	0.03	0.12	0.02	0.02	7/11
Mercury	0.0002	mg/L	0.002	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 504
SANTA MARGARITA RIVER NEAR TEMECULA
NEAR USGS GAUGING STATION 11044000

Analyte	Det. Limit	Units	MCL	Analytical Results										
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00
Nitrate-N	0.1	mg/L	45	1.32	1.88	0.868	0.82	1.22	0.381	2.08	2.0	ND	2.7	1.2
Oil and Grease	1.0	mg/L	None	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND
pH	1.00	mg/L	None	7.7	8.27	7.64	7.95	NS	7.78	7.89	7.88	7.59	7.99	7.52
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	0.4	0.4	1.2	ND
Potassium	1.0	mg/L	None	4.25	5	6.11	3.32	9.73	5.96	1.53	3.0	2.5	3.9	2.8
Sodium	0.5	mg/L	None	78.4	110	122	100	99.7	89.5	94.7	79.2	110	71.6	83.1
Sulfate	10	mg/L	250	123	164	273	203	135	108	216	113	133	69	107
Surfactants (MBAS)	0.05	mg/L	0.5	ND	0.108	ND	ND	0.358	NS	ND	ND	ND	0.11	ND
Total Coliform	2	MPN/100 mL	None	≥1600	≥1600	≥1600	500	≥1600	≥1600	>23	<2	240	≥1600	1600
Total Dissolved Solids	10	mg/L	750 500	476	668	803	622	570	499	761	519	756	480	537
Total Organic Carbon	0.5	mg/L	None	8.77	6.09	8.53	2.05	15.6	6.59	3.2	4.1	14.2	13	4.6
Zinc	0.03	mg/L	5	0.021	ND	ND	ND	0.0144	0.0205	ND	ND	ND	0.010J	ND

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 505
MURRIETA CREEK AT TEMECULA 902.52
NEAR USGS GAUGING STATION 11043000

Analyte	Det. Limit	Units	MCL	Analytical Results											
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00	
Alkalinity (CaCO3)	1	mg/L	None	127	169	201	140	114	122	185	142	238	124	164	
Arsenic	0.005	mg/L	0.05	ND	ND	ND	ND	ND	0.0387	ND	ND	ND	ND	ND	
Bicarbonate	1	mg/L	None	126	167	200	139	114	121	184	142	238	124	156	
Biochemical Oxygen Demand	2	mg/L	None	2.67	NS	ND	NS	10	NS	2.11	ND	NS	ND	NS	
Boron	0.1	mg/L	None	ND	ND	ND	0.175	0.389	0.378	0.44	0.1	ND	0.3	0.2	
Calcium	0.1	mg/L	None	50.7	76	100	58.7	37.5	36.2	53.5	65.2	60.7	43.8	56.8	
Carbonate	0.5	mg/L	None	ND	2.32	0.9	0.736	ND	0.687	1.09	ND	ND	ND	8	
Chloride	1	mg/L	250	134	133	212	78.2	104	90.8	124	73	104	100	93	
Conductivity	10	mg/L	900	755	1000	1260	812	755	697	1020	794	917	697	843	4/11
Copper	0.005	mg/L	1.0	ND	ND	ND	ND	0.0075	0.00706	ND	ND	ND	ND	ND	
Cyanide (Total)	0.01	mg/L	0.2	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS	
Fecal Coliform	2	MPN/100 mL	None	>1600	110	<2	<2	>1600	>1600	>23	14	9	1600	ND	
Fluoride	0.1	mg/L	None	0.236	0.343	0.502	0.313	0.356	0.279	0.526	0.5	0.5	0.5	0.5	
Hardness (CaCO3)	2	mg/L	None	174	342	339	277	153	148	201	236	240	164	208	
Hydroxide	0.5	mg/L	None	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	
Iron	0.05	mg/L	0.3	2.21	1.4	0.184	0.244	0.98	6.47	2.12	ND	0.18	0.038J	0.07	5/11
Lead	0.005	mg/L	0.015	ND	ND	ND	ND	ND	0.00188	0.0012	ND	ND	ND	ND	
Magnesium	0.2	mg/L	None	13.8	28	38.2	22.6	12.4	13.2	16.8	19.7	20.2	12.9	16.7	
Manganese	0.01	mg/L	0.05	0.126	0.07	0.058	0.0633	0.0882	0.0891	0.308	ND	0.05	0.006J	0.02	7/11
Mercury	0.0002	mg/L	0.002	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS	

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 505
MURRIETA CREEK AT TEMECULA
NEAR USGS GAUGING STATION 11043000

Analyte	Det. Limit	Units	MCL	Analytical Results										
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00
Nitrate-N	0.1	mg/L	45	0.872	1.42	0.724	0.29	1.21	0.153	0.153	2.1	ND	2.2	1.2
Oil and Grease	1.0	mg/L	None	ND	ND	ND	ND	ND	1.2	ND	ND	ND	ND	ND
pH	1.00	mg/L	None	7.63	8.29	7.64	7.75	NS	7.58	7.65	7.85	7.34	7.84	7.55
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	0.3	ND	1.4	0.3
Potassium	1.0	mg/L	None	4.67	5	7.91	3.6	11.8	6.76	4.67	3.4	2.3	4.3	3.4
Sodium	0.3	mg/L	None	73.9	100	141	84.6	91.9	88.3	134	75.3	101	74.5	89.1
Sulfate	10	mg/L	250	75.4	164	260	194	115	93	134	130	75	66	118
Surfactants (MBAS)	0.05	mg/L	0.5	ND	ND	ND	ND	0.516	0.224	ND	ND	ND	ND	ND
Total Coliform	2	MPN/100 mL	None	≥1600	≥1600	<2	<2	≥1600	≥1600	>23	≥1600	≥1600	≥1600	ND
Total Dissolved Solids	10	mg/L	500	387	658	879	506	498	425	602	504	552	444	600
Total Organic Carbon	0.5	mg/L	None	8.68	6.07	6.01	3.83	20.4	8.95	2.26	7.4	4.4	10	5.0
Zinc	0.02	mg/L	5	0.019	ND	ND	0.0144	0.216	0.0423	ND	ND	ND	ND	ND

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 506
DE LUZ CREEK NEAR FALLBROOK 902.21
NEAR USGS GAUGING STATION 11044800

Analyte	Det. Limit	Units	MCL	Analytical Results											
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00	
Alkalinity (CaCO3)	1	mg/L	None	140	82.4	119	170	170	175	174	NS	NS	112	174	
Arsenic	0.01	mg/L	0.05	ND	ND	0.026	ND	ND	ND	ND	NS	NS	ND	ND	
Bicarbonate	1	mg/L	None	139	81.4	118	168	168	172	172	NS	NS	112	154	
Biochemical Oxygen Demand	2	mg/L	None	ND	NS	ND	NS	ND	NS	ND	NS	NS	ND	NS	
Boron	0.1	mg/L	None	ND	ND	ND	0.154	0.218	0.146	0.123	NS	NS	ND	0.2	
Calcium	0.1	mg/L	None	103	51	50.8	84.4	103	88.4	94.2	NS	NS	68.4	119	
Carbonate	0.5	mg/L	None	1.3	0.941	0.944	2.23	2.13	2.57	1.9	NS	NS	ND	20	
Chloride	0.5	mg/L	250	224	62.3	98.7	143	164	141	142	NS	NS	135	202	
Conductivity	1	mg/L	900	1220	544	670	1030	1230	1120	1180	NS	NS	1,070	1,400	7/9
Copper	0.005	mg/L	1.0	ND	ND	ND	ND	ND	NS	ND	NS	NS	ND	ND	
Cyanide (Total)	0.005	mg/L	0.2	ND	NS	ND	NS	ND	NS	ND	NS	NS	ND	NS	
Fecal Coliform	2	MPN/100 mL	None	900	90	30	50	500	50	>23	NS	NS	900	70	
Fluoride	0.1	mg/L	None	ND	0.215	1.14	0.277	0.282	0.255	0.279	NS	NS	0.3	0.5	
Hardness (CaCO3)	1	mg/L	None	408	200	251	428	537	467	394	NS	NS	332	492	
Hydroxide	0.5	mg/L	None	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND	ND	
Iron	0.03	mg/L	0.3	0.243	4.2	0.971	0.678	1.2	0.427	0.247	NS	NS	ND	ND	5/9
Lead	0.001	mg/L	0.015	0.023	ND	ND	ND	ND	ND	ND	NS	NS	ND	ND	
Magnesium	0.1	mg/L	None	43.5	20	24.3	38.7	48.8	41.7	43.7	NS	NS	31.3	53.7	1/9
Manganese	0.005	mg/L	0.05	0.157	0.11	0.039	0.0407	0.0488	0.0139	0.0215	NS	NS	0.01	ND	2/9
Mercury	0.0002	mg/L	0.002	ND	NS	ND	NS	ND	NS	ND	NS	NS	ND	NS	

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 506
DE LUZ CREEK NEAR FALLBROOK
NEAR USGS GAUGING STATION 11044800

Analyte	Det. Limit	Units	MCL	Analytical Results											
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00	
Nitrate-N	0.05	mg/L	45	5.44	3.89	2.45	2.2	4.46	4.21	2.06	NS	NS	29.2	2.8	
Oil and Grease	0.5	mg/L	None	ND	ND	1.33	ND	ND	ND	ND	NS	NS	ND	ND	
pH	0.01	mg/L	None	7.94	7.97	7.93	8.15	NS	8.13	8.2	NS	NS	8.07	7.21	
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	NS	NS	1.4	ND	
Potassium	0.3	mg/L	None	3.04	ND	1.68	1.61	2.35	2.04	1.79	NS	NS	2.2	2.3	
Sodium	0.25	mg/L	None	72.7	53	57.3	78.2	87.7	78.7	83.2	NS	NS	75.5	104	
Sulfate	10	mg/L	250	189	83.5	106	188	260	189	210	NS	NS	167	259	1/9
Surfactants (MBAS)	0.03	mg/L	0.5	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND	ND	
Total Coliform	2	MPN/100 mL	None	≥1600	1600	300	900	≥1600	500	>23	NS	NS	1600	500	
Total Dissolved Solids	10	mg/L	~~500~~ 750	740	336	455	662	821	700	723	NS	NS	661	925	2/9
Total Organic Carbon	0.1	mg/L	None	7.28	3.47	4.79	2.86	1.47	3.18	2.62	NS	NS	7.3	6.1	
Zinc	0.01	mg/L	5	0.013	ND	ND	ND	ND	ND	ND	NS	NS	ND	ND	

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 507
FALLBROOK CREEK NEAR FALLBROOK
NEAR USGS GAUGING STATION 11045300

902.13

Analyte	Det. Limit	Units	MCL	Analytical Results										
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00
Alkalinity (CaCO3)	1	mg/L	None	121	220	269	363	179	204	266	398	380	112	320
Arsenic	0.005	mg/L	0.05	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND
Bicarbonate	1	mg/L	None	120	217	267	359	178	202	264	398	380	112	320
Biochemical Oxygen Demand	2	mg/L	None	2.48	NS	ND	NS	8.02	NS	ND	ND	NS	ND	NS
Boron	0.2	mg/L	None	ND	ND	ND	0.326	0.23	0.176	0.144	0.2	ND	ND	0.3
Calcium	0.5	mg/L	None	46.6	71	70.3	89.6	66.7	51.8	65.2	75.2	81.8	31.1	74.0
Carbonate	0.5	mg/L	None	ND	3.02	1.78	3.62	0.623	2.08	1.93	ND	ND	ND	ND
Chloride	1	mg/L	250	126	105	145	172	133	90.8	112	188	193	59	154
Conductivity	10	mg/L	900	740	935	1080	1450	1150	875	1120	1470	1500	536	1,320 8/..
Copper	0.02	mg/L	1.0	ND	ND	ND	ND	ND	NS	ND	ND	0.03	ND	ND
Cyanide (Total)	0.01	mg/L	0.2	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS
Fecal Coliform	2	MPN/100 mL	None	≥1600	300	900	140	>1600	30	>23	1600	50	240	50
Fluoride	0.1	mg/L	None	ND	0.429	0.403	0.586	0.37	0.322	0.476	0.8	0.8	0.4	0.7
Hardness (CaCO3)	2	mg/L	None	217	328	364	497	396	284	322	432	450	168	412
Hydroxide	0.5	mg/L	None	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND
Iron	0.05	mg/L	0.3	3.34	0.7	0.137	0.149	1.92	0.511	0.236	ND	0.24	0.04J	ND 4/..
Lead	0.05	mg/L	0.015	0.024	ND	ND	ND	ND	0.00107	ND	ND	ND	0.008	ND 7/..
Magnesium	0.5	mg/L	None	25.7	37	46.5	58.9	41.8	32.2	41.6	49.4	52.4	17.8	47.0
Manganese	0.01	mg/L	0.05	0.194	0.14	0.063	0.13	0.559	0.107	0.185	0.35	0.18	0.03	0.18 10/..
Mercury	0.0002	mg/L	0.002	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 507
FALLBROOK CREEK NEAR FALLBROOK
NEAR USGS GAUGING STATION 11045300

Analyte	Det. Limit	Units	MCL	Analytical Results										
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/7/00	6/1/00
Nitrate-N	0.1	mg/L	45	0.501	1.91	0.356	0.07	1.15	1.94	0.089	ND	ND	2.7	ND
Oil and Grease	1.0	mg/L	None	ND	ND	ND	ND	ND	0.952	ND	ND	ND	ND	ND
pH	1.00	mg/L	None	7.82	8.19	7.85	8.03	NS	7.91	7.86	7.74	7.67	7.90	7.23
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	1.8	0.3	1.1	0.9
Potassium	1.0	mg/L	None	4.15	2	2.22	2	6.69	2.81	ND	4.4	2.2	2.7	2.8
Sodium	0.5	mg/L	None	62.7	120	115	153	110	83.7	109	163	151	48.0	119
Sulfate	10	mg/L	250	102	142	143	240	264	121	152	104	123	62	170
Surfactants (MBAS)	0.05	mg/L	0.5	ND	0.126	ND	ND	0.135	NS	0.165	ND	ND	0.08	ND
Total Coliform	2	MPN/100 mL	None	≥1600	1600	≥1600	1600	>1600	900	>23	1600	500	≥1,600	≥1,600
Total Dissolved Solids	10	mg/L	500	387	655	741	918	746	536	689	880	889	340	864
Total Organic Carbon	0.5	mg/L	None	10.6	13.7	10.2	7.54	15.8	8.37	14	4.6	13.3	9.8	19
Zinc	0.03	mg/L	5	0.033	ND	ND	ND	0.0148	NS	ND	ND	ND	0.012J	ND

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 508
SANTA MARGARITA RIVER AT YSIDORA
NEAR USGS GAUGING STATION 11046000 902.12

Analyte	Det. Limit	Units	MCL	Analytical Results											
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/13/00	6/1/00	
Alkalinity (CaCO3)	2	mg/L	None	145	128	166	191	162	192	233	NS	NS	156	184	
Arsenic	0.005	mg/L	0.05	ND	ND	ND	ND	ND	NS	ND	NS	NS	ND	ND	
Bicarbonate	2	mg/L	None	143	126	164	186	158	188	231	NS	NS	156	164	
Biochemical Oxygen Demand	0	mg/L	None	ND	NS	ND	NS	ND	NS	3.06	NS	NS	ND	NS	
Boron	0.2	mg/L	None	ND	ND	ND	0.203	0.202	0.169	0.219	NS	NS	0.1	0.2	
Calcium	0.5	mg/L	None	85.7	77	72	91.6	88.3	84.7	94.7	NS	NS	84.4	91.3	
Carbonate	2	mg/L	None	2.18	1.5	2.08	4.6	3.91	3.61	1.73	NS	NS	ND	20	
Chloride	1	mg/L	250	183	105	164	159	160	139	172	NS	NS	143	170	
Conductivity	10	mg/L	900	1070	814	902	1140	1150	1130	1350	NS	NS	1,090	1,230	3/9
Copper	0.02	mg/L	1.0	0.01	ND	ND	ND	ND	NS	ND	NS	NS	0.009	ND	
Cyanide (Total)	.01	mg/L	0.2	ND	NS	ND	NS	ND	NS	ND	NS	NS	ND	NS	
Fecal Coliform	2	MPN/100 mL	None	1600	110	30	280	70	17	6.9	NS	NS	70	13	
Fluoride	0.2	mg/L	None	ND	0.239	0.331	0.367	0.354	0.326	0.382	NS	NS	0.4	0.5	
Hardness (CaCO3)	2	mg/L	None	350	290	331	431	426	432	363	NS	NS	368	408	
Hydroxide	2	mg/L	None	ND	ND	ND	ND	ND	NS	ND	NS	NS	ND	ND	
Iron	0.05	mg/L	0.3	2.47	3	1.14	0.283	0.1	0.136	0.5	NS	NS	0.041J	ND	4/9
Lead	0.05	mg/L	0.015	ND	ND	0.00104	ND	ND	0.00373	ND	NS	NS	ND	ND	
Magnesium	0.5	mg/L	None	34.3	30	33.8	39.8	41	38	34.9	NS	NS	35.7	37.6	
Manganese	0.01	mg/L	0.05	0.14	0.07	0.037	0.0287	0.0154	NS	0.237	NS	NS	0.014	ND	3/9
Mercury	0.0002	mg/L	0.002	ND	NS	ND	NS	ND	NS	ND	NS	NS	ND	NS	

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 508
SANTA MARGARITA RIVER AT YSIDORA
NEAR USGS GAUGING STATION 11046000

Analyte	Det. Limit	Units	MCL	Analytical Results											
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/28/99	12/6/99	3/13/00	6/1/00	
Nitrate-N	0.1	mg/L	45	1.4	3.59	2.19	0.24	0.393	1.19	0.1	NS	NS	5.3	ND	
Oil and Grease	1.0	mg/L	None	ND	ND	ND	ND	ND	NS	ND	NS	NS	ND	ND	
pH	1.00	mg/L	None	8.06	8.11	8.13	8.42	NS	8.24	7.55	NS	NS	7.90	7.24	
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.8	ND	
Potassium	1.0	mg/L	None	5.4	3	2.47	3.93	3.75	2.9	3.06	NS	NS	3.8	3.6	
Sodium	0.5	mg/L	None	78.8	80	78.9	101	94.5	90.8	134	NS	NS	87.9	95.3	
Sulfate	10	mg/L	250	157	132	171	224	278	193	193	NS	NS	185	205	1/9
Surfactants (MBAS)	0.05	mg/L	0.5	ND	ND	ND	ND	ND	NS	ND	NS	NS	0.06	ND	
Total Coliform	2	MPN/100 mL	None	>1600	1600	220	900	900	500	23	NS	NS	500	30	
Total Dissolved Solids	10	mg/L	500 450	660	522	642	748	785	717	786	NS	NS	701	776	5/9
Total Organic Carbon	0.5	mg/L	None	7.5	5.64	2.89	5.09	2.31	1.94	13.7	NS	NS	10	5.2	
Zinc	0.03	mg/L	5	0.022	ND	ND	ND	ND	NS	ND	NS	NS	0.016J	ND	

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 509
CRISTIANITOS CREEK NEAR SAN CLEMENTE
NEAR USGS GAUGING STATION 11046360

Analyte	Det. Limit	Units	MCL	Analytical Results										
				1/98**	3/3/98	5/26/98	8/4/98	NS	2/19/99	5/11/99	9/28/99	12/6/99	3/13/00	6/1/00
Alkalinity (CaCO3)	2	mg/L	None	NS	163	194	184	NS	208	180	NS	NS	210	68
Arsenic	0.005	mg/L	0.05	NS	ND	ND	ND	NS	ND	ND	NS	NS	ND	ND
Bicarbonate	2	mg/L	None	NS	160	190	182	NS	203	178	NS	NS	202	52
Biochemical Oxygen Demand	2	mg/L	None	NS	NS	ND	NS	NS	NS	ND	NS	NS	ND	NS
Boron	0.2	mg/L	None	NS	ND	ND	0.291	NS	0.423	0.386	NS	NS	0.3	0.5
Calcium	0.5	mg/L	None	NS	83	76.9	81	NS	98.9	95.8	NS	NS	101	67.7
Carbonate	2	mg/L	None	NS	2.45	3.34	2.25	NS	4.9	1.84	NS	NS	8	16
Chloride	1	mg/L	250	NS	78	101	92	NS	125	121	NS	NS	139	168
Conductivity	10	mg/L	900	NS	719	824	874	NS	1110	1140	NS	NS	1,240	1,160
Copper	0.02	mg/L	1.0	NS	ND	ND	ND	NS	ND	ND	NS	NS	0.008	ND
Cyanide (Total)	0.005	mg/L	0.2	NS	NS	ND	NS	NS	NS	ND	NS	NS	ND	NS
Fecal Coliform	2	MPN/100 mL	None	NS	13	17	900	NS	>2	170	NS	NS	1,600	50
Fluoride	0.2	mg/L	None	NS	0.386	0.342	0.446	NS	0.453	0.458	NS	NS	0.8	0.5
Hardness (CaCO3)	2	mg/L	None	NS	330	270	295	NS	389	321	NS	NS	364	274
Hydroxide	2	mg/L	None	NS	ND	ND	ND	NS	ND	ND	NS	NS	ND	ND
Iron	0.05	mg/L	0.3	NS	4	0.11	0.478	NS	0.382	0.835	NS	NS	0.10	ND
Lead	0.05	mg/L	0.015	NS	ND	ND	ND	NS	0.00587	ND	NS	NS	ND	ND
Manganese	0.01	mg/L	0.05	NS	0.11	0.017	0.202	NS	0.0346	0.0606	NS	NS	0.23	ND
Mercury	0.0002	mg/L	0.002	NS	NS	ND	NS	NS	NS	ND	NS	NS	ND	NS
Nitrate-N	0.1	mg/L	45	NS	0.298	ND	ND	NS	0.14	ND	NS	NS	0.4	ND

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled
** = Not Sampled in 1/98 due to lack of flow at sampling site.

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 509
CRISTIANITOS CREEK NEAR SAN CLEMENTE
NEAR USGS GAUGING STATION 11046360

Analyte	Det. Limit	Units	MCL	Analytical Results										
				1/98**	3/3/98	5/26/98	8/4/98	NS	2/19/99	5/11/99	9/28/99	12/6/99	3/13/00	6/1/00
Oil and Grease	1.0	mg/L	None	NS	ND	ND	ND	NS	1.5	ND	NS	NS	ND	ND
pH	1.00	mg/L	None	NS	8.16	8.27	8.12	NS	8.4	8.32	NS	NS	8.15	7.63
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.4	ND
Potassium	1.0	mg/L	None	NS	2	1.75	1.88	NS	2.16	ND	NS	NS	2.5	2.3
Sodium	0.5	mg/L	None	NS	70	74.3	77.8	NS	107	104	NS	NS	131	128
Sulfate	10	mg/L	250	NS	125	127	174	NS	199	219	NS	NS	236	249
Surfactants (MBAS)	0.05	mg/L	0.5	NS	ND	ND	ND	NS	ND	0.106	NS	NS	ND	ND
Total Coliform	2	MPN/100 mL	None	NS	900	80	>1600	NS	59	280	NS	NS	>1600	900
Total Dissolved Solids	10	mg/L	500	NS	478	553	545	NS	711	703	NS	NS	796	740
Total Organic Carbon	0.5	mg/L	None	NS	4.75	4.62	1.41	NS	5.29	2.51	NS	NS	11	20
Zinc	0.03	mg/L	5	NS	ND	ND	0.0184	NS	ND	ND	NS	NS	0.03	ND

Notes:
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ND = Not Detected
NS = Not Sampled
** = *Not Sampled in 1/98 due to lack of flow at sampling site.*

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 510
SAN MATEO CREEK AT SAN CLEMENTE
NEAR USGS GAUGING STATION 11046300

Analyte	Det. Limit	Units	MCL	Analytical Results										
				1/98**	3/3/98	6/4/98	8/4/98	11/19/98	2/19/99	5/11/99	9/28/99	12/7/99	3/22/00	6/6/00
Alkalinity (CaCO3)	1	mg/L	None	NS	103	134	189	182	170	175	NS	218	124	196
Arsenic	0.005	mg/L	0.05	NS	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND
Bicarbonate	1	mg/L	None	NS	102	131	183	179	167	172	NS	218	120	196
Biochemical Oxygen Demand	2	mg/L	None	NS	NS	ND	NS	ND	NS	ND	NS	NS	ND	NS
Boron	0.2	mg/L	None	NS	ND	ND	0.112	ND	0.138	ND	NS	ND	ND	0.1
Calcium	0.5	mg/L	None	NS	34	36.3	47.9	51.8	48.3	46.9	NS	69.4	45.3	56.8
Carbonate	0.5	mg/L	None	NS	1.23	3.02	5.57	3.13	3.27	2.57	NS	ND	4	ND
Chloride	1	mg/L	250	NS	28.2	84.9	56.6	60.8	55.2	50.2	NS	96	60	77
Conductivity	10	mg/L	900	NS	332	394	573	629	572	588	NS	822	570	710
Copper	0.02	mg/L	1.0	NS	ND	ND	ND	ND	ND	ND	NS	0.02	0.015	ND
Cyanide (Total)	0.01	mg/L	0.2	NS	NS	ND	NS	ND	NS	ND	NS	NS	ND	NS
Fecal Coliform	2	MPN/100 mL	None	NS	<2	2	2	4	>2	4	NS	<2	7	170
Fluoride	0.1	mg/L	None	NS	0.271	0.334	0.334	0.301	0.31	0.327	NS	0.4	0.5	0.4
Hardness (CaCO3)	2	mg/L	None	NS	106	142	204	222	201	184	NS	320	182	232
Hydroxide	0.5	mg/L	None	NS	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND
Iron	0.05	mg/L	0.3	NS	0.8	0.058	0.0618	ND	0.487	ND	NS	ND	0.07	ND
Lead	0.05	mg/L	0.015	NS	ND	ND	0.00223	ND	0.00616	ND	NS	ND	0.018	ND
Magnesium	0.5	mg/L	None	NS	11	13.3	18.4	21.6	18.7	17.5	NS	26.6	16.8	20.9
Manganese	0.01	mg/L	0.05	NS	0.02	0.007	0.0122	ND	ND	ND	NS	ND	ND	ND
Mercury	0.0002	mg/L	0.002	NS	NS	ND	NS	ND	NS	ND	NS	NS	ND	NS

Notes:
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ND = Not Detected
NS = Not Sampled
** = Not Sampled in 1/98 due to lack of flow at sampling site.

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 510
SAN MATEO CREEK AT SAN CLEMENTE
NEAR USGS GAUGING STATION 11046300

Analyte	Det. Limit	Units	MCL	Analytical Results										
				1/98**	3/3/98	6/4/98	8/4/98	11/19/98	2/19/99	5/11/99	9/28/99	12/7/99	3/22/00	6/6/00
Nitrate-N	0.1	mg/L	45	NS	0.434	0.168	ND	ND	ND	ND	NS	ND	ND	ND
Oil and Grease	1.0	mg/L	None	NS	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND
pH	1.00	mg/L	None	NS	7.89	8.61	8.51	NS	8.29	8.29	NS	7.61	8.05	7.83
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	NS	0.5	0.3	ND
Potassium	1.0	mg/L	None	NS	ND	0.95	0.651	0.839	ND	ND	NS	1.6	1.6	1.3
Sodium	0.5	mg/L	None	NS	33	39.5	48.8	51.5	48.3	45	NS	64.1	42.8	58.4
Sulfate	10	mg/L	250	NS	26.6	35.9	55.2	58	52.8	50	NS	69	58	59
Surfactants (MBAS)	0.05	mg/L	0.5	NS	ND	ND	ND	ND	ND	ND	NS	ND	0.06	ND
Total Coliform	11	MPN/100 mL	None	NS	900	300	220	11	30	70	NS	>1600	7	170
Total Dissolved Solids	10	mg/L	500	NS	206	283	366	391	358	361	NS	469	364	446
Total Organic Carbon	0.5	mg/L	None	NS	2.8	4.31	1.81	1.7	2.83	ND	NS	2.6	10.0	4.4
Zinc	0.03	mg/L	5	NS	0.09	ND	ND	0.0109	0.0104	ND	NS	ND	0.03	ND

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled
** = Not Sampled in 1/98 due to lack of flow at sampling site.

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 511
SAN MATEO CREEK AT SAN ONOFRE
NEAR USGS GAUGING STATION

Analyte	Det. Limit	Units	MCL	Analytical Results										
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/29/99	12/6/99	3/13/00	6/1/00
Alkalinity (CaCO3)	1	mg/L	None	143	111	149	164	156	164	151	152	148	142	152
Arsenic	0.005	mg/L	0.05	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND
Bicarbonate	1	mg/L	None	143	110	148	164	156	163	150	152	148	142	152
Biochemical Oxygen Demand	2	mg/L	None	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS
Boron	0.1	mg/L	None	ND	ND	ND	0.2	0.216	0.255	0.192	0.2	ND	0.1	0.2
Calcium	0.1	mg/L	None	81.1	45	43.2	68.5	83.5	84	87	84.5	73.9	57.6	77.8
Carbonate	0.5	mg/L	None	ND	1.42	0.941	0.509	ND	1.16	0.708	ND	ND	ND	ND
Chloride	1	mg/L	250	128	36.8	93.1	72.8	88.2	88.8	82.9	86	84	70	84
Conductivity	10	mg/L	900	860	434	496	739	886	934	932	875	854	657	836
Copper	0.005	mg/L	1.0	ND	ND	ND	ND	ND	NS	ND	ND	ND	0.016	ND
Cyanide (Total)	0.01	mg/L	0.2	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS
Fecal Coliform	2	MPN/100 mL	None	NS	30	13	130	500	13	30	300	50	50	50
Fluoride	0.1	mg/L	None	ND	0.295	0.278	0.296	0.275	0.251	0.254	0.4	0.4	0.3	0.5
Hardness (CaCO3)	2	mg/L	None	287	145	166	277	335	353	305	298	316	222	292
Hydroxide	0.5	mg/L	None	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND
Iron	0.05	mg/L	0.3	0.068	2.1	0.119	0.0894	0.5	NS	ND	ND	ND	0.04J	ND
Lead	0.05	mg/L	0.015	ND	ND	ND	ND	ND	0.00133	ND	ND	ND	ND	ND
Magnesium	0.2	mg/L	None	22.6	14	15.5	21.2	25.7	26.3	24.3	25.8	22.2	18.4	22.8
Manganese	0.01	mg/L	0.05	0.176	0.04	ND	0.0283	0.0821	NS	ND	ND	0.04	0.02	0.03
Mercury	0.002	mg/L	0.002	ND	NS	ND	NS	ND	NS	ND	ND	NS	ND	NS

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

COMPARISON OF RESULTS BY SAMPLING EVENT

SOURCE: SURFACE WATER: SAMPLING LOCATION 511
SAN MATEO CREEK AT SAN ONOFRE
NEAR USGS GAUGING STATION

Analyte	Det. Limit	Units	MCL	Analytical Results										
				12/9/97	3/3/98	5/26/98	8/4/98	11/9/98	2/10/99	5/11/99	9/29/99	12/6/99	3/13/00	6/1/00
Nitrate-N	0.1	mg/L	45	7.72	1.98	1.27	7.6	11.8	11.9	12.5	8.1	6.3	6.2	6.7
Oil and Grease	1.0	mg/L	None	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND
pH	1.00	mg/L	None	7.3	8.13	7.83	7.52	NS	7.3	7.18	7.02	7.10	7.68	7.19
Phosphate	0.3	mg/L	None	NS	NS	NS	NS	NS	NS	NS	ND	ND	ND	ND
Potassium	1.0	mg/L	None	1.45	ND	0.955	2.08	2.15	1.33	1.18	ND	1.6	2.3	1.9
Sodium	0.3	mg/L	None	60.8	42	45.1	62.2	67.4	68.6	60.6	72.0	61.5	52.7	61.8
Sulfate	10	mg/L	250	123	47	78.8	119	171	148	157	128	121	77	133
Surfactants (MBAS)	0.05	mg/L	0.5	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND
Total Coliform	2	MPN/100 mL	None	NS	240	170	300	900	60	≥1600	300	1600	300	≥1600
Total Dissolved Solids	10	mg/L	500	360	273	327	470	595	586	583	552	531	400	487
Total Organic Carbon	0.5	mg/L	None	4.21	5.84	2.48	3.53	ND	3.69	1.45	16.4	ND	5.8	38
Zinc	0.02	mg/L	5	ND	ND	ND	ND	ND	NS	ND	0.03	ND	0.03	ND

Notes:
MCL = Maximum Contaminant Level (California Domestic Water Quality and Monitoring Regulations (22 CCR Chapter 15))
ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 01

No.	Location	Sampling Date	No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	12/9/97	7	Fallbrook Creek near Fallbrook	12/9/97
2	Sandia Creek near Fallbrook	12/9/97	8	Santa Margarita River at Ysidora	12/9/97
3	Rainbow Creek near Fallbrook	12/9/97	9	Cristianitos Creek near San Clemente	NS - No Flow
4	Santa Margarita River near Temecula	12/9/97	10	San Mateo Creek at San Clemente	NS - No Flow
5	Murrieta Creek at Temecula	12/9/97	11	San Mateo Creek at San Onofre	12/9/97
6	Deluz Creek near Fallbrook	12/9/97			

4/7 1/6 no flow 7/7 4/7 5/7 (1-7) 1/7 (1-7) 7/7 (1-7) 4/7 (1-7)

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Alkalinity (CaCO3)	EPA 310.1	1.00	mg/L	116	154	162	164	127	140	121	145	NS	NS	143
MCL Arsenic .05	EPA 200.7	0.0250	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Bicarbonate	SM406C	1.00	mg/L	115	151	160	163	126	139	120	143	NS	NS	143
Biochemical Oxygen Demand	EPA 405.1	2.00	mg/L	2.5	ND	ND	2.38	2.67	ND	2.48	ND	NS	NS	ND
BP Boron 0.75	6010A	0.5	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Calcium	EPA 200.7	0.100	mg/L	71.4	141	122	85.3	50.7	103	46.6	85.7	NS	NS	81.1
Carbonate	SM406	1.00	mg/L	ND	2.83	1.73	1.08	ND	1.3	ND	2.18	NS	NS	ND
BP Chloride 300/250	EPA 300.0	10.0	mg/L	147	267	213	148	134	224	126	183	NS	NS	128
Conductivity	EPA 120.1	1.00	umhos/cm	849	1620	1470	934	755	1220	740	1070	NS	NS	860
MCL Copper 1.0	EPA 200.7	0.00500	mg/L	0.007	ND	ND	ND	ND	ND	ND	0.01	NS	NS	ND
Cyanide (Total) 0.2	EPA 335.2	0.00500	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Fecal Coliform	MTF	2	mpn/100ml	>1600	300	1600	>1600	>1600	900	>1600	1600	NS	NS	NS
BP Fluoride 1.0	EPA 300.0	0.200	mg/L	ND	ND	ND	ND	0.236	ND	ND	ND	NS	NS	ND
Hardness (CaCO3)	EPA 130.2	10.0	mg/L	259	555	515	247	174	408	217	350	NS	NS	287
Hydroxide	SM406	1.00	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
BP Iron 0.3	EPA 200.7	0.0500	mg/L	9.89	0.257	0.047	3	2.21	0.243	3.34	2.47	NS	NS	0.068
Lead	EPA 200.7	0.0200	mg/L	ND	ND	0.027	0.019	ND	0.023	0.024	ND	NS	NS	ND
Magnesium	EPA 200.7	0.200	mg/L	27.3	61.9	51.1	18.7	13.8	43.5	25.7	34.3	NS	NS	22.6

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 01

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	12/9/97
2	Sandia Creek near Fallbrook	12/9/97
3	Rainbow Creek near Fallbrook	12/9/97
4	Santa Margarita River near Temecula	12/9/97
5	Murrieta Creek at Temecula	12/9/97
6	Deluz Creek near Fallbrook	12/9/97
7	Fallbrook Creek near Fallbrook	12/9/97
8	Santa Margarita River at Ysidora	12/9/97
9	Cristianitos Creek near San Clemente	NS - No Flow
10	San Mateo Creek at San Clemente	NS - No Flow
11	San Mateo Creek at San Onofre	12/9/97

	Analyte	Method	Det. Limit	Units	Analytical Results										
					1	2	3	4	5	6	7	8	9	10	11
MCL	Manganese 0.05	EPA 200.7	0.0100	mg/L	0.252	0.051	0.027	0.251	0.126	0.157	0.194	0.14	NS	NS	0.176
MCL	Mercury 0.002	SW7470	0.000200	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
	Nitrate-N 45	EPA 300.0	0.500	mg/L	1.94	4.92	1.3	1.32	0.872	5.44	0.501	1.4	NS	NS	7.72
	Nitrogen 10	EPA 351.2	0.100	mg/L	0.379	0.38	0.483	0.434	0.483	0.447	0.222	0.2	NS	NS	ND
	Oil and Grease	EPA 413.1	1.18	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
	pH	EPA 150.1	2.0-12.5	pH units	7.85	8.21	7.98	7.7	7.63	7.94	7.82	8.06	NS	NS	7.3
	Phosphate	EPA 365.2	0.3	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Phosphorus	EPA 365.1	0.01	mg/L	0.27	0.063	1.13	0.254	0.266	0.089	0.297	0.208	NS	NS	0.027
	Potassium	EPA 200.7	0.300	mg/L	6.47	3.35	10.8	4.25	4.67	3.04	4.15	5.4	NS	NS	1.45
	Sodium 60%	EPA 200.7	0.300	mg/L	62.4	96.7	103	78.4	73.9	72.7	62.7	78.8	NS	NS	60.8
BP	Sulfate 250/300	EPA 300.0	10.0	mg/L	131	239	269	123	75.4	189	102	157	NS	NS	123
BP	Surfactants (MBAS) 0.5	EPA 425.1	0.100	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
	Total Coliform	MTF	2	mpn/100ml	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600	NS	NS	NS
	Total Dissolved Solids	EPA 160.1	10.0	mg/L	432	1010	910	476	387	740	387	660	NS	NS	360
	Total Organic Carbon	SW415.1	1.00	mg/L	6.21	4.27	11.1	8.77	8.68	7.28	10.6	7.5	NS	NS	4.21
2 MCL	Zinc 5	EPA 200.7	0.0100	mg/L	0.037	0.017	0.015	0.021	0.019	0.013	0.033	0.022	NS	NS	ND

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 02

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	3/3/98
2	Sandia Creek near Fallbrook	3/3/98
3	Rainbow Creek near Fallbrook	3/3/98
4	Santa Margarita River near Temecula	3/3/98
5	Murrieta Creek at Temecula	3/3/98
6	Deluz Creek near Fallbrook	3/3/98
7	Fallbrook Creek near Fallbrook	3/3/98
8	Santa Margarita River at Ysidora	3/3/98
9	Cristianitos Creek near San Clemente	3/3/98
10	San Mateo Creek at San Clemente	3/3/98
11	San Mateo Creek at San Onofre	3/3/98

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Alkalinity (CaCO3)	EPA 310.1	1	mg/L	157	135	79.5	173	169	82.4	220	128	163	103	111
Arsenic	EPA 200.7	0.01	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bicarbonate	SM406C	1	mg/L	155	133	78.7	170	167	81.4	217	126	160	102	110
Biochemical Oxygen Demand	EPA 405.1	2	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Boron	EPA 200.7	0.5	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	EPA 200.7	0.2	mg/L	90	110	46	85	76	51	71	77	83	34	45
Carbonate	SM406	0.5	mg/L	2.3	1.98	0.757	2.48	2.32	0.941	3.02	1.5	2.45	1.23	1.42
Chloride	EPA 300.0	20	mg/L	120	158	70.7	115	133	62.3	105	105	78	28.2	36.8
Conductivity	EPA 120.1	1	umhos/cm	1016	1155	641	983	1000	544	935	814	719	332	434
Copper	EPA 200.7	0.02	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cyanide (Total)	EPA 335.2	0.005	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fecal Coliform	MTF	2	mpn/100ml	140	110	220	300	110	90	300	110	13	<2	30
Fluoride	EPA 300.0	0.2	mg/L	0.29	0.273	0.203	0.32	0.343	0.215	0.429	0.239	0.386	0.271	0.295
Hardness (CaCO3)	EPA 130.2	10	mg/L	348	442	208	320	342	200	328	290	330	106	145
Hydroxide	SM406	0.5	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	EPA 200.7	0.1	mg/L	0.9	5.5	0.7	1.4	1.4	4.2	0.7	3	4	0.8	2.1
Lead	EPA 239.2	0.015	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium	EPA 200.7	0.1	mg/L	34	48	20	28	28	20	37	30	24	11	14

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 02

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	3/3/98
2	Sandia Creek near Fallbrook	3/3/98
3	Rainbow Creek near Fallbrook	3/3/98
4	Santa Margarita River near Temecula	3/3/98
5	Murrieta Creek at Temecula	3/3/98
6	Deluz Creek near Fallbrook	3/3/98
7	Fallbrook Creek near Fallbrook	3/3/98
8	Santa Margarita River at Ysidora	3/3/98
9	Cristianitos Creek near San Clemente	3/3/98
10	San Mateo Creek at San Clemente	3/3/98
11	San Mateo Creek at San Onofre	3/3/98

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Manganese	EPA 200.7	0.01	mg/L	0.06	0.12	0.05	0.1	0.07	0.11	0.14	0.07	0.11	0.02	0.04
Mercury	EPA 245.1	0.0002	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrate-N	EPA 300.0	2	mg/L	3.6	7.63	4.95	1.88	1.42	3.89	1.91	3.59	0.298	0.434	1.98
Nitrogen	EPA 351.2	0.1	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Oil and Grease	EPA 413.1	0.962	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
pH	EPA 150.1	2.0-12.5	pH units	8.19	8.2	8.12	8.27	8.29	7.97	8.19	8.11	8.16	7.89	8.13
Phosphate	365.2	0.3	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus	EPA 365.1	0.01	mg/L	0.481	0.225	0.612	0.511	0.53	0.151	0.456	0.378	0.227	0.108	0.373
Potassium	EPA 200.7	2	mg/L	4	3	3	5	5	ND	2	3	2	ND	ND
Sodium	EPA 200.7	4	mg/L	100	99	69	110	100	53	120	80	70	33	42
Sulfate	EPA 300.0	4	mg/L	179	222	108	164	164	83.5	142	132	125	26.6	47
Surfactants (MBAS)	EPA 425.1	0.1	mg/L	0.112	ND	ND	0.108	ND	ND	0.126	ND	ND	ND	ND
Total Coliform	MTF	2	mpn/100ml	>1600	>1600	>1600	>1600	>1600	1600	1600	1600	900	900	240
Total Dissolved Solids	EPA 160.1	10	mg/L	680	786	453	668	658	336	655	522	478	206	273
Total Organic Carbon	EPA 415.1	1	mg/L	5.87	5.04	8.45	6.09	6.07	3.47	13.7	5.64	4.75	2.8	5.84
Zinc	EPA 200.7	0.03	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.09	ND

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 03

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	5/26/98
2	Sandia Creek near Fallbrook	5/26/98
3	Rainbow Creek near Fallbrook	5/26/98
4	Santa Margarita River near Temecula	5/26/98
5	Murrieta Creek at Temecula	5/26/98
6	Deluz Creek near Fallbrook	5/26/98
7	Fallbrook Creek near Fallbrook	5/26/98
8	Santa Margarita River at Ysidora	5/26/98
9	Cristianitos Creek near San Clemente	5/26/98
10	San Mateo Creek at San Clemente	6/4/98
11	San Mateo Creek at San Onofre	5/26/98

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Alkalinity (CaCO3)	EPA 310.1	1	mg/L	178	159	114	211	201	119	269	166	194	134	149
Arsenic	EPA 200.7	0.025	mg/L	ND	ND	ND	ND	ND	0.026	ND	ND	ND	ND	ND
Bicarbonate	BICARB	1	mg/L	176	157	104	195	200	118	267	164	190	131	148
Biochemical Oxygen Demand	EPA 405.1	2	mg/L	ND	ND	4.02	ND	ND	ND	ND	ND	ND	ND	ND
Boron	6010A	0.5	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	EPA 200.7	0.1	mg/L	92.3	95.3	65.6	97.9	100	50.8	70.3	72	76.9	36.3	43.2
Carbonate	CARBONAT	0.5	mg/L	1.94	1.99	0.642	0.862	0.9	0.944	1.78	2.08	3.34	3.02	0.941
Chloride	EPA 300.0	50	mg/L	189	225	128	197	212	98.7	145	164	101	84.9	93.1
Conductivity	EPA 120.1	1	umhos/cm	1070	1150	848	1120	1260	670	1080	902	824	394	496
Copper	EPA 200.7	0.005	mg/L	ND	ND	0.008	ND	ND	ND	ND	ND	ND	ND	ND
Cyanide (Total)	EPA 335.2	0.005	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fecal Coliform	MTF	2	mpn/100ml	60	220	1600	1600	<2	30	900	30	17	2	13
Fluoride	EPA 300.0	0.2	mg/L	0.301	0.316	0.325	1.12	0.502	1.14	0.403	0.331	0.342	0.334	0.278
Hardness (CaCO3)	EPA 130.2	5	mg/L	344	442	354	310	339	251	364	331	270	142	166
Hydroxide	HYDROXID	0.5	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	EPA 200.7	0.05	mg/L	0.134	0.765	0.486	0.447	0.184	0.971	0.137	1.14	0.11	0.058	0.119
Lead	EPA 239.2	0.001	mg/L	ND	ND	0.00106	ND	ND	ND	ND	0.00104	ND	ND	ND
Magnesium	EPA 200.7	0.2	mg/L	40.8	50.6	29.1	32.2	38.2	24.3	46.5	33.8	24	13.3	15.5

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 03

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	5/26/98
2	Sandia Creek near Fallbrook	5/26/98
3	Rainbow Creek near Fallbrook	5/26/98
4	Santa Margarita River near Temecula	5/26/98
5	Murrieta Creek at Temecula	5/26/98
6	Deluz Creek near Fallbrook	5/26/98
7	Fallbrook Creek near Fallbrook	5/26/98
8	Santa Margarita River at Ysidora	5/26/98
9	Cristianitos Creek near San Clemente	5/26/98
10	San Mateo Creek at San Clemente	6/4/98
11	San Mateo Creek at San Onofre	5/26/98

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Manganese	EPA 200.7	0.01	mg/L	0.024	0.028	0.055	0.075	0.058	0.039	0.063	0.037	0.017	0.007	ND
Mercury	7470	0.0002	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate-N	EPA 300.0	0.5	mg/L	4.58	5.56	10.3	0.868	0.724	2.45	0.356	2.19	ND	0.168	1.27
Nitrogen	EPA 351.2	0.5	mg/Kg	0.7	ND	2.7	0.8	0.8	0.6	0.8	0.7	ND	NS	ND
Oil and Grease	EPA 413.1	1	mg/L	ND	ND	ND	ND	ND	1.33	ND	ND	ND	ND	ND
pH	EPA 150.1	2.5-12.0	pH units	8.07	8.13	7.78	7.64	7.64	7.93	7.85	8.13	8.27	8.61	7.83
Phosphate	EPA 365.2	0.3	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus	EPA 365.1	0.01	mg/L	0.263	0.014	1.14	0.101	0.092	0.014	0.154	0.095	0.012	ND	0.021
Potassium	EPA 200.7	0.3	mg/L	4.75	3.09	7.21	6.11	7.91	1.68	2.22	2.47	1.75	0.95	0.955
Sodium	EPA 200.7	0.3	mg/L	99.9	87.5	83.2	122	141	57.3	115	78.9	74.3	39.5	45.1
Sulfate	EPA 300.0	50	mg/L	197	249	134	273	260	106	143	171	127	35.9	78.8
Surfactants (MBAS)	EPA 425.1	0.1	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Coliform	MTF	2	mpn/100ml	>1600	1600	>1600	>1600	<2	300	>1600	220	80	300	170
Total Dissolved Solids	EPA 160.1	10	mg/L	764	814	662	803	879	455	741	642	553	283	327
Total Organic Carbon	EPA 415.1	1	mg/L	8.06	3.03	10.3	8.53	6.01	4.79	10.2	2.89	4.62	4.31	2.48
Zinc	EPA 200.7	0.01	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 04

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	8/4/98
2	Sandia Creek near Fallbrook	8/4/98
3	Rainbow Creek near Fallbrook	8/4/98
4	Santa Margarita River near Temecula	8/4/98
5	Murrieta Creek at Temecula	8/4/98
6	Deluz Creek near Fallbrook	8/4/98
7	Fallbrook Creek near Fallbrook	8/4/98
8	Santa Margarita River at Ysidora	8/4/98
9	Cristianitos Creek near San Clemente	8/4/98
10	San Mateo Creek at San Clemente	8/4/98
11	San Mateo Creek at San Onofre	8/4/98

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Alkalinity (CaCO3)	EPA 310.1	1	mg/L	196	177	242	205	140	170	363	191	184	189	164
Arsenic	EPA 200.7	0.025	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bicarbonate	BICARB	1	mg/L	192	175	240	203	139	168	359	186	182	183	164
Biochemical Oxygen Demand	EPA 405.1	2	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Boron	EPA 200.7	0.1	mg/L	0.219	0.161	0.125	0.228	0.175	0.154	0.326	0.203	0.291	0.112	0.2
Calcium	EPA 200.7	0.1	mg/L	99.7	108	114	83.4	58.7	84.4	89.6	91.6	81	47.9	68.5
Carbonate	CARBONAT	0.5	mg/L	3.53	2.32	1.92	1.7	0.736	2.23	3.62	4.6	2.25	5.57	0.509
Chloride	EPA 325.3	1	mg/L	162	227	189	98.3	78.2	143	172	159	92	56.6	72.8
Conductivity	EPA 120.1	1	umhos/cm	1280	1290	1400	977	812	1030	1450	1140	874	573	739
Copper	EPA 200.7	0.005	mg/L	ND	ND	0.0063	ND	ND	ND	ND	ND	ND	ND	ND
Cyanide (Total)	EPA 335.2	0.005	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fecal Coliform	MTF	2	mpn/100ml	110	170	900	17	<2	50	140	280	900	2	130
Fluoride	EPA 340.2	0.1	mg/L	0.319	0.307	0.239	0.353	0.313	0.277	0.586	0.367	0.446	0.334	0.296
Hardness (CaCO3)	EPA 130.2	5	mg/L	483	525	564	295	277	428	497	431	295	204	277
Hydroxide	HYDROXID	0.5	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	EPA 200.7	0.05	mg/L	0.149	0.103	ND	0.221	0.244	0.678	0.149	0.283	0.478	0.0618	0.0894
Lead	EPA 239.2	0.001	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00223	ND
Magnesium	EPA 200.7	0.2	mg/L	49	52.5	55.4	24.2	22.6	38.7	58.9	39.8	20.9	18.4	21.2

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 04

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	8/4/98
2	Sandia Creek near Fallbrook	8/4/98
3	Rainbow Creek near Fallbrook	8/4/98
4	Santa Margarita River near Temecula	8/4/98
5	Murrieta Creek at Temecula	8/4/98
6	Deluz Creek near Fallbrook	8/4/98
7	Fallbrook Creek near Fallbrook	8/4/98
8	Santa Margarita River at Ysidora	8/4/98
9	Cristianitos Creek near San Clemente	8/4/98
10	San Mateo Creek at San Clemente	8/4/98
11	San Mateo Creek at San Onofre	8/4/98

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Manganese	EPA 200.7	0.01	mg/L	0.0776	0.0153	0.0329	0.108	0.0633	0.0407	0.13	0.0287	0.202	0.0122	0.0283
Mercury	EPA 245.1	0.0002	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrate-N	EPA 353.2	0.1	mg/L	2.27	4.36	4.54	0.82	0.29	2.2	0.07	0.24	ND	ND	7.6
Nitrogen	EPA 351.2	0.1	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Oil and Grease	EPA 413.1	1.03	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
pH	EPA 150.1	2.5-12.0	pH units	8.29	8.15	7.93	7.95	7.75	8.15	8.03	8.42	8.12	8.51	7.52
Phosphate	365.2	0.3	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus	EPA 365.1	0.01	mg/L	0.04	0.03	0.48	0.07	0.04	0.08	0.36	0.13	0.19	0.02	0.1
Potassium	EPA 200.7	0.3	mg/L	4.47	3.08	5.38	3.32	3.6	1.61	2	3.93	1.88	0.651	2.08
Sodium	EPA 200.7	0.3	mg/L	108	96.4	NS	100	84.6	78.2	153	101	77.8	48.8	62.2
Sulfate	EPA 375.4	50	mg/L	292	265	252	203	194	188	240	224	174	55.2	119
Surfactants (MBAS)	EPA 425.1	0.1	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Coliform	MTF	2	mpn/100ml	>1600	>1600	>1600	500	<2	900	1600	900	>1600	220	300
Total Dissolved Solids	EPA 160.1	10	mg/L	846	850	884	622	506	662	918	748	545	366	470
Total Organic Carbon	EPA 415.1	1	mg/L	2.87	1.66	3.42	2.05	3.83	2.86	7.54	5.09	1.41	1.81	3.53
Zinc	EPA 200.7	0.01	mg/L	ND	ND	ND	ND	0.0144	ND	ND	ND	0.0184	ND	ND

Note: *ND = Not Detected*
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 05

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	11/9/98
2	Sandia Creek near Fallbrook	11/9/98
3	Rainbow Creek near Fallbrook	11/9/98
4	Santa Margarita River near Temecula	11/9/98
5	Murrieta Creek at Temecula	11/9/98
6	Deluz Creek near Fallbrook	11/9/98
7	Fallbrook Creek near Fallbrook	11/9/98
8	Santa Margarita River at Ysidora	11/9/98
9	Cristianitos Creek near San Clemente	NS - No Flow
10	San Mateo Creek at San Clemente	11/19/98
11	San Mateo Creek at San Onofre	11/9/98

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Alkalinity (CaCO3)	EPA 310.1	1	mg/L	180	158	163	159	114	170	179	162	NS	182	156
Arsenic	EPA 200.7	0.025	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Bicarbonate	SM406C	1	mg/L	178	156	162	158	114	168	178	158	NS	179	156
Biochemical Oxygen Demand	EPA 405.1	2	mg/L	2.14	ND	ND	6.72	10	ND	8.02	ND	NS	ND	ND
Boron	EPA 200.7	0.1	mg/L	0.244	0.197	0.2	0.377	0.389	0.218	0.23	0.202	NS	ND	0.216
Calcium	EPA 200.7	0.1	mg/L	118	112	112	61.3	37.5	103	66.7	88.3	NS	51.8	83.5
Carbonate	SM406	0.5	mg/L	1.43	2.32	1.13	ND	ND	2.13	0.623	3.91	NS	3.13	ND
Chloride	EPA 325.3	1	mg/L	176	192	169	109	104	164	133	160	NS	60.8	88.2
Conductivity	EPA 120.1	1	umhos/cm	1410	1370	1460	860	755	1230	1150	1150	NS	629	886
Copper	EPA 200.7	0.005	mg/L	ND	ND	0.0058	ND	0.0075	ND	ND	ND	NS	ND	ND
Cyanide (Total)	EPA 335.2	0.005	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Fecal Coliform	MTF	2	mpn/100ml	>1600	1600	>1600	>1600	>1600	500	>1600	70	NS	4	500
Fluoride	EPA 340.2	0.1	mg/L	0.336	0.298	0.35	0.352	0.356	0.282	0.37	0.354	NS	0.301	0.275
Hardness (CaCO3)	EPA 130.2	1	mg/L	570	551	562	230	153	537	396	426	NS	222	335
Hydroxide	SM406	0.5	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Iron	EPA 200.7	0.05	mg/L	1.48	0.451	0.156	0.564	0.98	1.2	1.92	0.1	NS	ND	0.5
Lead	EPA 239.2	0.001	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Magnesium	EPA 200.7	0.2	mg/L	50.9	55	51.5	16.7	12.4	48.8	41.8	41	NS	21.6	25.7

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 05

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	11/9/98
2	Sandia Creek near Fallbrook	11/9/98
3	Rainbow Creek near Fallbrook	11/9/98
4	Santa Margarita River near Temecula	11/9/98
5	Murrieta Creek at Temecula	11/9/98
6	Deluz Creek near Fallbrook	11/9/98
7	Fallbrook Creek near Fallbrook	11/9/98
8	Santa Margarita River at Ysidora	11/9/98
9	Cristianitos Creek near San Clemente	NS - No Flow
10	San Mateo Creek at San Clemente	11/19/98
11	San Mateo Creek at San Onofre	11/9/98

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Manganese	EPA 200.7	0.01	mg/L	0.143	0.0282	0.048	0.0656	0.0882	0.0488	0.559	0.0154	NS	ND	0.0821
Mercury	SW7470A	0.0002	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Nitrate-N	353.2-354.1	0.05	mg/L	4.2	5.33	13.2	1.22	1.21	4.46	1.15	0.393	NS	ND	11.8
Nitrogen	EPA 351.2	0.1	mg/L	1.36	0.781	1.66	1.57	1.8	0.619	1.75	0.453	NS	0.2	0.526
Oil and Grease	EPA 413.1	1	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Phosphate	EPA 365.2	0.3	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus	EPA 365.1	0.01	mg/L	0.188	ND	0.917	0.25	0.45	0.04	0.704	0.036	NS	ND	0.071
Potassium	EPA 200.7	0.3	mg/L	7.14	3.35	9.35	9.73	11.8	2.35	6.69	3.75	NS	0.839	2.15
Sodium	EPA 200.7	0.3	mg/L	111	98.3	120	99.7	91.9	87.7	110	94.5	NS	51.5	67.4
Sulfate	EPA 375.4	5	mg/L	294	296	326	135	115	260	264	278	NS	58	171
Surfactants (MBAS)	EPA 425.1	0.1	mg/L	ND	ND	0.113	0.358	0.516	ND	0.135	ND	NS	ND	ND
Total Coliform	MTF	2	mpn/100ml	>1600	>1600	>1600	>1600	>1600	>1600	>1600	900	NS	11	900
Total Dissolved Solids	EPA 160.1	10	mg/L	963	925	1010	570	498	821	746	785	NS	391	595
Total Organic Carbon	SW415.1	1	mg/L	5.85	2.66	58.9	15.6	20.4	1.47	15.8	2.31	NS	1.7	ND
Zinc	EPA 200.7	0.01	mg/L	ND	ND	ND	0.0144	0.216	ND	0.0148	ND	NS	0.0109	ND

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 06

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	2/10/99
2	Sandia Creek near Fallbrook	2/10/99
3	Rainbow Creek near Fallbrook	2/10/99
4	Santa Margarita River near Temecula	2/10/99
5	Murrieta Creek at Temecula	2/10/99
6	Deluz Creek near Fallbrook	2/10/99
7	Fallbrook Creek near Fallbrook	2/10/99
8	Santa Margarita River at Ysidora	2/10/99
9	Cristianitos Creek near San Clemente	2/19/99
10	San Mateo Creek at San Clemente	2/19/99
11	San Mateo Creek at San Onofre	2/10/99

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Alkalinity (CaCO3)	EPA 310.1	1	mg/L	186	172	174	154	122	175	204	192	208	170	164
Arsenic	EPA 200.7	0.025	mg/L	NS	NS	NS	NS	0.0387	ND	NS	NS	ND	ND	NS
Bicarbonate	SM406C	1	mg/L	183	168	172	153	121	172	202	188	203	167	163
Biochemical Oxygen Demand	EPA 405.1	2	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Boron	EPA 200.7	0.1	mg/L	0.19	0.141	0.173	0.345	0.378	0.146	0.176	0.169	0.423	0.138	0.255
Calcium	EPA 200.7	0.1	mg/L	89.1	104	91	47.9	36.2	88.4	51.8	84.7	98.9	48.3	84
Carbonate	SM406	0.5	mg/L	2.55	3.71	2.18	1.09	0.687	2.57	2.08	3.61	4.9	3.27	1.16
Chloride	EPA 325.3	1	mg/L	136	179	136	96.6	90.8	141	90.8	139	125	55.2	88.8
Conductivity	EPA 120.1	1	umhos/cm	1180	1300	1240	776	697	1120	875	1130	1110	572	934
Copper	EPA 200.7	0.005	mg/L	NS	NS	0.00511	0.005	0.00706	NS	NS	NS	ND	ND	NS
Cyanide (Total)	EPA 335.2	0.005	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fecal Coliform	*9221*	2	mpn/100ml	*900*	*220*	*>1600*	*1600*	*>1600*	*50*	*30*	*17*	*>2*	*>2*	*13*
Fluoride	EPA 340.2	0.1	mg/L	0.297	0.283	0.294	0.292	0.279	0.255	0.322	0.326	0.453	0.31	0.251
Hardness (CaCO3)	EPA 130.2	1	mg/L	460	559	445	192	148	467	284	432	389	201	353
Hydroxide	SM406C	0.5	mg/L	NS	NS	NS	NS	NS	ND	NS	NS	ND	ND	NS
Iron	EPA 200.7	0.05	mg/L	0.932	0.336	0.214	3.46	6.47	0.427	0.511	0.136	0.382	0.487	NS
Lead	EPA 239.2	0.001	mg/L	NS	NS	NS	0.00107	0.00188	ND	0.00107	0.00373	0.00587	0.00616	0.00133
Magnesium	EPA 200.7	0.2	mg/L	40.7	52	43.8	14.7	13.2	41.7	32.2	38	26.2	18.7	26.3

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 06

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	2/10/99
2	Sandia Creek near Fallbrook	2/10/99
3	Rainbow Creek near Fallbrook	2/10/99
4	Santa Margarita River near Temecula	2/10/99
5	Murrieta Creek at Temecula	2/10/99
6	Deluz Creek near Fallbrook	2/10/99
7	Fallbrook Creek near Fallbrook	2/10/99
8	Santa Margarita River at Ysidora	2/10/99
9	Cristianitos Creek near San Clemente	2/19/99
10	San Mateo Creek at San Clemente	2/19/99
11	San Mateo Creek at San Onofre	2/10/99

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Manganese	EPA 200.7	0.01	mg/L	0.0454	0.0118	0.0168	0.0786	0.0891	0.0139	0.107	NS	0.0346	ND	NS
Mercury	EPA 245.1	0.0002	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrate-N	353.2-354.1	0.05	mg/L	4.76	5.15	9.34	0.381	0.153	4.21	1.94	1.19	0.14	ND	11.9
Nitrogen	EPA 351.2	0.1	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Oil and Grease	EPA 413.1	1	mg/L	NS	NS	0.98	NS	1.2	ND	0.952	NS	1.5	ND	NS
pH	EPA 150.1		pH units	8.09	8.33	8.06	7.78	7.58	8.13	7.91	8.24	8.4	8.29	7.3
Phosphate	365.2	0.3	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus	EPA 365.1	0.01	mg/L	0.165	NS	0.713	0.256	0.255	ND	0.259	0.033	0.027	ND	NS
Potassium	EPA 200.7	1	mg/L	4.63	2.72	7.56	5.96	6.76	2.04	2.81	2.9	2.16	ND	1.33
Sodium	EPA 200.7	0.3	mg/L	92.3	90.3	102	89.5	88.3	78.7	83.7	90.8	107	48.3	68.6
Sulfate	EPA 375.4	5	mg/L	222	240	250	108	93	189	121	193	199	52.8	148
Surfactants (MBAS)	EPA 425.1	0.1	mg/L	NS	NS	NS	NS	0.224	ND	NS	NS	ND	ND	NS
Total Coliform	9221	2	mpn/100ml	>1600	500	>1600	>1600	>1600	500	900	500	59	30	60
Total Dissolved Solids	EPA 160.1	10	mg/L	771	854	806	499	425	700	536	717	711	358	586
Total Organic Carbon	SW415.1	1	mg/L	6.37	1.53	7.31	6.59	8.95	3.18	8.37	1.94	5.29	2.83	3.69
Zinc	EPA 200.7	0.01	mg/L	NS	0.0111	NS	0.0205	0.0423	ND	NS	NS	ND	0.0104	NS

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 07

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	5/11/99
2	Sandia Creek near Fallbrook	5/11/99
3	Rainbow Creek near Fallbrook	5/11/99
4	Santa Margarita River near Temecula	5/11/99
5	Murrieta Creek at Temecula	5/11/99
6	Deluz Creek near Fallbrook	5/11/99
7	Fallbrook Creek near Fallbrook	5/11/99
8	Santa Margarita River at Ysidora	5/11/99
9	Cristianitos Creek near San Clemente	5/11/99
10	San Mateo Creek at San Clemente	5/11/99
11	San Mateo Creek at San Onofre	5/11/99

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Alkalinity (CaCO3)	EPA 310.1	1	mg/L	185	166	222	237	185	174	266	233	180	175	151
Arsenic	EPA 200.7	0.025	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bicarbonate	SM406C	1	mg/L	183	164	221	235	184	172	264	231	178	172	150
Biochemical Oxygen Demand	EPA 405.1	2	mg/L	ND	ND	ND	ND	2.11	ND	ND	3.06	ND	ND	ND
Boron	EPA 200.7	0.1	mg/L	0.215	ND	ND	0.197	0.44	0.123	0.144	0.219	0.386	ND	0.192
Calcium	EPA 200.7	0.1	mg/L	87.4	108	112	105	53.5	94.2	65.2	94.7	95.8	46.9	87
Carbonate	SM406	0.5	mg/L	1.84	1.77	1.04	2.11	1.09	1.9	1.93	1.73	1.84	2.57	0.708
Chloride	EPA 325.3	1	mg/L	135	175	166	95.1	124	142	112	172	121	50.2	82.9
Conductivity	EPA 120.1	1	umhos/cm	1230	1360	1420	1140	1020	1180	1120	1350	1140	588	932
Copper	EPA 200.7	0.005	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cyanide (Total)	EPA 335.2	0.005	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fecal Coliform	9221	2	mpn/100ml	>23	>23	>23	>23	>23	>23	>23	6.9	170	4	30
Fluoride	EPA 340.2	0.1	mg/L	0.326	0.285	0.242	0.281	0.526	0.279	0.476	0.382	0.458	0.327	0.254
Hardness (CaCO3)	EPA 130.2	2	mg/L	376	466	492	353	201	394	322	363	321	184	305
Hydroxide	SM406C	0.5	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	EPA 200.7	0.05	mg/L	ND	ND	ND	0.0668	2.12	0.247	0.236	0.5	0.835	ND	ND
Lead	EPA 239.2	0.001	mg/L	ND	ND	ND	0.00286	0.0012	ND	ND	ND	ND	ND	ND
Magnesium	EPA 200.7	0.2	mg/L	38.9	51.6	53.6	22.4	16.8	43.7	41.6	34.9	26.1	17.5	24.3

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 07

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	5/11/99
2	Sandia Creek near Fallbrook	5/11/99
3	Rainbow Creek near Fallbrook	5/11/99
4	Santa Margarita River near Temecula	5/11/99
5	Murrieta Creek at Temecula	5/11/99
6	Deluz Creek near Fallbrook	5/11/99
7	Fallbrook Creek near Fallbrook	5/11/99
8	Santa Margarita River at Ysidora	5/11/99
9	Cristianitos Creek near San Clemente	5/11/99
10	San Mateo Creek at San Clemente	5/11/99
11	San Mateo Creek at San Onofre	5/11/99

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Manganese	EPA 200.7	0.01	mg/L	0.0274	ND	ND	0.0417	0.308	0.0215	0.185	0.237	0.0606	ND	ND
Mercury	EPA 245.1	0.0002	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate-N	353.2-354.1	0.05	mg/L	1.83	2.77	8.6	2.08	0.153	2.06	0.089	0.1	ND	ND	12.5
Nitrogen	EPA 351.2	0.4	mg/L	0.59	0.507	0.535	ND	0.546	0.509	0.545	0.404	ND	ND	ND
Oil and Grease	EPA 413.1	1.02	mg/L	ND	ND	0.962	ND	ND	ND	ND	ND	ND	ND	ND
pH	EPA 150.1	2.5-12.0	pH units	7.95	8.24	7.98	7.89	7.65	8.2	7.86	7.55	8.32	8.29	7.18
Phosphate	EPA 365.2	0.3	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus	EPA 365.1	0.01	mg/L	0.076	0.022	0.446	0.085	0.161	0.046	0.356	0.118	0.016	0.015	0.038
Potassium	EPA 200.7	1	mg/L	3.26	2.47	5.06	1.53	4.67	1.79	ND	3.06	ND	ND	1.18
Sodium	EPA 200.7	0.3	mg/L	106	87.8	96	94.7	134	83.2	109	134	104	45	60.6
Sulfate	EPA 375.4	50	mg/L	247	262	254	216	134	210	152	193	219	50	157
Surfactants (MBAS)	EPA 425.1	0.1	mg/L	0.116	0.116	ND	ND	ND	ND	0.165	ND	0.106	ND	ND
Total Coliform	9221	2	mpn/100ml	>23	>23	>23	>23	>23	>23	>23	23	280	70	>1600
Total Dissolved Solids	EPA 160.1	10	mg/L	787	879	848	761	602	723	689	786	703	361	583
Total Organic Carbon	SW415.1	1	mg/L	2.13	1.5	5.77	3.2	2.26	2.62	14	13.7	2.51	ND	1.45
Zinc	EPA 200.7	0.02	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 08

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	9/28/99
2	Sandia Creek near Fallbrook	9/28/99
3	Rainbow Creek near Fallbrook	9/28/99
4	Santa Margarita River near Temecula	9/28/99
5	Murrieta Creek at Temecula	9/28/99
6	Deluz Creek near Fallbrook	9/28/99
7	Fallbrook Creek near Fallbrook	9/28/99
8	Santa Margarita River at Ysidora	9/28/99
9	Cristianitos Creek near San Clemente	9/28/99
10	San Mateo Creek at San Clemente	9/28/99
11	San Mateo Creek at San Onofre	9/29/99

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Alkalinity (CaCO3)	GEN.MINERAL	1	mg/L	172	160	234	164	142	NS	398	NS	NS	NS	152
Arsenic	{6010/7000}	0.005	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	NS	ND
Bicarbonate	GEN.MINERAL	1	mg/L	172	140	234	164	142	NS	398	NS	NS	NS	152
Biochemical Oxygen Demand	405.1	2	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	NS	ND
Boron	SM-4500-B	0.2	mg/L	0.2	0.1	0.1	0.2	0.1	NS	0.2	NS	NS	NS	0.2
Calcium	GEN.MINERAL	0.5	mg/L	81.4	99.1	114	63.4	65.2	NS	75.2	NS	NS	NS	84.5
Carbonate	GEN.MINERAL	0.5	mg/L	ND	20	ND	ND	ND	NS	ND	NS	NS	NS	ND
Chloride	GEN.MINERAL	1	mg/L	147	219	188	81	73	NS	188	NS	NS	NS	86
Conductivity	GEN.MINERAL	10	umhos/cm	1230	1430	1420	821	794	NS	1470	NS	NS	NS	875
Copper	GEN.MINERAL	0.02	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	NS	ND
Cyanide (Total)	335.2	0.01	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	NS	ND
Fecal Coliform	9221	2	mpn/100ml	130	130	80	<2	14	NS	1600	NS	NS	NS	300
Fluoride	GEN.MINERAL	0.1	mg/L	0.4	0.4	0.3	0.5	0.5	NS	0.8	NS	NS	NS	0.4
Hardness (CaCO3)	GEN.MINERAL	2	mg/L	400	506	532	236	236	NS	432	NS	NS	NS	298
Hydroxide	GEN.MINERAL	0.5	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	NS	ND
Iron	GEN.MINERAL	0.05	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	NS	ND
Lead	{6010/7000}	0.1	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	NS	ND
Magnesium	GEN.MINERAL	0.5	mg/L	37.5	47.5	56.2	17.5	19.7	NS	49.4	NS	NS	NS	25.8

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 08

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	9/28/99
2	Sandia Creek near Fallbrook	9/28/99
3	Rainbow Creek near Fallbrook	9/28/99
4	Santa Margarita River near Temecula	9/28/99
5	Murrieta Creek at Temecula	9/28/99
6	Deluz Creek near Fallbrook	9/28/99
7	Fallbrook Creek near Fallbrook	9/28/99
8	Santa Margarita River at Ysidora	9/28/99
9	Cristianitos Creek near San Clemente	9/28/99
10	San Mateo Creek at San Clemente	9/28/99
11	San Mateo Creek at San Onofre	9/29/99

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Manganese	GEN.MINERAL	0.01	mg/L	0.02	ND	ND	0.03	ND	NS	0.35	NS	NS	NS	ND
Mercury	{6010/7000}	0.0002	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	NS	ND
Nitrate-N	GEN.MINERAL	0.1	mg/L	1.7	2.4	4.1	2.0	2.1	NS	ND	NS	NS	NS	8.1
Nitrite	GEN.MINERAL	0.02	mg/L	ND	ND	ND	0.03	ND	NS	ND	NS	NS	NS	ND
Nitrogen	351.3	0.1	mg/L	0.5	0.8	0.5	0.4	0.4	NS	0.6	NS	NS	NS	ND
Oil and Grease	413.1	1.0	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	NS	ND
pH	GEN.MINERAL	1.00	pH units	8.05	8.32	7.91	7.88	7.85	NS	7.74	NS	NS	NS	7.02
Phosphate	365.2	0.3	mg/L	ND	ND	1.3	0.4	0.3	NS	1.8	NS	NS	NS	ND
Potassium	GEN.MINERAL	1.0	mg/L	3.9	3.6	4.6	3.0	3.4	NS	4.4	NS	NS	NS	ND
Sodium	GEN.MINERAL	0.5	mg/L	94.2	87.2	91.9	79.2	75.3	NS	163	NS	NS	NS	72.0
Sulfate	GEN.MINERAL	10	mg/L	214	218	196	113	130	NS	104	NS	NS	NS	128
Surfactants (MBAS)	GEN.MINERAL	0.05	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	NS	ND
Total Coliform	9221	2	mpn/100ml	900	300	300	<2	>1600	NS	1600	NS	NS	NS	300
Total Dissolved Solids	GEN.MINERAL	10	mg/L	785	913	964	519	504	NS	880	NS	NS	NS	552
Total Organic Carbon	415.1	0.5	mg/L	20.3	1.5	7.0	4.1	7.4	NS	4.6	NS	NS	NS	16.4
Zinc	GEN.MINERAL	0.03	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	NS	0.03

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 09

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	12/6/99
2	Sandia Creek near Fallbrook	12/6/99
3	Rainbow Creek near Fallbrook	12/6/99
4	Santa Margarita River near Temecula	12/6/99
5	Murrieta Creek at Temecula	12/6/99
6	Deluz Creek near Fallbrook	12/6/99
7	Fallbrook Creek near Fallbrook	12/6/99
8	Santa Margarita River at Ysidora	12/6/99
9	Cristianitos Creek near San Clemente	12/6/99
10	San Mateo Creek at San Clemente	12/7/99
11	San Mateo Creek at San Onofre	12/6/99

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Alkalinity (CaCO3)	GEN.MINERAL.	2	mg/L	194	168	238	288	238	NS	380	NS	NS	218	148
Aluminum	GEN.MINERAL	0.1	mg/L	0.2	0.2	0.2	0.2	0.2	NS	0.1	NS	NS	0.1	0.1
Arsenic	{6010/7000}	0.005	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	ND	ND
Bicarbonate	GEN.MINERAL.	2	mg/L	194	156	238	288	238	NS	380	NS	NS	218	148
Biochemical Oxygen Demand	EPA 405.1	2	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Boron	SM-4500-B	0.2	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	ND	ND
Calcium	GEN.MINERAL.	0.5	mg/L	120	114	113	112	60.7	NS	81.8	NS	NS	69.4	73.9
Carbonate	GEN.MINERAL.	2	mg/L	ND	12	ND	ND	ND	NS	ND	NS	NS	ND	ND
Chloride	GEN.MINERAL.	1	mg/L	188	215	192	147	104	NS	193	NS	NS	96	84
Conductivity	GEN.MINERAL.	10	umhos/cm	1510	1430	1390	1250	917	NS	1500	NS	NS	822	854
Copper	GEN.MINERAL.	0.02	mg/L	0.03	0.03	0.03	0.03	ND	NS	0.03	NS	NS	0.02	ND
Cyanide (Total)	EPA 335.2	0.005	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fecal Coliform	9221	2	mpn/100ml	30	2	900	80	9	NS	50	NS	NS	<2	50
Fluoride	GEN.MINERAL.	0.2	mg/L	0.4	0.4	0.3	0.4	0.5	NS	0.8	NS	NS	0.4	0.4
Hardness (CaCO3)	GEN.MINERAL.	2	mg/L	564	514	530	400	240	NS	450	NS	NS	320	316
Hydroxide	GEN.MINERAL.	2	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	ND	ND
Iron	GEN.MINERAL.	0.05	mg/L	0.06	0.06	0.06	0.11	0.18	NS	0.24	NS	NS	ND	ND
Lead	{6010/7000}	0.05	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	ND	ND

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 09

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	12/6/99
2	Sandia Creek near Fallbrook	12/6/99
3	Rainbow Creek near Fallbrook	12/6/99
4	Santa Margarita River near Temecula	12/6/99
5	Murrieta Creek at Temecula	12/6/99
6	Deluz Creek near Fallbrook	12/6/99
7	Fallbrook Creek near Fallbrook	12/6/99
8	Santa Margarita River at Ysidora	12/6/99
9	Cristianitos Creek near San Clemente	NS - No Flow
10	San Mateo Creek at San Clemente	12/7/99
11	San Mateo Creek at San Onofre	12/6/99

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Magnesium	GEN.MINERAL.	0.5	mg/L	56.9	54.0	56.1	27.4	20.2	NS	52.4	NS	NS	26.6	22.2
Manganese	GEN.MINERAL.	0.01	mg/L	0.04	0.03	0.03	0.12	0.05	NS	0.18	NS	NS	ND	0.04
Mercury	EPA 245.1	0.0002	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrate-N	GEN.MINERAL.	0.1	mg/L	3.2	2.6	4.8	ND	ND	NS	ND	NS	NS	ND	6.3
Nitrite	GEN.MINERAL.	0.02	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	ND	ND
Nitrogen	EPA 351.2	0.1	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Oil and Grease	413.1	1.0	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	ND	ND
pH	GEN.MINERAL.	1.00	pH units	7.83	8.14	7.62	7.59	7.34	NS	7.67	NS	NS	7.61	7.10
Phosphate	365.2	0.3	mg/L	ND	ND	1.1	0.4	ND	NS	0.3	NS	NS	0.5	ND
Potassium	GEN.MINERAL.	1.0	mg/L	3.5	2.8	3.4	2.5	2.3	NS	2.2	NS	NS	1.6	1.6
Sodium	GEN.MINERAL.	0.5	mg/L	101	93.3	85.6	110	101	NS	151	NS	NS	64.1	61.5
Sulfate	GEN.MINERAL.	10	mg/L	285	224	187	133	75	NS	123	NS	NS	69	121
Surfactants (MBAS)	GEN.MINERAL.	0.05	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	ND	ND
Total Coliform	9221	2	mpn/100ml	1600	900	1600	240	>1600	NS	500	NS	NS	>1600	1600
Total Dissolved Solids	GEN.MINERAL.	10	mg/L	1010	908	879	756	552	NS	889	NS	NS	469	531
Total Organic Carbon	415.1	0.5	mg/L	0.9	0.5	1.4	14.2	4.4	NS	13.3	NS	NS	2.6	ND
Zinc	GEN.MINERAL.	0.03	mg/L	ND	ND	ND	ND	ND	NS	ND	NS	NS	ND	ND

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 10

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	3/7/00
2	Sandia Creek near Fallbrook	3/7/00
3	Rainbow Creek near Fallbrook	3/7/00
4	Santa Margarita River near Temecula	3/7/00
5	Murrieta Creek at Temecula	3/7/00
6	Deluz Creek near Fallbrook	3/7/00
7	Fallbrook Creek near Fallbrook	3/7/00
8	Santa Margarita River at Ysidora	3/13/00
9	Cristianitos Creek near San Clemente	3/13/00
10	San Mateo Creek at San Clemente	3/22/00
11	San Mateo Creek at San Onofre	3/13/00

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Alkalinity (CaCO3)	GEN.-MINERALS	1	mg/L	118	158	172	134	124	112	112	156	210	124	142
Arsenic	6010/7000	0.025	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bicarbonate	GEN.-MINERALS	1	mg/L	118	158	168	134	124	112	112	156	202	120	142
Biochemical Oxygen Demand	405.1	2	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Boron	SM-4500B	0.1	mg/L	ND	0.1	0.1	0.3	0.3	ND	ND	0.1	0.3	ND	0.1
Calcium	GEN.-MINERALS	0.10	mg/L	61.4	110	116	47.7	43.8	68.4	31.1	84.4	101	45.3	57.6
Carbonate	GEN.-MINERALS	0.5	mg/L	ND	ND	4	ND	ND	ND	ND	ND	8	4	ND
Chloride	GEN.-MINERALS	0.5	mg/L	102	224	197	99	100	135	59	143	139	60	70
Conductivity	GEN.-MINERALS	5	mg/L	842	1,520	1,610	728	697	1,070	536	1,090	1,240	570	657
Copper	GEN.-MINERALS	0.005	mg/L	ND	ND	ND	ND	ND	ND	ND	0.009	0.008	0.015	0.016
Cyanide (Total)	335.2	0.01	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fecal Coliform	MPN(F)	2	MPN/100 ml	240	1,600	1,600	>1,600	1,600	900	240	70	1,600	7	50
Fluoride	GEN.-MINERALS	0.1	mg/L	0.4	0.4	0.4	0.5	0.5	0.3	0.4	0.4	0.8	0.5	0.3
Hardness (CaCO3)	GEN.-MINERALS	1	mg/L	278	554	568	186	164	332	168	368	364	182	222
Hydroxide	GEN.-MINERALS	0.5	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	GEN.-MINERALS	0.03	mg/L	ND	ND	ND	0.035J	0.038J	ND	0.04J	0.041J	0.10	0.07	0.04J
Lead	6010/7000	0.005	mg/L	ND	0.011	0.018	0.025	ND	ND	0.008	ND	ND	0.018	ND
Magnesium	GEN.-MINERALS	0.20	mg/L	25.2	53.8	54.0	13.2	12.9	31.3	17.8	35.7	22.5	16.8	18.4

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 10

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	3/7/00
2	Sandia Creek near Fallbrook	3/7/00
3	Rainbow Creek near Fallbrook	3/7/00
4	Santa Margarita River near Temecula	3/7/00
5	Murrieta Creek at Temecula	3/7/00
6	Deluz Creek near Fallbrook	3/7/00
7	Fallbrook Creek near Fallbrook	3/7/00
8	Santa Margarita River at Ysidora	3/13/00
9	Cristianitos Creek near San Clemente	3/13/00
10	San Mateo Creek at San Clemente	3/22/00
11	San Mateo Creek at San Onofre	3/13/00

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Manganese	GEN.-MINERALS	0.005	mg/L	0.03	0.03	0.01	0.02	0.006J	0.01	0.03	0.014	0.23	ND	0.02
Mercury	6010/7000	0.0002	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate-N	352.1	0.05	mg/L	15.5	30.1	62.9	2.7	2.2	29.2	2.7	5.3	0.4	ND	6.2
Nitrogen	351.3	0.05	mg/L	0.09J	0.1	0.1	ND	0.1	ND	0.1	0.2	0.2	0.2	0.2
Oil and Grease	413.1	0.5	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
pH	GEN.-MINERALS	0.01	mg/L	8.02	8.28	8.25	7.99	7.84	8.07	7.90	7.90	8.15	8.05	7.68
Phosphate	365.2	0.30	mg/L	1.2	0.8	2.0	1.2	1.4	1.4	1.1	0.8	0.4	0.3	ND
Potassium	GEN.-MINERALS	0.5	mg/L	4.0	3.4	9.8	3.9	4.3	2.2	2.7	3.8	2.5	1.6	2.3
Sodium	GEN.-MINERALS	0.25	mg/L	59.7	96.0	122	71.6	74.5	75.5	48.0	87.9	131	42.8	52.7
Sulfate	GEN.-MINERALS	5	mg/L	117	262	290	69	66	167	62	185	236	58	77
Surfactants (MBAS)	GEN.-MINERALS	0.03	mg/L	ND	ND	0.06	0.11	ND	ND	0.08	0.06	ND	0.06	ND
Total Coliform	MPN(T)	3.0	MPN/100 ml	>1,600	>1,600	>1,600	>1,600	>1,600	1,600	>1,600	500	>1,600	7	300
Total Dissolved Solids	GEN.-MINERALS	5	mg/L	538	966	1,060	480	444	661	340	701	796	364	400
Total Organic Carbon	415.1	0.1	mg/L	7.7	5.6	8.1	13	10	7.3	9.8	10	11	10.0	5.8
Zinc	GEN.-MINERALS	0.01	mg/L	ND	ND	0.019J	0.010J	ND	ND	0.012J	0.016J	0.03	0.03	0.03

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 11

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	6/1/00
2	Sandia Creek near Fallbrook	6/1/00
3	Rainbow Creek near Fallbrook	6/1/00
4	Santa Margarita River near Temecula	6/1/00
5	Murrieta Creek at Temecula	6/1/00
6	Deluz Creek near Fallbrook	6/1/00
7	Fallbrook Creek near Fallbrook	6/1/00
8	Santa Margarita River at Ysidora	6/1/00
9	Cristianitos Creek near San Clemente	6/1/00
10	San Mateo Creek at San Clemente	6/6/00
11	San Mateo Creek at San Onofre	6/1/00

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Alkalinity (CaCO3)	GEN.-MINERALS	1	mg/L	180	166	216	188	164	174	320	184	68	196	152
Arsenic	6010BSCAN	0.025	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bicarbonate	GEN.-MINERALS	1	mg/L	180	146	204	180	156	154	320	164	52	196	152
Biochemical Oxygen Demand	405.1	2	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Boron	SM-4500B	0.1	mg/L	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.5	0.1	0.2
Calcium	GEN.-MINERALS	0.1	mg/L	92.0	112	141	66.0	56.8	119	74.0	91.3	67.7	56.8	77.8
Carbonate	GEN.-MINERALS	0.5	mg/L	ND	20	12	8	8	20	ND	20	16	ND	ND
Chloride	GEN.-MINERALS	0.5	mg/L	176	230	208	99	93	202	154	170	168	77	84
Conductivity	GEN.-MINERALS	5	mg/L	1,350	1,490	1,650	873	843	1,400	1,320	1,230	1,160	710	836
Copper	GEN.-MINERALS	0.005	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cyanide (Total)	335.2	0.01	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fecal Coliform	MPN(F)	2	MPN/mL	130	50	130	13	ND	70	50	13	50	170	50
Fluoride	GEN.-MINERALS	0.1	mg/L	0.6	0.6	0.5	0.5	0.5	0.5	0.7	0.5	0.5	0.4	0.5
Hardness (CaCO3)	GEN.-MINERALS	1	mg/L	424	542	600	242	208	492	412	408	274	232	292
Hydroxide	GEN.-MINERALS	0.5	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	GEN.-MINERALS	0.03	mg/L	ND	ND	ND	ND	0.07	ND	ND	ND	ND	ND	ND
Lead	6010BSCAN	0.005	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium	GEN.-MINERALS	0.2	mg/L	44.1	54.7	64.2	17.7	16.7	53.7	47.0	37.6	27.8	20.9	22.8

Note: ND = Not Detected
NS = Not Sampled

SURFACE WATER RESULTS FOR SAMPLING EVENT 11

No.	Location	Sampling Date
1	Santa Margarita River near Fallbrook	6/1/00
2	Sandia Creek near Fallbrook	6/1/00
3	Rainbow Creek near Fallbrook	6/1/00
4	Santa Margarita River near Temecula	6/1/00
5	Murrieta Creek at Temecula	6/1/00
6	Deluz Creek near Fallbrook	6/1/00
7	Fallbrook Creek near Fallbrook	6/1/00
8	Santa Margarita River at Ysidora	6/1/00
9	Cristianitos Creek near San Clemente	6/1/00
10	San Mateo Creek at San Clemente	6/6/00
11	San Mateo Creek at San Onofre	6/1/00

Analyte	Method	Det. Limit	Units	Analytical Results										
				1	2	3	4	5	6	7	8	9	10	11
Manganese	GEN.-MINERALS	0.005	mg/L	0.04	ND	ND	0.02	0.02	ND	0.18	ND	ND	ND	0.03
Mercury	6010/7000	0.0002	mg/L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrate-N	GEN.-MINERALS	0.05	mg/L	1.5	5.0	15.0	1.2	1.2	2.8	ND	ND	ND	ND	6.7
Oil and Grease	413.1	0.5	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
pH	GEN.-MINERALS	0.01	mg/L	7.31	7.36	7.39	7.52	7.55	7.21	7.23	7.24	7.63	7.83	7.19
Phosphate	365.2	0.30	mg/L	ND	ND	1.1	ND	0.3	ND	0.9	ND	ND	ND	ND
Potassium	GEN.-MINERALS	0.5	mg/L	3.7	3.3	7.9	2.8	3.4	2.3	2.8	3.6	2.3	1.3	1.9
Sodium	GEN.-MINERALS	0.25	mg/L	109	95.1	125	83.1	89.1	104	119	95.3	128	58.4	61.8
Sulfate	GEN.-MINERALS	5	mg/L	231	273	314	107	118	259	170	205	249	59	133
Surfactants (MBAS)	GEN.-MINERALS	0.03	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Coliform	MPN(T)	2	MPN/100 ml	1,600	240	>1,600	1,600	ND	500	>1,600	30	900	170	>1,600
Total Dissolved Solids	GEN.-MINERALS	5	mg/L	877	1,030	1,190	537	600	925	864	776	740	446	487
Total Organic Carbon	415.1	0.5	mg/L	5.8	6.0	13	4.6	5.0	6.1	19	5.2	20	4.4	38
Zinc	GEN.-MINERALS	0.01	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: ND = Not Detected
NS = Not Sampled

Draft

Framework Monitoring Plan

for the

Santa Margarita River Watershed
California

Prepared for:

United States Bureau of Reclamation
Southern California Area Office
27710 Jefferson Avenue, Suite 201
Temecula, California 92590

Prepared by:

CDM Federal Programs Corporation

Boyle Engineering Corporation

RECON

26 February 2001

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Executive Summary

Executive Summary will be completed following review and confirmation of Draft FMP findings by the SMR Group. Below are the headings for the subsections.

Introduction

Watershed Setting

Issues Driving FMP

Proposed Framework Monitoring Plan

Contents

Contents (continued)

Tables

Figures

Appendices

Acronyms and Abbreviations

Basin Plan	Water Quality Control Plan for the San Diego Basin
BMP	best management practices
CDM Federal	CDM Federal Programs Corporation
cfs	cubic feet per second
EMWD	Eastern Municipal Water District
EPA	Environmental Protection Agency
FMP	Framework Monitoring Plan
GIS	Geographical Information System
mgd	millions gallons per day
mg/L	milligrams per liter
mi^2	square miles
NGVD	National Geodetic Vertical Datum
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PUD	Public Utilities Department
RCWD	Rancho California Water District
RWQCB	Regional Water Quality Control Board
SMR	Santa Margarita River
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
TMDL	Total Maximum Daily Load
U.S.	United States
West	West Consultants Incorporated

Section 1
Introduction

CDM Federal Programs Corporation (CDM Federal), Boyle Engineering and RECON have prepared this Framework Monitoring Plan (FMP) for the Santa Margarita River (SMR) Watershed pursuant to Contract 00-CA-30-0028, Delivery Order 00-A2-30-0028 with the United States (U.S.) Department of the Interior, Bureau of Reclamation, Lower Colorado Region. This FMP was developed to meet the goals of local, state, and federal participants and to begin to address issues related to impending regulatory mandates for the SMR Watershed.

The Santa Margarita watershed covers approximately 740 square miles in San Diego and Riverside Counties in Southern California as shown on Figure 1-1. The U.S. Bureau of Reclamation (USBR) currently holds water rights permits that were intended for surface water impoundments that the (USBR) was at one time proposing to develop. These water rights permits must be perfected (i.e., demonstrated to be put to beneficial uses) by 2007, or the water rights may be lost. These permits amount to 185,000 acre-feet per year. The USBR began facilitating discussions with other interested participants in the SMR Watershed to examine the possibility of identifying and implementing a functional equivalent to the dams and other surface impoundments originally proposed for the water rights permits. It was during these discussions that the USBR recognized that a more effective approach at water management depended on water quality monitoring that included water supply management. Therefore, FMP incorporates a watershed approach that will start the process of realizing both the current and future watershed management goals.

The FMP is the starting point for a comprehensive SMR Watershed Management Plan. This FMP will be used as the initial step towards implementing a complete and comprehensive monitoring plan that encompasses all the water quality and water management goals for the SMR Watershed.

1.1 Participants and Goals

The participants in the FMP are known as the Santa Margarita River Water Quality Monitoring Group (SMR Group). The list of members for the SMR Group has expanded over the course of the planning effort and is anticipated to continue to expand in future phases. However, not all members have demonstrated the same level of activity in the group. As of February 7, 2001 the SMR contact list included representatives from 26 organizations (in alphabetical order shown in Table 1-1). Figure 1-2 illustrates the boundaries of many of the SMR Group relative to the watershed.

Santa Margarita River Water Quality Sampling Group List of Organizations is as follows:

- CALTRANS
- Cahuilla Indian Reservation
- CA Department of Water Resources
- Conservation Biology Institute
- Eastern Municipal Water District
- Elsinore, Murrieta, Anza Resource Conservation District
- Fallbrook Public Utilities District
- Fallbrook Naval Weapons Station
- Hines Nursery
- Metropolitan Water District of Southern California
- Mission Resource Conservation District
- Murrieta County Water District
- Pechanga Indian Reservation
- Rancho California Water District
- Riverside County Flood Control and Water Conservation District
- San Diego County
- San Diego County Water Authority
- San Diego Regional Water Quality Control Board
- San Diego State University
- The Nature Conservancy
- U.C. Cooperative Extension San Diego County
- U.S. Bureau of Indian Affairs
- U.S. Bureau of Reclamation
- U.S. Environmental Protection Agency
- U.S. Geological Survey
- Santa Margarita Watermaster

The active members of the SMR Group developed a list of goals for the FMP. Generally, the goals are intended to facilitate development of water resources to meet demands in a manner consistent with sustainable use, human safety, and habitat and ecological needs, including protection of listed species.

The goals, as identified by the involved SMR Group participants, are as follows:

1. Provide monitoring data capable of supporting objective standards for water quality impairment (Section 303(d) of the Clean Water Act listing);
2. Provide monitoring data capable of supporting scientific development of total maximum daily loads (TMDLs) for contaminants of concern;
3. Provide monitoring data capable of assessing the river system's assimilative capacity for nutrients and total dissolved solids (TDS);
4. Provide water quality data that can be usefully related to contemporaneous habitat health data to determine ecological relationships between habitat health and water quality, especially as pertains to listed species on the watershed;
5. Identify water quality issues related to water supply alternatives associated with existing Reclamation water rights permits;
6. Develop a scientific basis for decisions regarding section 303(d) of the Clean Water Act listing;
7. Identify the causes of beneficial use impairments by contaminant and source, including identification of major contaminants of concern;
8. Quantify pollutant loading from stormwater and non-point source discharges;
9. Evaluate sediment transport;
10. Evaluate effectiveness of stormwater best management practices (BMPs);
11. Verify regulatory compliance (as a replacement of all existing permit requirements for monitoring) and support for future permitting; and
12. Facilitate water recycling in the watershed.

1.2 Scope of Work

The Scope of Work for the FMP was to perform the following:

- Review all available information provided by SMR Group participants on the current monitoring in the watershed;
- Identify the regulatory drivers of the SMR Group monitoring programs;
- Obtain an understanding of the SMR Group concerns regarding their current monitoring plans;

- Obtain information pertaining to suggested monitoring alternatives and goals;
- Prepare a FMP that recommends proposed future monitoring general locations and provides justifications for the proposed locations; and
- Prepare a PowerPoint® presentation that involved SMR Group participants can present to their respective boards and/or other authority figures. The presentation will provide a clear and concise rationale why a complete and comprehensive monitoring plan is required and why it should be funded and implemented.

1.3 Framework Monitoring Plan Approach

The FMP approach included attending and conducting meetings, reviewing available documents and reports, obtaining information from the Internet, contacting SMR Group, evaluating the current monitoring, identifying drivers for future monitoring, identifying potential future monitoring locations and justifications for each new location, and preparing a PowerPoint presentations for SMR Group to use.

1.3.1 Meetings

Four meetings were conducted to develop the FMP. Each meeting had a specific purpose relative to the overall project goals.

The Kick Off Meeting was conducted on November 01, 2000 and presented the FMP approach and provided an opportunity to discuss issues with the SMR Group. Most of the participants were contacted prior to the meeting to discuss their current monitoring approach, available data, data format (e.g., EXCEL®, ACCESS®, geographical information system [GIS]), and methods to receive their data. Key objectives of the meeting were to identify the key contact(s) at each participant responsible for coordination, confirm the process to receive data, define data formats, and identify dates that data will be provided.

The First Progress Meeting was conducted on December 20, 2000 and addressed the work to date, emerging issues, and schedule. Critical path issues that require input from the participants were highlighted and a process for resolving any issues was defined. A brief facilitated discussion was used to identify concerns and issues in the SMR Watershed.

In addition to addressing the work to date, emerging issues, and schedule, the Second Progress Meeting conducted on February 07, 2001, allowed for presentation of findings from the Draft FMP. Additionally, in order to develop the presentation materials, at the meeting the project team and the participants developed a preliminary storyboard for the PowerPoint® presentation. This process was intended to identify key topics and issues to be highlighted in the presentation to ensure that key drivers for each of the SMR Group participating at the meeting are included.

The Final Meeting occurred on for April 14, 2001 and presented the Final FMP and PowerPoint presentation that incorporated SMR Group comments.

1.3.2 Review Existing Methodology and Regulations

The review process included review of information supplied by the participants followed by direct communication with designated participant staff to understand the current program, the concerns of the participant, and the participant's suggested monitoring alternatives and goals. The Internet was also a very helpful tool in locating information pertaining to the SMR Watershed.

1.3.3 Development of Framework Monitoring Plan

The FMP was developed to identify the water quality issues and general locations for monitoring in the SMR Watershed. STET provided recommendations for developing a comprehensive plan in future phases of the work.

Geographic information systems (GIS) data was used whenever available from the SMR Group to generate many of the figures used in this FMP. Most of the GIS data used was provided by several of the SMR Group, but a large portion had to be obtained through the Internet or through purchases. As identified at the First Progress Meeting, there were issues in that GIS information from one participant did not match up with GIS information from another participant. The GIS data provided by the SMR Group or acquired by other means came from a variety of sources: West Consulting (West), SANDAG, Eastern Municipal Water District (EMWD), Rancho California Water District (RCWD), Stetson Engineers (Stetson) and RECON. The data was essentially used "as is". The only change to the data was to re-project the data into UTM Zone 11 NAD83, meters so preliminary overlays were possible. The data used in the GIS has varying degrees of positional and attribute accuracy and no attempt was made to improve on the positional or attribute accuracy of the individual coverage's, shape files or databases. A GIS database was not created and there were no quality checks performed on the data of any kind. Future work will include evaluating all types of GIS information available for the SMR Watershed and provide one common set of GIS data.

Issues Addressed. The FMP addresses the water quality issues driving the 303(d) listings in the watershed, the potential issues associated with development of TMDLs, the assimilative capacity for nutrients on the river, the relationship of water quality to habitat health, and other water management drivers.

Watershed Goals. The FMP sets the stage for development of an integrated comprehensive monitoring plan that meets the goals of the SMR Group. The future comprehensive monitoring plan will identify and address such issues as monitoring data addressing objective standards, scientific development of TMDL's, river assimilative capacity, relationships between habitat health and water quality, relationship of water quality to water supply and water rights, 303(d) listing, beneficial use impairment issues, stormwater and nonpoint source discharges, sediment, stormwater BMP's, regulatory compliance and water recycling.

Narrative Justification. The justification in this report for proposed monitoring changes is based on:

- Issues identified by the SMR Group,
- Activities and comments of regulatory agencies,
- Current and projected land uses,
- 303(d) listing information and supporting data,
- Location of streamflow measurements,
- Habitat information.

The narrative here is intended to document the process used to develop the FMP. It identifies benefits of the new plan in supporting future evaluations of assimilative capacity and in providing input to tools for TMDL development.

1.3.4 Presentation Materials

A draft and final PowerPoint® presentation has been developed that highlights the key monitoring issues on the river, the drivers for changing the monitoring approach, a summary of the FMP, benefits of the FMP, and an estimate of costs to implement the FMP and the final comprehensive plan.

1.3.5 Report Organization

This FMP is organized as follows:

- Section 1 is this current section;
- Section 2 presents an overview of the watershed including physical and regulatory issues;
- Section 3 presents the current and proposed monitoring for the SMR Watershed. The narrative includes drivers for the monitoring, proposed monitoring locations, and a justification for proposed monitoring locations;

- Section 4 presents the estimated cost for the future monitoring and for creating and implementing an integrated comprehensive monitoring plan for the SMR Watershed; and
- Section 5 presents references.

Figure 1-1

Figure 1-2

Section 2
Watershed Setting and Current Monitoring

This section discusses the watershed setting and sets the stage for discussions regarding current monitoring and the rationale for proposed monitoring under the Framework Monitoring Plan.

The Santa Margarita Hydrologic Unit is a rectangular area of about 740 square miles. Included in it are portions of Camp Pendleton as well as the civilian population centers of Murrieta, Temecula and part of Fallbrook. The unit is drained largely by the Santa Margarita River, Murrieta Creek, and Temecula Creek. The only coastal lagoon of the unit is the Santa Margarita Lagoon that lies totally within the Camp Pendleton Naval Reservation of the U.S. Marine Corps. The slough at the mouth of the river is normally closed off from the ocean by a sandbar. The major surface water storage areas are Vail Lake, O'Neill Lake, and Diamond Lake.

The San Margarita Hydrologic Unit is comprised of the following nine hydrologic areas; the Ysidora, Deluz, Murrieta, Auld, Pechanga, Wilson, Cave Rocks, Aguanga, and Oak Grove Hydrologic Areas. The hydrologic unit, areas, and subareas are shown on Figure 2-1 and listed in Table 2-1 below.

2.1 Watershed Physical Characteristics

The following section is quoted from the July 2000 *Santa Margarita River Hydrology, Hydraulics and Sedimentation Study* prepared by West Consultants Inc. (West) for SMR Group member Camp Pendleton.

Basin Description

The Santa Margarita River basin lies in northern San Diego and western Riverside Counties and encompasses approximately 740 square miles (mi^2). The cities of Temecula and Murrieta, and portions of Camp Pendleton and the City of Fallbrook lie within the basin. Also within the basin are portions of the Cleveland and San Bernardino National Forests and the Cahuilla, Ramona, Pauma, and Pechanga Indian Reservations. Two major drainage basins compose the upper watershed: Temecula Creek (360 mi^2) and Murrieta Creek (220 mi^2). These join near the City of Temecula to form the Santa Margarita River, which flows in a southwesterly direction through Camp Pendleton to the Pacific Ocean near Oceanside, California.

Table 2-1 Areas and Subareas of the Santa Margarita Hydrologic Unit

Basin Number	Hydrologic Basin		
2.00	Santa Margarita Hydrologic Unit		
2.1		Ysidora	
2.11			Lower Ysidora
2.12			Chappo
2.13			Upper Ysidora
2.20		DeLuz	
2.21			DeLuz Creek
2.22			Gavilan
2.23			Vallecitos
2.3		Murrieta	
2.31			Wildomar
2.32			Murrieta
2.33			French
2.34			Lower Domenigoni
2.35			Domenigoni
2.36			Diamond
2.40		Auld	
2.41			Bachelor Mountain
2.42			Gertrudis
2.43			Lower Tucalota
2.44			Tucalota
2.50		Pechanga	
5.51			Pauba
2.52			Wolf
2.60		Wilson	
2.61			Lancaster Valley
2.62			Lewis
2.63			Reed Valley
2.7		Cave Rocks	
2.71			Lower Coahuila
2.72			Upper Coahuila
2.73			Anza

Topography

Topography of the upper basin is generally mountainous along the northern, eastern and southern boundaries, with valley and mesa lands in the western portions, particularly in the Murrieta Creek drainage area. Elevations range from 960 feet (using the National Geodetic Vertical Datum or NGVD) at the confluence of Murrieta and Temecula Creeks to 6812 feet at Thomas Mountain and 6138 feet at Mount Palomar. Most of the valley and mesa lands in the upper basin lie between 1000 and 1500 feet.

The topography of the lower basin is mountainous in the eastern two-thirds of the drainage area, with valley and mesa lands in the lower one-third. Elevations range from sea level at the Pacific Ocean up to about 2500 feet. In the lower basin the Santa Margarita River flows in a narrow, precipitous gorge for about 18 miles from Temecula downstream to a point below its confluence with De Luz Creek, where it emerges onto the coastal plain.

Climate

The climate of the basin varies in relation to the topography with temperature and precipitation varying directly with elevation and distance from the coast. The mean annual temperature for the coastal area of the basin, as taken from records at Oceanside from 1953 to 1998, is 61 degrees Fahrenheit, with a mean monthly winter low of 45 degrees and a mean monthly summer high of 72 degrees. The average maximum temperature is 68 degrees while the average minimum temperature is 53 degrees. For the high elevation areas of the basin, as represented by records from the Palomar Mountain Observatory (1948-1998), the average maximum temperature is 66 degrees while the average minimum temperature is 45 degrees.

The mean annual rainfall for the entire basin is approximately 16 inches (California Rivers Assessment, 1999) although the average annual rainfall for gages within the basin ranges from 11 to 27.5 inches. Over 90% of the rainfall usually occurs between the months of November and April. Using the Köpen system of climatic classification, the basin would be divided into "Steppe" areas in the lower basin and "Mediterranean hot summer" areas in the upper basin (Hornbeck, 1983). The steppe climate is characterized as a dry semi-arid environment with grassland and shrubs where evaporation exceeds precipitation on the average throughout the year. The Mediterranean hot summer classification is for areas with mild, mesothermal climates with hot, dry summers.

Soils

The soils of the watershed vary widely as reported by the Natural Resources Conservation Service (NRCS) soil surveys for San Diego and Riverside Counties. Coastal plains soils are typically well-drained sandy loams with a component of sandy clay which contributes to a relatively high fertility. Soils in this area are generally used for citrus, truck crops, avocados, and flowers (Steinitz, 1996). Foothills soils are very to moderately well-drained sandy loams to silt loams that have a coarse sandy loam to clay subsoil. Soils in this region are used for citrus avocados, and irrigated field crops. Mountain soils are excessively drained to well-drained loamy coarse sands to loams. In most areas, rock outcrops and large boulders are distributed widely. Soils in this area are generally unusable for crop production and are suitable only for range and wildlife habitat.

2.2 Basin Plan, 303(d) Listings, and TMDL for SMR

This section discusses the relationship of the Water Quality Control Plan for the San Diego Basin (Basin Plan) activities of beneficial use designation and water quality objectives to impaired waters listing under 303(d) of the Clean Water Act and Total Maximum Daily Load process.

2.2.1 Basin Plan

The following description of the Basin Plan was derived from the San Diego Regional Water Quality Control Board (RWQCB) webpage. The San Diego (RWQCB) Basin Plan is designed to preserve and enhance water quality and protect the beneficial uses of all regional waters. Specifically, the Basin Plan:

1. Designates beneficial uses for surface and ground waters;
2. Sets narrative and numerical objectives that must be attained or maintained to protect the designated beneficial uses and conform to the state's antidegradation policy;
3. Describes implementation programs to protect the beneficial uses of all waters in the Region;
4. Describes surveillance and monitoring activities to evaluate the effectiveness of the Basin Plan.

Key definitions from the basin plan for beneficial uses and water quality objectives:

- Beneficial uses are the uses of water necessary for the survival and well being of man, plants and wildlife. These uses of water serve to promote the tangible and intangible economic, social, and environmental goals of mankind.

- Water quality objectives are the levels of water quality constituents or characteristics that must be met to protect the beneficial uses.

The Basin Plan identifies the following beneficial uses for the SMR Watershed:

- Municipal and Domestic Supply;
- Agricultural Supply;
- Industrial Service Supply;
- Industrial Process Supply;
- Ground Water Recharge;
- Contact Water Recreation;
- Non-Contact Water Recreation;
- Warm Freshwater Habitat;
- Cold Freshwater Habitat;
- Wildlife Habitat; and
- Rare, Threatened, or Endangered Species.

Figures 2-1 through 2-5 highlight the location of some of these beneficial uses in the SMR watershed.

- Figure 2-2 Ground Water Recharge (GWR) - Includes uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers. It is interesting to note that the groundwater basins shown on Figure 2-2 as defined by Stetson Engineers in studies for Camp Pendleton show little overlap with the subareas shown in the Basin Plan for GWR
- Figure 2-3 Contact Water Recreation (REC-1) - Includes uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, white water activities, fishing, or use of natural hot springs.
- Figure 2-4 Cold Freshwater Habitat (COLD) - Includes uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates. Although the COLD designation has not been discussed by the SMR Group as an area of concern, this definition could create challenges to the point and nonpoint dischargers in the watershed.

- Figure 2-5 Rare, Threatened, or Endangered Species (RARE) - Includes uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened or endangered.

2.2.2 303(d) Listing

Section 303(d) of the federal Clean Water Act (CWA), requires States to identify waters that do not meet water quality standards (set in the Basin plan) after applying effluent limits for point sources other than POTWs that are based on the best practicable control technology currently available and effluent limits for POTWs based on secondary treatment. This list is known as the 303(d) list of impaired waters (303(d) lists). States are then required to prioritize waters/watersheds on the list for total maximum daily loads (TMDL) development. States compile this information in a list and submit the list to USEPA for review and approval.

In the SMR Watershed there are two locations listed in the 1998 California 303(d) List and TMDL Priority Schedule dated May 12, 1999 (Approved by USEPA):

Name	Pollutant/ Stressor	Source	Hydro Unit	Priority	Size Affected	Start Date	End Date
Rainbow Creek	Eutrophic	Nonpoint/Point Source	902.20	High	5 Miles	7/98	7/00
Santa Margaita Lagoon	Eutrophic	Nonpoint/Point Source	902.110	High	1 Acre	7/96	7/05

2.2.3 TMDL Overview

A TMDL is the sum of the individual wasteload allocations for point sources, load allocations for nonpoint sources and natural background pollutants, and an appropriate margin of safety. TMDL Plans may address individual pollutants or groups of pollutants, as long as they clearly identify the links between:

- The waterbody use impairment or threat of concern.
- The causes of the impairment or threat.
- The load reductions or actions needed to remedy or prevent the impairment.

TMDLs are usually based on readily available information and studies. In some cases, complex studies or models are needed to understand how stressors are causing waterbody impairment. Where inadequate information is available to draw precise links between these factors, TMDLs may be developed through a phased approach. The phased approach enables states to use available information to establish interim targets, begin to implement needed controls and restoration actions, monitor waterbody response to these actions, and plan for TMDL review and revision in the future. Phased approach TMDLs are particularly appropriate to address nonpoint source issues.

The TMDL process provides for allocation of allowable loads or load reductions among different sources of concern, providing an adequate margin of safety. These allocations are usually expressed as wasteload allocations to point sources and load allocations to nonpoint sources. Allocations can be expressed in terms of mass loads or other appropriate measures.

Key for the SMR Watershed is the issue of data availability and the fact that the 303(d) listings for Rainbow Creek and the Santa Margarita River Lagoon are for eutrophication that is attributed to point and non-point sources. Therefore, the one-acre Santa Margarita Lagoon TMDL has the potential to impact all upstream point sources and non-point sources.

2.2.4 Rainbow Creek TMDL

The TMDL process was initiated after Rainbow Creek was identified as an impaired water body on the 1998 303(d) list. The TMDL was initiated due to eutrophication based on high nutrient (i.e., nitrogen and phosphorus) levels and was based on non-point and point sources. The Basin Plan does not establish numeric objectives, however it does have narrative objectives that assume concentrations of nitrogen in excess of 0.25 milligrams per liter (mg/L) in standing water and 1.0 mg/L in flowing streams could be expected to promote eutrophication. Nitrate concentrations in Rainbow Creek have exceeded 300 mg/L, which is over 300 times the narrative objective.

The TMDL has been prepared by the RWQCB–San Diego Region and was submitted to the U.S. EPA on April 24, 2000. Revisions to the TMDL are currently under way.

2.3 Land Use Issues in the Santa Margarita River

Southwest Riverside County has experienced tremendous growth in Temecula, Murrieta, and along the Interstate 215 corridor in the last ten years. Continued growth is anticipated for the foreseeable future. The portion of San Diego County in the SMR Watershed along the Interstate 15 corridor also continues to grow. Figure 2-6 presents both current and future land use for the SMR Watershed based on combined GIS data from a number of sources. The data has been drawn from a number of sources and is only provided here to generally highlight where potential urbanization has been projected. There is a significant amount of conflict between the GIS data provided for the FMP. For example, some of the data showed urbanization projected to occur in the national forest. The GIS issues have been discussed during project status meetings. It is acknowledged that future work will need to address the acquisition or development of more accurate and up to date projections from the counties and cities in the watershed.

2.4 Habitat Issues in the Santa Margarita Watershed

The following is a preliminary list of species that potentially need to be addressed in developing an integrated watershed monitoring program. Figure 2-7 generally indicates where targeted species and vegetation occur in the watershed. Additional information regarding sightings of the Arroyo Chub and the Southwestern Pond Turtle collected during a 3-year study were provided by San Diego State University and are shown on Figure 2-8.

2.4.1 Target Animal Species for the Santa Margarita River Watershed

California red-legged frog (Rana aurora draytonii). The USFWS listed the California red-legged frog as a threatened species on June 24, 1996. The California red-legged frog (Rana aurora draytonii) is endemic to California and threatened within its remaining range. Activities that threatened this species include habitat destruction due to human encroachment, construction of water diversions and reservoirs, contaminants, agriculture, and livestock grazing. These activities can destroy, degrade, and fragment habitat. Non-native predators and competitors also threaten the California red-legged frog populations.

The California red-legged frog is the largest native frog in the western United States, ranging in size from approximately one to five inches. Distinguishing characteristics include a red or salmon pink belly and hind legs of adult frogs, and the back is typically brown, gray, olive, or reddish-brown with small black flecks. This species is found in a variety of habitats. The frogs breed in aquatic habitats including streams, ponds, marshes and stock ponds. During wet weather, frogs may move through upland habitats. They feed on invertebrates at night and rest during the day.

Historically, the California red-legged frog was found in 46 counties in California, currently only 23 counties support known populations. The California red-legged frog is known to occur in one stream in the Santa Margarita Watershed.

Actions needed to recover the California red-legged frog include protecting known populations and reestablishing populations, protecting suitable habitat, corridors, and core areas, developing and implementing management plans for preserved habitat, occupied watersheds, and core areas; developing land use guidelines; gathering biological and ecological data necessary for conservation of the species; monitoring existing populations and conducting surveys for new populations; and establishing an outreach program.

Arroyo toad (Bufo microscaphus californicus). The USFWS listed the arroyo southwestern toad (Bufo microscaphus californicus)as an endangered species on January 17, 1995. The arroyo southwestern toad is endemic to southern California and has been extirpated from approximately 75 percent of its former range. Threats to this species include habitat degradation, predation, and small population sizes.

The arroyo southwestern toad is small toad, approximately two to three inches in size, with light greenish gray or tan coloration. Its skin is warty and often has dark spots. A distinguishing feature is a light-colored stripe that crosses the head and eyelids. This species is restricted to rivers that have shallow, gravelly pools adjacent to sandy terraces. This species breeds in large streams with persistent water flow from late march until mid-June. This species forages for insects on sandy stream terraces that have trees, typically cottonwood, oaks or willow, with closed canopies and little ground cover. Adult toads excavate shallow burrows where they shelter during the day during longer intervals in the dry season.

Historically, the arroyo southwestern toad occurred along the coastal region of Baja California, Mexico to the San Quintin area. Most remaining populations of the arroyo southwestern toad occur on private lands, primarily within or adjacent to the Cleveland National Forest. Habitat alternation is the most severe threat to the species. Currently, the arroyo southwestern toad is confined to the headwaters of streams it occupied historically along their entire lengths. Current threats include short- and long-term changes in river hydrology, including construction of dams and water diversions, alternation of riparian wetland habitats by agriculture and urbanization, construction of roads, site-specific damage by off-highway vehicle use, development of campgrounds and other recreational activities, over-grazing and mining activities.

Arroyo chub (Gila orcutti). The arroyo chub is native to Southern California. While it has been successfully introduced to other river systems, it is threatened in its native range. Currently, this species is mostly absent from much of their native range, and are abundant only in the upper Santa Margarita River and its tributaries. Threats to this species includes habitat degradation and fragmentation, especially in the low-gradient stream areas, hybridization with other species (California roach and Mohave tui chub), and competition from introduced species.

The arroyo chub is a small fish that typically reach lengths of three to four inches. This species has a chunky body with large eyes and a small mouth. The coloration is silver or gray to olive-green. This species prefers slow-moving or backwater sections of warm to cool streams with mud or sand substrates, typically in depths greater than one inch. The arroyo chub feeds on algae, insects and small crustaceans.

Surveys should be done annually in this species' native range. Streams should be managed to enhance the survival of the arroyo chub.

Tidewater goby (Eucyclogobius newberryi). The USFWS designated critical habitat for the tidewater goby (Eucyclogobius newberryi) on December 20, 2000. The Santa Margarita River, along with nine other streams, was designated as critical habitat. The tidewater goby is endemic to California and is restricted to coastal brackish water habitats. Historically, the species ranged from northern California near the Oregon border to the Agua Hedionda Lagoon in northern San Diego County.

The tidewater goby is a small elongate fish approximately two inches in length. Distinguishing characteristics include large, dusky pectoral fins and a ventral sucker-like disk. Coloration is nearly transparent, with a brownish upper surface typically having spots on dusky dorsal and anal fins. The tidewater goby prefers waters of low salinities in the brackish zone of estuaries and coastal lagoons, although it can tolerate a wide range of salinities. This species is typically found in water less than one meter deep. This species breeds by the male digging a breeding burrow where the female deposits the eggs, then the males guard the eggs. The tidewater goby feeds on small benthic invertebrates, crustaceans, snails, and aquatic insect larvae. Predators of the tidewater goby include native (prickly sculpin, staghorn sculpin, starry flounder) and non-native species (largemouth bass, yellowfin gobies, sunfish and channel catfish).

2.4.2 Target Plant Species

San Diego ambrosia (Ambrosia pumila). This species is proposed for federally endangered status USFWS 1999), is a narrow endemic species under the MSCP, and is a CNPS List 1B species. This perennial herb in the sunflower family (Asteraceae) emerges from rhizomes in spring and flowers from June to September. It is found in Riverside and San Diego counties and in northern Baja California. It may occur in disturbed areas in chaparral, coastal scrub, grassland, or vernal pool communities (Skinner and Pavlik 1994). Its preferred habitats in San Diego County are along creek beds, seasonally dry drainages, and floodplains along the edge of willow woodland, in riverwash or sandy alluvial soils (Rieser 1994). Primary threats to this species are highway and utility construction and maintenance, trampling by horses, humans, and off-road vehicles, and competition from non-native plants (USFWS 1999).

Nevin's Barberry (Berberis nevinii). This species is listed as endangered by the state and federal governments, and is a narrow endemic species under the MSCP. Its natural range is restricted to the interior foothills of Los Angeles, Riverside, and San Bernardino counties; two groups of cultivars occur in Spring Valley and Torrey Pines State Reserve in San Diego County. The largest known extant population is at Vail Lake in southern Riverside County, and it may be present in the nearby Agua Tibia Wilderness in San Diego County (Rieser 1994). It is a perennial evergreen shrub with stiff branched stems and spine-tipped leaves. The flowering period for this shrub is from March to April. This species is typically found in sandy and gravelly places in chaparral, cismontane woodlands, coastal sage scrub, and riparian scrub habitats.

Thread-leaved Brodiaea (Brodiaea filifoia). This plant is federally listed as a threatened species (USFWS 1998), is a narrow endemic under the MSCP, and is a CNPS List 1B species. This perennial bulbiferous herb in the Lily Family (Liliaceae) may reach 16 inches in height. This plant may occur in coastal sage scrub, chaparral, cismontane woodland (Skinner and Pavlik 1994) and alkali scrub (State of California 2000) communities, but is most commonly found in native grasslands or in association with vernal pools (USFWS 1998). Thread-leaved brodiaea is restricted to clay, loamy sand, or alkaline silty-clay soils, and is typically found on gentle hillsides, in valleys, or in floodplains (USFWS 1998). Outside of its flowering period, in May or June, it is difficult to distinguish from grasses.

The range of thread-leaved brodiaea formerly extended from the foothills of the San Gabriel and San Bernardino Mountains in the north, through Orange County and western Riverside County, to Carlsbad in northwestern San Diego County.

Salt marsh bird's-beak (Cordylanthus maritimus). This species is a small annual plant that prefers salt marsh habitat. This species is typically found in salt marsh areas with slightly raised hammocks and the edges of salt pans. It has also been found in areas of shell ands sand dredgings. The range of this species extends south into Baja California. The salt marsh bird's beak is approaching extirpation in San Diego County and other areas of its range.

Slender-horned spineflower (Dodecahema leptoceras). This plant is an annual herb that blooms from April to June. This species is listed as endangered. Threats to this species include urbanization, development, flood control, vehicles and proposed reservoirs. This species typically inhabits alluvial sand in coastal scrub.

Coulter's goldfields (Lasthenia glabrata ssp. coulteri). This species is an annual herb which formerly ranged from Kern and San Luis Obispo Counties southward into Baja California. This species which inhabits coastal salt marshes, playas and vernal pools, has declined significantly as many historical occurrences have been extirpated.

Parish's meadow-foam (Limnanthes gracilis). This species is an annual that inhabits rocky coarse sandy loam, typically in alluvial areas. It is slowly declining in San Diego and Riverside counties. Threats to this species include increased recreational uses of montane meadows and development. This species is relatively easy to identify in meadows during the blooming season.

In general, monitoring of the target species should include monitoring of existing populations and conducting surveys for new populations, and measures to protect known populations and reestablish populations. Protection of suitable habitat and core areas is essential. A management plan for habitat, occupied areas and core areas should be developed and implemented.

2.5 Water Rights on the Santa Margarita River

A 1940 stipulated judgement for the SMR Watershed divided the water rights of the year-round natural base flow at 1/3 to Vail Ranch (now the Rancho California Water District) and 2/3 to the U.S. Government (now Camp Pendleton).

Currently, water rights on the Santa Margarita River are the responsibility of the court appointed Watermaster, James Jenks, who is part of the SMR Group. Each year the Watermaster submits a written report surface and subsurface water availability, imports and exports of water, water production and use, unauthorized water use, threats to the water supply, and water quality. An overview of the water rights on the Santa Margarita River is quoted here from the Santa Margarita River Watershed Annual Watermaster Report Water Year 1998-1999:

> On January 25, 1951, the United States of America filed Complaint No. 1247 in the United States District Court for the Southern California District of California to seek a judicial determination of all respective water rights in the Santa Margarita River Watershed. The Final Judgement and Decree was entered on May 1963, and appealed to the U.S. Court of Appeals. A modified Final Judgement and Decree was entered on April 6, 1966. Among other things the Decree provided that the Court:
>
> > ... Retains continuing jurisdiction of this cause as to the use of all surface waters in the watershed of the Santa Margarita River and all underground and sub-surface waters within the watershed of the Santa Margarita River, which are determined in any of the constituent parts of his Modified Final Judgment to be a part of the sub-surface flow of any specific river or creek, or which are determined in any of the constituent parts of this Modified Judgment to add to, contribute to, or support the Santa Margarita River stream system.

The Court appointed a Steering Committee, currently comprised of representatives from the United States, Eastern Municipal Water District, Fallbrook Public Utility District, Metropolitan Water District of Southern California, Pechanga Tribe, and Rancho California Water District, to assist the Court, to facilitate litigation, and assist the Watermaster.

A proposed settlement is currently being evaluated by the Rancho California Water District that would guarantee a minimum flow volume measured at the Gorge (located just downstream of the Murrieta Creek and Temecula Creek confluence), that no new reservoir would be constructed in the Upper Basin, that water quality will be maintained, that there will be safe yield operations, and that the annual Watermaster Report will report on the agreement implementation.

The USBR holds three water rights permits, totaling 185,000 acre-feet on the Santa Margarita River, which were originally provided to the USBR by the local and Federal partners. These permits were intended for surface impoundments that, at one time, the USBR was proposing to develop. Under California water rights law, these permits must be perfected (demonstrated to be put to beneficial use) by 2007, or the water rights may be lost. The USBR has been facilitating discussions with various interested parties in the watershed to examine a functional equivalent to dams and surface impoundments originally envisioned for those permits.

2.6 Four Party Agreement

The Four Party Agreement is an agreement between EMWD, RCWD, Fallbrook Public Utilities Department (PUD), and Camp Pendleton regarding recycled water discharge to the SMR. The agreement currently consists of 2.0 mgd of recycled water discharge into the SMR. The four agencies signed the Four Party Agreement on September 21, 1990 and were initially interested in implementing a large scale (15 to 45 mgd) recycled water discharge program into the SMR. The agreement provides, in part, that if EMWD and RCWD receive regulatory permission to discharge the recycled water to the SMR, a portion of the recycled water will be allocated for use by Fallbrook PUD and Camp Pendleton. Also, EMWD and RCWD will provide a wellhead demineralization facility at Camp Pendleton to provide water that meets all applicable requirements for potable use.

Under the Four Party Agreement 2.0 mgd of recycled water is discharged under a "pilot" program. This is a cooperative effort between EMWD and RCWD. RCWD provides treatment for the stream discharge which includes tertiary filtration, treatment for nutrient reduction, and ultraviolet disinfection.

Recycling will become more and more critical in the SMR Watershed as the area continues to develop. Recycling, other than the discharge into the SMR, is currently being performed by the EMWD and RCWD for irrigation for agriculture and landscaping. Expanded recycling is being evaluated by the USBR and local participants under the Southern California Comprehensive Water Recycling and Reuse Study (SCWRRS). Recycling also needs to be investigated for recharge of the Murrieta-Temecula Groundwater Basin. New water quality and flow sampling locations in the

FMP will provide information to assess if there is any impacts as reclamation is expanded.

2.7 Imported Water

Imported water is important in the SMR Watershed. For the water year 1998-1999, a total of 58,041 acre-feet were imported to 8 agencies in the SMR Watershed (Watermaster 2000). This figure includes 3,781 acre-feet for the Metropolitan Water District, which only stores the water in the SMR Watershed, but is not used in the SMR Watershed (Watermaster 2000). The largest importer of water is RCWD, which totals 34,490 acre-feet for the water year 1998-1999 (Watermaster 2000). Imported water has increased from 6,287 acre-feet in 1966 to the current 58,041 acre-feet in 1999 (Watermaster 2000). The general trend has been an increase in imports each year, with the few exceptions following extremely rainy years. Table 2-2 presents the monthly totals for imported water for the 1998-1999 water year.

The Native American tribes have expressed concern with imported water and potential impacts on the salt balance (i.e., TDS). Future sampling needs to include continued analysis and assessment for TDS.

Table 2-2 Imported Water for the SMR Watershed, Water Year 1998-1999

Year/ Month	EMWD	Elsinore Valley MWD	Fallbrook PUD	MWD	Rainbow MWD	RCWD	US Naval Weapons Station	Western MWD	Total Imports
1998									
October	295	506	822	180	177	2,567	17	3	4,567
November	347	461	515	68	171	1,395	8	3	2,968
December	407	246	341	100	88	1,047	7	3	2,239
1999									
January	384	410	496	166	111	984	9	2	2,562
February	467	235	322	166	78	293	6	2	1,569
March	-259	425	410	396	76	1,528	7	2	2,585
April	218	318	394	280	98	1,560	5	2	2,875
May	776	608	640	518	110	3,170	7	3	5,832
June	498	578	680	484	140	4,176	10	5	6,571
July	640	708	836	479	219	5,228	12	5	8,127
August	524	940	1,049	587	209	6,549	8	5	9,871
September	30	699	925	357	250	5,993	15	6	8,275
Totals	4,327	6,134	7,430	3,781	1,727	34,490	111	41	58,041

Notes:

Quantities in acre-feet.

Source: Annual Watermaster Report, Water Year 1998-1998 (Watermaster 2000).

Figure 2-1

Figure 2-2

Figure 2-3

Figure 2-4

Figure 2-5

Figure 2-6

Figure 2-7

Section 3
Current and Future Monitoring

The section summarizes the current monitoring and presents preliminary proposed future framework monitoring plan. The drivers that will influence future monitoring, the proposed monitoring locations, justifications for the chosen locations, and the type of data to be collected in the future are summarized.

3.1 Current Monitoring Programs

Members of the SMR Group have provided their current monitoring program information. Potentially, other monitoring programs outside the SMR Group may exist. Future more detailed analysis may determine the location, type and timing of those programs.

3.1.1 Current Monitoring Drivers

Drivers are the outside influences that generate the need for water quality monitoring. There are a number of drivers that require water quality monitoring for the SMR Watershed. They are both regulatory and beneficial in usage. They are as follows:

- Hydrologic Data
- National Pollutant Discharge Elimination System (NPDES) permits;
- District Programs; and
- Base Programs.

Hydrologic Data. A number of streamflow gages in the SMR watershed were identified on the U.S. Geological Survey webpage. The gages are summarized on Table 3-1 and shown on Figure 2-7. The drainage area and period of record are indicated on Table 3-1.

Table 3-1 USGS Stream Gage List

Station Number	Station Name	County	Drainage Area	Start Recording	End Recording
11042400	Temecula C Nr Aguanga Ca	Riverside	131	Aug-57	Sep-99
11042430	Coahuila C Trib A Anza Ca	Riverside	4.9		
11042490	Wilson C Ab Vail Lk Nr Radec Ca	Riverside	122	Oct-89	Sep-94
11042520	Temecula C A Nigger Cyn Nr Temecula Ca	Riverside	320	Feb-23	Sep-48
11042600	Temecula C Bl Vail Dam Ca	Riverside	-	Oct-77	Sep-78
11042631	Pechanga C Nr Temecula Ca	Riverside	13.8	Oct-87	Sep-99
11042700	Murrieta C A Tenaja Rd Nr Murrieta Ca	Riverside	30.04	Oct-97	Sep-99
11042800	Warm Springs C Nr Murrieta Ca	Riverside	55.4	Jun-92	Sep-99
11042900	Santa Gertrudis C Nr Temecula Ca	Riverside	90.16	Oct-92	Sep-99
11043000	Murrieta C A Temecula Ca	Riverside	222	Oct-30	Sep-99
11044000	Santa Margarita R Nr Temecula Ca	Riverside	588	Feb-23	Sep-99
11044250	Rainbow C Nr Fallbrook Ca	San Diego	10.3	Nov-89	Sep-99
11044300	Santa Margarita R A Fpud Sump Nr Fallbrook Ca	San Diego	620	Oct-89	Sep-99
11044350	Sandia C Nr Fallbrook Ca	San Diego	21.14	Oct-89	Sep-99
11044500	Santa Margarita R Nr Fallbrook,Calif.	San Diego	705	Oct-24	Sep-26
11044600	Santa Margarita R Trib Nr Fallbrook Ca	San Diego	0.52	Oct-61	Sep-65
11044800	De Luz C Nr De Luz Ca	San Diego	33.03	Oct-92	Sep-99
11044900	De Luz C Nr Fallbrook Ca	San Diego	47.5	Oct-89	Sep-90
11045000	Santa Margarita R Nr De Luz Sta Ca	San Diego	705	Oct-24	Sep-26
11045050	Santa Margarita R A Usmc Div Dam Nr Ysidora Ca	San Diego	709.96	Feb-99	Sep-99
11045300	Fallbrook C Nr Fallbrook Ca	San Diego	6.97	Oct-93	Sep-99
11045600	Oneill Lake Outlet Ch Nr Fallbrook Ca	San Diego	9.77	Oct-98	Sep-99
11045700	Oneill Lk Spill Ch Nr Fallbrook Ca	San Diego	9.77	Oct-98	Sep-99
11046000	Santa Margarita R A Ysidora Ca	San Diego	722.51	Oct-30	Feb-99
11046025	Plant 2 Discharge To Pond 2 Ca	San Diego	-	Oct-93	Sep-99

NPDES Permits. There are several NPDES permited discharges that exist within the SMR Watershed. Camp Pendleton has an industrial stormwater NPDES permit covering stormwater discharges from the developed portions of the base and five NPDES permits for its wastewater treatment plants. The Rancho California Water District (RCWD) has an NPDES permit that allows for live stream discharge of recycled tertiary treated wastewater into Murrieta Creek at a current rate of 2 million gallons per day (mgd). This discharge is done in conjunction with Eastern Municipal Water District (EMWD). There are also municipal stormwater NPDES permits for both San Diego County and Riverside County.

District Program. Rancho California Water District conducts a water quality monitoring program based on NPDES requirements, recycled water used in the SMR Watershed for irrigation and landscaping, and under the Four Party Agreement (see Section 2.6).

Base Program. Camp Pendleton conducts water quality sampling for its wastewater program (under NPDES requirements) and for its industrial stormwater program (under NPDES requirements). Camp Pendleton also performs sampling for water quality from the SMR entering Camp Pendleton.

3.1.2 Monitoring Locations

A majority of the current monitoring is being performed for regulatory purposes, mainly NPDES requirements. Table 3-1 presents the current sampling locations for the SMR Watershed provided by the SMR Group.

3.1.3 Current Data Being Collected

In general, current water quality analyses include TDS, coliform, nutrients, and chlorine. Additional parameters are also analyzed at different locations. Table 3-2 presents the type of water quality analyses being performed. Figure 3-2 illustrate the current ongoing water quality sampling locations

Table 3-2 Current Surface Water Quality Sampling Locations

Location	Participant	Type of Program	Sampling Frequency	Sampling Parameters
SMR at Camp DeLuz Road Crossing	Camp Pendleton	Base Program	Weekly	TDS, nitrate, pH, fecal coliform
SMR at Stuart Mesa [1]		NPDES	Weekly	DO, chlorine, fecal coliform, total nitrates, phosphorus, estimated flow
SMR at railroad at Interstate 5		NPDES	Weekly	DO, chlorine, fecal coliform, total nitrates, phosphorus, estimated flow
SMR at railroad at Interstate 5		Industrial Stormwater Permit	Storm Events	pH, oil and grease, TSS, SC, TOC, aluminum, lead, iron, and zinc
SMR at Temecula	Rancho California Water District	District Program	Weekly	TDS and nitrate
SMR near Ecology Reserve		Live Stream Order	Monthly/ Quarterly	TDS, pH, DO, nitrogen series, phosphorus series, residual chlorine, THM, coliforms, benthic invertebrates
SMR at Diversion Weir		Live Stream Order	Monthly/ Quarterly	TDS, pH, DO, nitrogen series, phosphorus series, residual chlorine, THM, coliforms, benthic invertebrates
SMR at Stuart Mesa [1]		Live Stream Order	Monthly/ Quarterly	TDS, pH, DO, nitrogen series, phosphorus series, residual chlorine, THM, coliforms, benthic invertebrates
Murrieta Creek u/s SR Plant		Live Stream Order	Monthly/ Quarterly	TDS, pH, DO, nitrogen series, phosphorus series, residual chlorine, THM, coliforms, benthic invertebrates
Murrieta Creek at Temecula	Riverside County Flood Control and Water Conservation District[2]	Municipal Stormwater Permit	Quarterly	Standard chemicals, oil and grease, phosphorus (dissolved and total), nitrogen, turbidity, carbon, barium, and boron

Table 3-2 Current Surface Water Quality Sampling Locations (continued)

Location	Participant	Type of Program	Sampling Frequency	Sampling Parameters
Upper Murrieta at Cole Canyon		Municipal Stormwater Permit	Quarterly	Standard chemicals, oil and grease, phosphorus (dissolved and total), nitrogen, turbidity, carbon, barium, and boron
Temecula Creek at Pala Road		Municipal Stormwater Permit	Quarterly	Standard chemicals, oil and grease, phosphorus (dissolved and total), nitrogen, turbidity, carbon, barium, and boron

Notes:

(1) Sampled by both Camp Pendleton and Rancho California Water District

(2) The Riverside County Flood Control and Water Conservation District also samples 14 stormwater outfalls for its Municipal Stormwater Permit.

DO = dissolved oxygen
SC = specific conductance
SMR = Santa Margarita River
THM = trihalomethanes
TSS = total suspended solids

3.2 Future Monitoring

The interrelated nature of the water management issues in the SMR Watershed is driving the need for an integrated monitoring approach that addresses the SMR Group goals listed in Section 1. This section identifies monitoring issues to be addressed and proposed monitoring to accomplish the goals set forth by the SMR Group.

3.2.1 Issues to be Addressed

The interrelated issues affecting the SMR Watershed have created the need for evaluating water quality not just for at the lower end of the watershed, at the Lagoon TMDL site but in an integrated manner for the entire 740 square miles of the watershed. The issues discusses in this section are :

- Total Maximum Daily Load (TMDL);
- Beneficial Uses;
- Non-point source discharges;
- Point source discharges;
- Assimilative capacity of the river;
- Habitat health;
- Sediment transport;
- Imported Water;
- Water supply rights; and
- Four Party Agreement.

TMDL. There are two water bodies listed on the 303(d) list for the SMR Watershed. The first is Rainbow Creek and the second is the Santa Margarita Lagoon. The Rainbow Creek TMDL is discussed in Section 2.2.4. While the TMDL for Rainbow Creek affects only the Rainbow Creek drainage basin, the TMDL for the Santa Margarita Lagoon has much greater potential impact to the entire SMR Watershed. The Santa Margarita Lagoon is located at the mouth of the SMR that is the drainage mouth for the entire watershed. Any contaminant loading allocations identified in the upcoming TMDL could affect every subbasin in the SMR Watershed.

Like Rainbow Creek, the Santa Margarita Lagoon was placed on the 303(d) list because of eutrophication impacts resulting from both point and non-point sources. A TMDL is tentatively scheduled to commence in 2008.

One challenge associated with the TMDLs for Rainbow Creek and the Santa Margarita Lagoon is the criteria for a narrative definition of eutrophication and how to assess cleanup or return to its natural state. Are water quality analyses the only indicator, or can the degree of eutrophication be documented using photography of other visual means? For example, eutrophication might be addressed qualitatively by the presence of algal mats, such as in the Malibu Creek Lagoon in Los Angeles County. Regulatory agencies might require photography and measurements of Chlorophyll-a, Total Nitrogen, and Total Phosphous. Answers to these questions must be investigated and defined for the final comprehensive monitoring plan.

Beneficial Uses. There are four key beneficial uses as identified in the Basin Plan that could significantly affect water quality monitoring in the SMR Watershed. They are Ground Water Recharge, Contact Water Recreation, Cold Freshwater Habitat, and Rare, Threatened, or Endangered Species. (See Figure 2-2 through 2-5)

The following groundwater basins can be found in the SMR Watershed:

- Aguanga GWA;
- Wilson Creek - Above Aguanga GWA;
- Temecula Creek;
- Upper Murrieta Creek;
- Lower Murrieta Creek;
- Murrieta-Temecula GW;
- De Luz Creek;
- Sandia Creek;
- Rainbow Creek; and
- Santa Margarita River.

Groundwater recharge plays a crucial role in the SMR Watershed in that a majority of water used in the SMR Watershed comes from these groundwater basins. Water entering these basins, either naturally or via recharge programs, must be monitored to ensure that this recharge water meets water quality requirements for the specified beneficial use. TDS and nutrients are anticipated to be key parameters in light of imported water and non-point source contributions to the basin. Poor water quality could limit the ability to store additional water in conjunctive use programs.

Contact Water Recreation involves those surface waters that can be used for recreation that involved direct contact with the water. Monitoring needs to continue to evaluate if water quality is affecting this type of beneficial use.

The Cold Freshwater Habitat beneficial use definition could prove to have a significant impact of flexibility to water resources management in the SMR Watershed. Although this use has not been highlighted as a key issue in the SMR Watershed by the project local participants, it could present a significant challenge to future watershed management schemes by the USBR to exercise its water rights. Sampling programs to confirm or deny the appropriateness of the Cold Freshwater Habitat beneficial use at this time is a prudent activity.

The Rare beneficial use designation is addressed below in Habitat Health

Habitat Health. There are a number of federally and state listed endangered or threatened species in the SMR Watershed as described in Section 2.4.1. The primary threats to the target species include pesticides and herbicides, salinity, dissolved oxygen levels, and turbidity. The fish species, arroyo chub and tidewater goby, are most susceptible to changes in dissolved oxygen levels, increased turbidity. Specifically, the tidewater goby is susceptible to changes in salinity, since it is an estuarine species. The amphibian species, arroyo southwestern toad and California red-legged frog, are most vulnerable to pesticides, including effects from bioacculumation in their prey. The plant species are vulnerable to herbicides and changes in salinity.

In addition, some chemicals of concern may be present in the watershed due to agriculture and land use practices. The use of these chemicals in the watershed should be determined to establish an effective monitoring plan to detect the impact of these chemicals on the target species. Water quality monitoring tests should include methods to determine the levels of these chemicals in the watershed area

Non-Point Source Discharges. Non-point source discharges are reported to be the largest contributor to surface water pollution in the watershed. The definition of a non-point discharge is pollution that does not come from a defined discrete source, such as a pipe. Non-point source discharges are typically associated with urban or agricultural runoff. Stormwater typically conveys non-point source pollution discharges into the streams, creeks, and rivers within the watershed.

Factors that affect non-point source discharges include existing and future land use, stormwater BMPs, and the Phase II stormwater regulations that will go into affect in 2002. Because non-point source discharges have such a large potential for polluting the beneficial waters in the watershed, it is imperative that the type of monitoring performed is sufficient to assess the load of pollutants the non-point source discharges are adding to the watershed.

Land Use. Land use can have a tremendous affect on non-point source discharges. As the urbanized area replaces natural habitat areas it's potential for non-point source discharges increases. More homes potentially means more fertilizers, more pesticides, more cars, more car washings, more household chemicals, and more yard clippings. As additional open and naturally vegetated areas are asphalted over, the natural absorption capabilities of the watershed are diminished. With less absorption ability, additional stormwater runoff is conveyed into the storm drain system and the peak stormwater flow data can increase the greater likelihood for polluted runoff to reach surface waters in the watershed.

Figure 3-3 presents both current and future percent urbanization per subarea for the SMR Watershed based on combined data from a number of sources (see section 2.3). The change to a greater percentage of urbanization in the watershed is demonstrated by the darker colors in the future condition.

Another issue related to increased development in a watershed is sedimentation runoff associated with construction activities. Current stormwater regulations require any construction activity affecting an area more than 5 acres in size to have a Notice of Intent (NOI) submitted to the State Water Resource Control Board (SWRCB) and are required to have a Stormwater Pollution Prevention Plan prepared. Phase II stormwater regulations, as discussed below, will include those construction activities affecting more than one acre to submit an NOI.

Stormwater BMPs. Structural and non-structural stormwater BMPs are used for both industrial and municipal stormwater programs to reduce potential pollution. The final comprehensive monitoring plan should allow for evaluation of existing structural and non-structural BMPs in place in the SMR Watershed, and provide information to implement recommendations for modifying the current program. A "Pilot" BMP Program is recommended for assessing the effectiveness of BMPs being performed in the SMR Watershed. Because many urban areas in Southern California can be fairly similar, data that has been collected from other watershed along with data collected from several locations in the SMR Watershed could provide sufficient data for assessing the BMP effectiveness. This recommended BMP Pilot Program would be detailed in the comprehensive monitoring plan.

Phase II Stormwater Regulations. Phase II stormwater regulations will extend coverage of the NPDES stormwater program to small municipal stormwater systems. Implementation of the Phase II regulations begins in 2002 and will affect all urbanized areas not covered under the Phase I stormwater regulations (Phase I regulations covered urbanized areas serving over 100,000 people).

The Phase II regulations include the following minimum control measures:

- Public education and outreach;
- Public participation/involvement;

- Illicit discharge detection and elimination;
- Construction site runoff control for sites that disturb one or more acres;
- Post construction runoff control; and
- Pollution prevention/good housekeeping.

The final comprehensive monitoring plan will need to provide information to establish and measure the effectiveness for each of these minimum control measures.

Point Source Discharges. There are several point source discharges in the SMR Watershed. These permitted point source discharges are released by Camp Pendleton, RCWD, and the EMWD. Camp Pendleton has five NPDES permits associated with their wastewater treatment plants with a combined total discharge of 6.6 mgd. RCWD has an NPDES permit for its recycled water it discharges into the SMR at a capacity of 2.0 mgd. This recycled water discharge is performed in association with EMWD. Continued monitoring at these point discharges will be unchanged under future monitoring.

Assimilative Capacity of the Santa Margarita River. Several participants within the SMR Watershed have concerns regarding the assimilative capacity of the SMR. This FMP is intended to highlight key locations for calculating flow and water quality measurements to allow for estimates of mass loading. The final comprehensive monitoring plan will refine the locations to allow estimates of the assimilative capacity for phosphorus, TDS, and nutrients. A monitoring site in included in the FMP to add information to allow future evaluation of assimilative capacity

Sediment Transport. The *Santa Margarita River Hydrology, Hydraulics and Sedimentation Study* (WEST 2000) developed a set of hydrologic, hydraulic, and sedimentation models to address water quality issues in the SMR Watershed. The study performed a sediment yield analysis which was used in conjunction with the hydraulic model (also prepared in the study) to prepare a sediment transport model. This sediment transport model can be improved using additional flow data activated by the FMP. Better calibration will allow assessing sediment transport in the final comprehensive monitoring plan.

Two suspended sediment gaging stations should be established in the SMR Watershed. One located at the gorge just below the confluence of the Murrieta Creek and Temecula Creek at the location of the USGS flow gage "Santa Margarita near Temecula" and one located at the Basilone Road Bridge on Camp Pendleton. Data from these stations can be used to calibrate the model.

Imported Water. Imported water will continue to be important in the SMR Watershed.. The general trend has been an increase in imports each year, with the few exceptions following extremely rainy years. The Native American tribes have expressed concern with imported water and potential impacts on the salt balance (i.e., TDS). Future sampling needs to include continued analysis and assessment for TDS.

3.3 Proposed Monitoring Locations

The proposed monitoring locations in the FMP for future surface water quality sampling include both new locations and locations that are currently being monitored. Table 3-3 presents the types of monitoring that would be appropriate for each of the 14 goals identified for the SMR Watershed (see Section 1.1). Figure 3-4 shows the proposed locations and provides a brief summary as to why these locations were selected. Table 3-4 presents the new locations identified on Figure 3-4, plus expanded justifications for each sampling location and the type of data to be collected at each sampling location.

The current monitoring program should continue as is with the following changes:

- The sampling located at SMR at Stuart Mesa is being performed by two separate participants with overlapping of many analyses. This sampling should be coordinated into a single joint effort.
- Flow gaging stations should be installed at the following locations:
    - SMR at Camp De Luz Road Crossing;
    - Upper Murrieta Creek at Cole Canyon; and
    - Temecula Creek at Pala Road.

New water quality monitoring stations should include the following:

- De Luz Creek near SMR (for TMDL data);
- Sandia Creek at gaging station (for TMDL data);
- Rainbow Creek at gaging station (for TMDL data);
- Pechanga Creek at gaging station (for TMDL data);
- Santa Gertrudis Creek at gaging station (for TMDL data);
- Warm Springs Creek at gaging station (for TMDL data);
- Murrieta Creek just downstream of SR Plant (for assimilative capacity);
- Temecula Creek downstream of Cottonwood Creek (for TMDL data)
- Multiple locations near listed animal and plant species (for habitat data)
- SMR near Temecula (suspended sediment gaging station data); and
- Basilone Road Bridge (suspended sediment gaging station data).

In addition to the specified purpose, it is anticipated that sampling at these locations will support analysis for many of the other identified drivers. It is important to note that a monitoring plan should be flexible. The monitoring program should be evaluated on an annual basis and changes made where and when appropriate. The comprehensive monitoring plan will need to allow for this annual evaluation and the potential annual changes. By using a flexible program, data needs can be met more accurately and efficiently.

Table 3-3 Types of Monitoring per Watershed Goal

	Framework Monitoring Plan Goals												
Type of Monitoring	1	2	3	4	5[a]	6	7	8	9	10	11	12	13
Instream:													
Flow Rate/ Quality Data	X	X	X	X		X	X	X	X	X		X	X
Hot Spot	X	X				X	X	X					
Habitat Assessment/ RBI				X			X						
Stream Geomorphology				X			X	X	X			X	X
Source:													
Municipal Stormwater Quality	X	X				X	X	X	X				X
Point Source	X	X	X			X	X	X	X			X	X
Agriculture													
- Avocados and Grapes	X	X	X			X	X	X	X				X
- Nurseries	X	X	X			X	X	X	X				X
- Grazing	X	X	X			X	X	X	X				X
BMP Pilot Testing										X			

Goals:

1. Provision of monitoring data capable of supporting objective standards for water quality impairment (section 303(d) of the Clean Water Act listing);
2. Provision of monitoring data capable of supporting scientific development of TMDL's for contaminants of concern;
3. Provision of monitoring data capable of assessing the river system's assimilative capacity for nutrients and total dissolved solids (TDS);
4. Provision of water quality data that can be usefully related to contemporaneous habitat health data to determine ecological relationships between habitat health and water quality, especially as pertains to listed species on the watershed;
5. Identification of water quality issues related to water supply alternatives associated with existing Reclamation water rights permits;
6. Scientific basis for decisions regarding section 303(d) of the Clean Water Act listing;
7. Identification of the causes of beneficial use impairments by contaminant and source, including identification of major contaminants of concern;
8. Quantification of pollutant loading from stormwater and non-point source discharges;
9. Evaluation of sediment transport;
10. Evaluation of effectiveness of stormwater BMPs;
11. Verification of regulatory compliance (as a replacement of all existing permit requirements for monitoring) and support for future permitting;
12. Facilitating water recycling in the watershed; and
13. Facilitating development of water resources to meet demands in a manner consistent with sustainable use, human safety, and habitat and ecological needs including protection of listed species.

Note:

a – No sampling is identified because the goal does not require water quality sampling.

Table 3-4 Proposed Monitoring

Sampling Location	Type of Monitoring	Flow Gage Station (Y/ N)	Install Flow Gage (Y/ N)	Sampling Frequency	Parameters [1]
SMR at Camp DeLuz Road Crossing	Current - Instream	N	Y	Weekly	TDS, nitrate, pH, fecal coliform, **phosphorus**
SMR at Stuart Mesa	Current - Instream	N	N	Weekly/ Monthly/ Quarterly	Weekly: DO, chlorine, coliform, total nitrates, phosphous, Est. flow Monthly/Quarterly (in addition to weekly): TDS, pH, THM, benthic invertebrates
SMR at railroad at Interstate 5	Current - Instream	N	N	Weekly/ storm events	Weekly: DO, chlorine, coliform, total nitrates, phosphous, Est. flow Storm events: pH, oil and grease, TSS, SC, TOC, aluminum, lead, iron, zinc
SMR at Temecula	Current - Instream	Y	N	Weekly	TDS, nitrate, and **phosphorus**
SMR near Ecology Reserve	Current - Instream	?	?	Monthly/ Quarterly	Monthly/Quarterly: TDS, pH, THM, benthic invertebrates
SMR at Diversion Weir	Current - Instream	Y	N	Monthly/ Quarterly	Monthly/Quarterly: TDS, pH, THM, benthic invertebrates
Murrieta Creek u/s SR Plant	Current - Instream	Y	N	Monthly/ Quarterly	Monthly/Quarterly: TDS, pH, THM, benthic invertebrates, **phosphorus**
Murrieta Creek at Temecula	Current - Instream	Y	N	Monthly/ Quarterly	Monthly: TDS and nutrients. Quarterly: Standard chemicals, oil and grease, phosphorus, nitrogen, carbon, barium, and boron
Upper Murrieta at Cole Canyon	Current - Instream	N	Y	Quarterly	Standard chemicals, oil and grease, phosphorus, nitrogen, carbon, barium, and boron
Temecula Creek at Pala Road	Current - Instream	N	Y	Quarterly	Standard chemicals, oil and grease, phosphorus, nitrogen, carbon, barium, and boron
New Locations					
De Luz Creek near SMR	Instream	N	Y	Quarterly	TDS and nutrients

Table 3-4 Proposed Monitoring (Continued)

Sampling Location	Type of Monitoring	Flow Gage Station (Y/ N)	Install Flow Gage (Y/ N)	Sampling Frequency	Parameters [1]
Sandia Creek at gaging station	Instream	Y	N	Quarterly	TDS and nutrients
Rainbow Creek at gaging station	Instream	Y	N	Quarterly	TDS and nutrients
Pechanga Creek at gaging station	Instream	Y	N	Quarterly	TDS and nutrients
Tecalota Creek at gaging station	Instream	Y	N	Quarterly	TDS and nutrients
Warm Springs Creek at gaging station	Instream	Y	N	Quarterly	TDS and nutrients
Murrieta Creek just downstream of SR Plant	Instream	N	Y	Monthly	TDS and nutrients
Temecula Creek downstream of Cottonwood Creek	Instream	Y	N	Quarterly	Temecula Creek downstream of Cottonwood Creek
SMR near Temecula	Instream – Suspended Sedimentation Gage	Y	N	Monthly	SMR near Temecula
Basilone Road Bridge	Instream – Suspended Sedimentation Gage	N	N	Monthly	Basilone Road Bridge
Locations (9) near Listed Animal and Plant Species	Instream	Varies	Y (for 6)	Quarterly	Pesticides and Herbicides

Notes:
(1) Parameters in bold type are new parameters from the current sampling parameters.

Figure 3-1

Figure 3-2

Figure 3-3

Figure 3-4

Section 4
Future Activities & Cost Analysis

This section presents the preliminary estimates of cost for performing the proposed monitoring described in Section 3 for the Framework Monitoring Plan and provides a preliminary list potential tasks for the comprehensive monitoring plan and for additional tasks to address the goals developed by the SMR Group.

4.1 Proposed FMP Sampling Cost

A preliminary estimate of annual costs has been developed for the monitoring sites identified in Table 3-4 and summarized in Table 4-1 below. This estimated cost is based upon the newly identified sampling parameters identified for the current monitoring program, the cost for data processing of flow gaging stations, and the cost for operation of all monitoring locations. This is the total costs for all sampling and not the incremental costs beyond current sampling. In this way the total future costs are estimated on the same basis rather than using potentially different costs for different members of the SMR Group. The installation costs of new monitoring or gaging sites have not been estimated under the assumption that some or all of the sites might be installed with SMR Group agency staff.

The FMP costs include labor, other direct costs, laboratory analysis, and streamflow data processing by the USGS. The labor costs include the costs to drive to the sites, obtain the samples, provide the samples to a laboratory, and manage of the invoicing and documentation process. Other indirect costs associated with the expenses include such items as mileage, field supplies, etc. Laboratory costs are included as a separate item. Finally, a preliminary estimate of USGS charges for annual data processing of streamflow gages is provided based on estimates from the Santa Ana River:

Preliminary Estimate of Framework Monitoring Plan Annual Costs:

Labor:	$125,000
Other Direct Costs:	$6,000
Laboratory Analysis:	$95,000
Streamflow Gage Data Processing:	$396,000
Total Annual Costs:	$622,000

Table 4-1. Framework Monitoring Plan Sites

Sampling Location	Type of Monitoring
Existing Locations	
SMR at Camp DeLuz Road Crossing	Current - Instream
SMR at Stuart Mesa	Current - Instream
SMR at railroad at Interstate 5	Current - Instream
SMR at Temecula	Current - Instream
SMR near Ecology Reserve	Current - Instream
SMR at Diversion Weir	Current - Instream
Murrieta Creek u/s SR Plant	Current - Instream
Murrieta Creek at Temecula	Current - Instream
Upper Murrieta at Cole Canyon	Current - Instream
Temecula Creek at Pala Road	Current - Instream
New Locations	
De Luz Creek near SMR	Instream
Sandia Creek at gaging station	Instream
Rainbow Creek at gaging station	Instream
Pechanga Creek at gaging station	Instream
Tecalota Creek at gaging station	Instream
Warm Springs Creek at gaging station	Instream
Murrieta Creek just downstream of SR Plant	Instream
Temecula Creek downstream of Cottonwood Creek	Instream
SMR near Temecula	Instream – Suspended Sedimentation Gage
Basilone Road Bridge	Instream – Suspended Sedimentation Gage
Locations (7) near Target Species	Instream

4.2 Comprehensive Monitoring Plan Activities

Activities on the Framework Monitoring Plan have identified a number of data gaps and unresolved issues that need to be addressed. The comprehensive monitoring plan will rely on completion of the following elements:

1. **Database Design:** Coordinate with San Diego State University, U.S. Environmental Protection Agency Office of Water (regarding the use of the STORET System), the counties, and other agencies. Design a single SMR Watershed database with the involved parties for all historical and future water

quality sampling. Identify cost-effective approaches for making data available using Web-based technologies.

2. **GIS Database Development:** Design/coordinate a standard GIS format and consistency for the SMR Watershed. Meet with agencies developing land use data for the counties, cities, tribes, and agencies in the watershed. Acquire the most current land use data and develop a consistent set of land use categories to apply to the watershed for water management planning activities. Develop a composite land use for current and future conditions to better define water quality sampling needs.

3. **Water Quality Model:** Identify potential models that would be appropriate for preliminary and ultimate water quality modeling in the watershed to meet the SMR Group goals such as TMDL development and assimilative capacity. The proposed model must be able to address water quantity and quality in the surface and groundwater to accurately address the questions posed by the SMR Group in its list of goals. Develop and apply screening level model to identify key water quality areas to assist in developing the final monitoring locations and to support the program justification with the San Diego RWQCB.

4. **Stormwater BMP:** Develop Stormwater BMP Pilot Program using available Southern California data from CALTRANS, counties, and cities in combination with ongoing regional data to determine the potential effectiveness of proposed programs in the watershed and how to monitor effectiveness.

5. **Water Quality Monitoring:** Refine water quality monitoring approach working with SMR Group agencies' staff and other organizations identified to be collecting samples. Identify activities that can be done by the agencies and those that need to be done with outside support. Develop a cost estimate of all costs including outside services and in-kind services for a cost-effective program.

6. **Streamflow Monitoring:** Refine streamflow gaging approach working with the Watermaster and U.S. Geological Survey. Identifying and document the parameters to be addressed to quantifying the relationship between water supply rights and water quality. Develop final costs for stream gaging installation and data processing.

7. **Habitat Monitoring Issues:** Refine monitoring approach to identifying and understanding the relationship between habitat health and water quality working with Riverside County HCP team and the San Diego State University programs. Combine and resolve any differences between habitat databases. Develop preliminary flow and quality objectives to meet habitat requirements.

8. **Sampling and Analysis Plan:** Prepare one a standard Sampling and Analysis Plan (to include a Field Sampling Plan and a Quality Assurance Plan) for the SMR Watershed.

9. **Activities with San Diego RWQCB:** Develop a process for working with the San Diego RWQCB to receive approval for revisions to individual monitoring plans that allows for a watershed based monitoring approach. Identify the features and benefits and prepare draft and final presentations to the staff and Board. Attend meetings with the staff and Board to discuss the proposed monitoring plan.
10. **Draft and Final Plan Report**
11. **Workshops with the SMR Group**

4.3 Potential Future Activities to Meet SMR Group Goals

The development of a Comprehensive Monitoring Program does not in itself address all the goals defined by the SMR Group. Additional tasks will be needed to use the data in combination with analytical tools and decision support tools to address the range of issues raised by the SMR Group. Following is a list of potential activities that can be initiated during development of the Comprehensive Monitoring Plan and proceed beyond the Plan to manage the water resources of the Santa Margarita River.

- Support scientific development of TMDL: Apply data from the Comprehensive Monitoring Plan to develop a sophisticated watershed model for the development of the rationale and documentation of a TMDL.
- Estimate assimilative capacity of the SMR: Apply data to watershed model to estimate the assimilative capacity and address the issues associated with the Four-Party Agreement.
- Identify relationship between habitat health & water quality: Apply the data and watershed model to compare current and projected water quality and quantity to habitat needs in the critical reaches of the watershed.
- Identify relationship between water supply rights & water quality: Apply data and watershed model to illustrate the linkages between local runoff, imported water, and groundwater basins to address water management options. Formulate and evaluate alternatives for perfecting USBR water rights for the benefit of local sponsors and the protection of the watershed habitat.
- Address water recycling water quality issues: Coordinate water quality and quantity opportunities with the USBR SCCWRRS and follow-on studies to maximize beneficial uses of recycled water in the watershed;

- Review Beneficial Use Designation. Use the database to evaluate the beneficial use designation in the Basin Plan. Where appropriate recommended potential revisions that are justified by data provided through sampling and monitoring programs in combination with GIS data.

- Identify beneficial use impairments: Apply the data and watershed model to address and evaluate proposals for changes in land use as to their potential impacts on beneficial uses.

- Support implementing Phase II stormwater regulations: Work with the counties and local agencies to apply the water quantity and quality database derived from the Comprehensive Monitoring Plan to address the regulations.

- Apply new data to existing sediment transport model: Use data from the new sampling program to address the projected changes in land use and to identify impacts to property, water supply, and habitat health

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Section 5
References

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SAN DIEGO REGIONAL WATER QUALITY CONTROL BOARD

2001 MAY 18 P 1:10

UNITED STATES MARINE CORPS
Assistant Chief of Staff, Facilities
Marine Corps Base
Box 555013
Camp Pendleton, California 92055-5013

5000
FAC/E
MAY 17 2001

From: Assistant Chief of Staff, Facilities
To: Director, Traffic Management Office (Attn: Freight Section)

Subj: FEDERAL EXPRESS MAIL

Encl: (1) Two CD's

1. It is requested that the enclosure be Federal Expressed to the following name and address:

Ms. Keri Cole
San Diego Regional Water Quality Control Board
9771 Clairemont Mesa Blvd., Suite A
San Diego, CA 92124-1324
(858) 467-2798

2. The following information applies:

a. Doc# M93326-01MD-FEDXF

b. Ship #2

c. FIP: M00681 6A 25 SA 2607 ERD0 SBF3

d. APPROP DATA: AA 1711106.27A0 000 00681 0 067443 2D 000000 SA16ASBF36025T

e. Estimated Amount: $

3. Point of contact for this matter is Ms. Eileen Juarez at 725-6451.

A. J. ESPINOZA
By direction

Copy to:
Dir, FRM (Attn: S. Galvez)

4161 1913 2683

16 May 2001

SAN DIEGO REGIONAL
WATER QUALITY
CONTROL BOARD

2001 MAY 18 P 1:09

Ms. Keri Cole
San Diego Regional Water Quality Control Board
9771 Clairemont Mesa Blvd., Suite A
San Diego, CA 92124-1324

Here are the files we discussed Tuesday afternoon, 15 May. These CDs include:

1) Complete files from WEST Consultants, Inc. of the Hydrology, Hydraulics and Sediment Transport study completed last summer (because they is so many files, they're in both CDs);
2) Complete files from the LAW/Crandall Water Quality study of the Santa Margarita River and San Mateo Creek (these too are in both CDs;
3) Files from the draft CDM-Federal, Boyle Engineering, and RECON I.Q. Contract through the U.S. Bureau of Reclamation called "Framework Monitoring Plan for the Santa Margarita River Watershed California" and the Power Point Presentation of that Plan. The final files on this study/presentation we are hoping to receive at our next meeting of the Santa Margarita River Water Quality Monitoring Group schedule for 4 June at Rancho California Water District at 1 P.M.

Let me know if we can be of further service by calling me at 760-725-1061 or by e-mail at carlsonle@mail.cpp.usmc.mil.

Very Respectfully,

LAWRENCE E. CARLSON
Office of Water Resources
Assistant Chief of Staff, Facilities
Marine Corps Base
Camp Pendleton, CA 92055-5013

DATA SUMMARY
Disc 1 of 2 (submitted by Camp Pendleton)

LAW-Crandall

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precip9	San Clem 1931 – 1979 data = ?
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SWR West Study

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SMRWQM-Group

SMR Figure3_41	Figure 3-4 = Proposed Water Quality Sampling Locations
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SMRWQM-Group Presentation	Powerpoint Presentation: Water Quality Monitoring and Water Management

Disc 2 of 2

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SMR West Study

Final West Project

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Santa Margarita ~~Creek~~ River
(3 locations)

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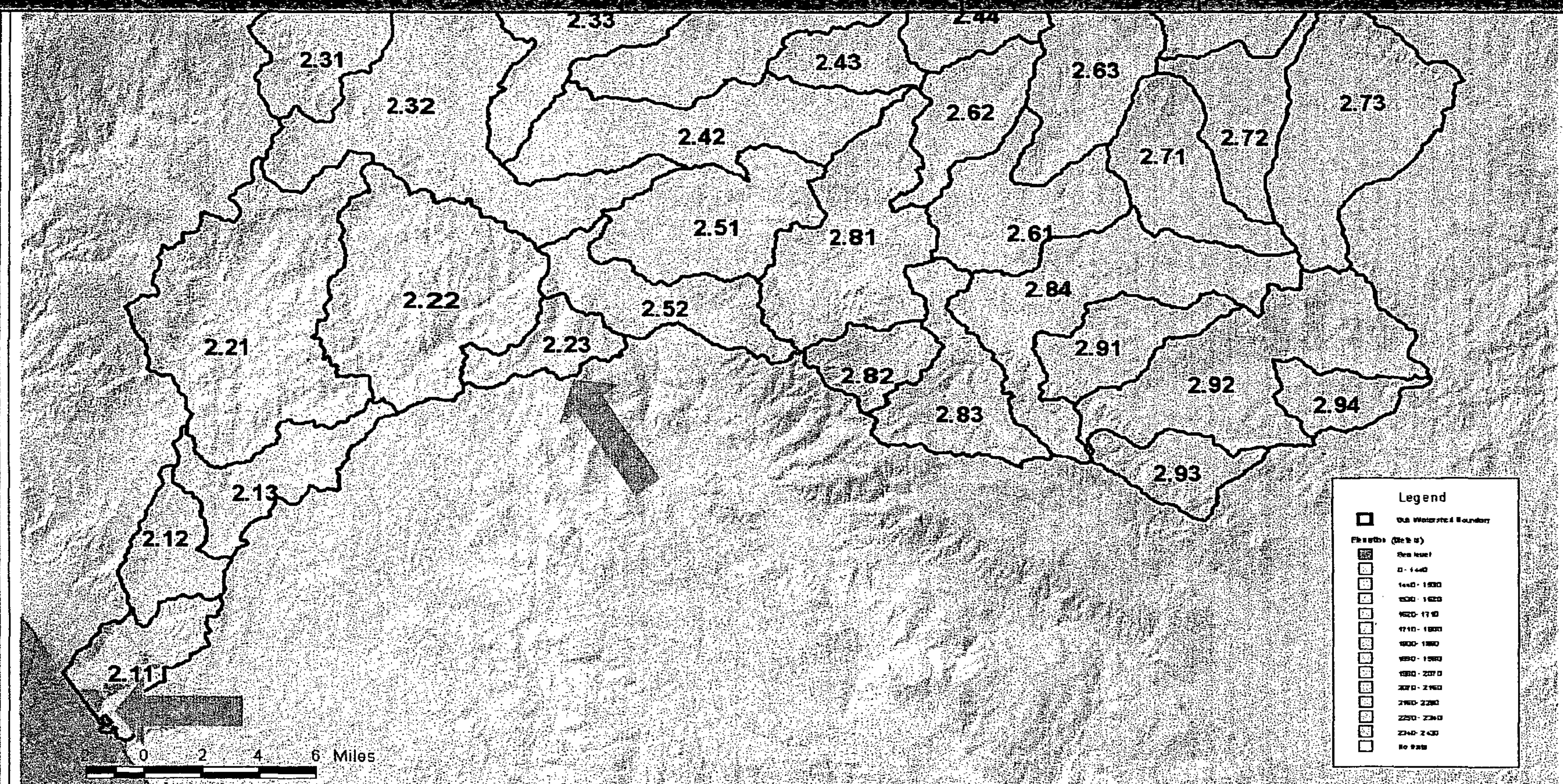
1998 CA 303(d) Listed Sites in Santa Margarita Watershed

Listing state	ID	Waterbody	Parameter of Concern	Potential sources of Impairment
CA	CAE902.110 SANTA MARGARITA 1998	SANTA MARGARITA LAGOON	EUTROPHIC	NONPOINT/POINT SOURCE
CA	CAR902.200 RAINBOW CREEK 1998	RAINBOW CREEK	EUTROPHIC	NONPOINT/POINT SOURCE



Santa Margarita River Watershed

See also, Marine Corps Base - Camp Pendleton

Contact Person Larry McKenney
Address: 9 Cottage Lane, Aliso Viejo, CA 92656
Telephone Number/Fax Number (7 60) 725-1059 FAX (760) 725-1058
Email/Web Page Address mckenneyl@pendleton.usmc.mil

There have been three great efforts to approach management of the water and water-related resources in the Santa Margarita River watershed, and all three have failed. A new effort is about to be launched, although it may come out of any of several different programs that are tending in that direction. No matter its origin, the next effort to create such a program should learn from the previous failures.

The Original Problem: Water Supply In 1951, water supply was the main problem. Water rights to the river and its connected groundwater basins had been the subject of litigation since the 1 920s, although a fragile peace had been achieved in 1940. The Marine Corps had since created Camp Pendleton, and the downstream use of water was growing. Upstream, Vail Ranch remained an important agricultural water user. In between, Fallbrook Public Utility District served a rapidly growing agricultural region and hoped to dam the river for water supply. In 1951, the United States sued Fallbrook PUD to quiet its title to senior water rights. Litigation in federal court was the only tool available at the time to address such an issue. After the suit was tried once between several major water users, the Ninth Circuit Court of Appeals reversed and sent the case back to trial because such water rights cannot be adjudicated except on a watershed basis. The United States then joined thousands of property owners as defendants and took the case to court again. The publicity and political reaction were a disaster for the Marine Corps. More than fifteen years later, the case finally sputtered to a stop, not really concluded. It remains a pending case, but since then the parties have sought to negotiate solutions to their contentions. Success has not yet been achieved.

The Second Problem: Water Quality At the end of the active litigation, a joint powers agency was formed in the Santa Margarita and San Luis Rey River watersheds. The IPA provided administrative support to the federal court appointed Watermaster who was overseeing efforts to settle the water rights adjudication. In 1972 the Clean Water Act was enacted and directed the development of water quality control plans. The WA obtained a §208 planning grant, under the Clean Water Act, which it used to fund development of the water quality control plan for the two watersheds. That plan became a part of the first San Diego Regional Board basin plan. Despite this initial success and productivity, the WA, is now virtually inactive. Part of the problem is that the issues in each watershed and their relative priorities have diverged, making it difficult for the WA to retain a sense of a defined character or purpose. The other key shortcoming of the JPA is its composition entirely of water supply agencies, which narrows its approach to the issues. The San Luis Rey River now has a watershed council completely separate from the WA, while the Santa Margarita River efforts have again stalled, as described below.

The Latest Challenge: Connecting Water and Land Use Most accept that the watershed approach is a holistic consideration of all water related resource issues, including water supply, water quality for humans and the ecosystem including nonpoint source pollution issues, habitat health and physical integrity, recreational opportunities, and flood protection. This means that water resource planning must be linked in a meaningful way to land use regulation. An effort to implement such an approach in the Santa Margarita in the early 1 990s stalled after two years of effort and significant state and federal agency support. In part, the financial support of U.S. EPA and the California Coastal Conservancy proved to be problematic, as it aroused local suspicions. Another problem not solved was the need to be inclusive of the full range of stakeholder interests, yet keep the working teams or committees from becoming too cumbersome. Here, the advisory committees took on all volunteers. Not only were the committees and therefore difficult to manage, but a small group of stakeholders used the program's lack of structure and focus to disrupt and delay progress. As time passed and the issues became politicized, the scientific and technical momentum was lost. The controversies sapped the political will of the program's key supporters, and the program was shelved.

There is hope yet that the watershed initiative will be revived, either in its old incarnation with improvements, or as a result of efforts by the Regional Water Quality Control Board (centered on the municipal stormwater program), the Mission Resource Conservation District (as in the San Luis Rey River), or an Army Corps of Engineers cost-shared initiative. Ultimately, though, a successful effort must be locally driven and controlled.

Back to Directory

USGS

1999 California Hydrologic Data Report

11044000 SANTA MARGARITA RIVER NEAR TEMECULA, CA

LOCATION.-Lat 33°28'26", long 117°08'29", in Temecula Grant, Riverside County, Hydrologic Unit 18070302, on left bank, at upper end of Temecula Canyon, 0.1 mi downstream from confluence of Murrieta and Temecula Creeks, 1.4 mi south of Temecula, 10 mi downstream from Vail Dam, and about 12 mi downstream from Skinner Reservoir.

DRAINAGE AREA.-588 mi^2.

PERIOD OF RECORD.-January 1923 to current year. Prior to October 1952, published as Temecula Creek at Railroad Canyon, near Temecula.

REVISED RECORDS.-WSP 981: 1927(M). WSP 1928: Drainage area.

GAGE.-Water-stage recorder and crest-stage gage. Concrete control since Nov. 3, 1966; buried by sand Nov. 19, 1985, uncovered by high flow in March 1991. Elevation of gage is 950 ft above sea level, from topographic map. Prior to Nov. 3, 1966, at site 100 ft downstream at same datum.

REMARKS.-Records good. Flow partly regulated since November 1948 by Vail Lake (station 11042510) on Temecula Creek, and since 1974 by Skinner Reservoir. Rancho California Water District can discharge into Murrieta Creek, approximately 1.0 mi upstream, to supplement low flow. Beginning in water year 1999, flows on Warm Springs Creek, a tributary to Murrieta Creek, are slightly regulated by East Side Reservoir, capacity, 800,00 acre-ft (see station 11042800). See schematic diagram of Santa Margarita River Basin.

EXTREMES FOR PERIOD OF RECORD.-Maximum discharge, 31,000 ft^3/s, Jan. 16, 1993, gage height, 22.5 ft, from rating curve extended above 4,000 ft^3/s on basis of slope-area measurement of peak flow; minimum daily, 0.16 ft^3/s, Mar. 31, Apr. 1, 11, 1988.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	3.7	1.2	3.8	1.3	4.1	2.5	28	2.5	4.7	3.2	4.2	4.0
2	3.7	1.2	3.1	1.2	3.2	2.4	20	2.3	11	2.8	3.5	4.2
3	3.8	1.2	2.5	1.2	2.6	1.6	4.6	3.3				

1999 California Hydrologic Data Report

11046050 SANTA MARGARITA RIVER AT MOUTH, NEAR OCEANSIDE, CA

LOCATION.-Lat 33°14'08", long 117°24'27", in SW 1/4 NE 1/4 sec.9, T.11 S., R.5 W., San Diego County, Hydrologic Unit 18070302, on Camp Joseph H. Pendleton Naval Reservation, on right bank, 300 ft downstream from bridge on Interstate Highway 5, 0.5 mi upstream from mouth, and 3.5 mi northwest of Oceanside.
DRAINAGE AREA.-744 mi^2.
GAGE-HEIGHT RECORDS
PERIOD OF RECORD.-October 1989 to current year. Unpublished records for water year 1989 available in files of the U.S. Geological Survey.
GAGE.-Water-stage recorder. Datum of gage is 2.78 ft below sea level.
REMARKS.-Gage height generally affected by tide. See schematic diagram of Santa Margarita River Basin.
EXTREMES FOR PERIOD OF RECORD.-Maximum gage height, 15.10 ft, from floodmarks and hydrographers' notes, Jan. 16, 1993; minimum recorded gage height, 2.02 ft, Feb. 3, 1999.
EXTREMES FOR CURRENT YEAR.-Maximum recorded gage height, 10.13 ft, Jan. 24; minimum recorded gage height, 2.02 ft, Feb. 3.

GAGE HEIGHT, FEET, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999

DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
	OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH	
1	6.96	6.92	7.27	7.22	7.90	7.75	---	---	6.75	2.12	6.60	3.05
2	6.95	6.92	7.28	7.22	8.05	7.90	---	---	6.12	2.09	6.57	3.53
3	6.98	6.95	7.28	7.23	8.15	8.05	---	---	5.73	2.02	5.80	3.49
4	7.04	6.96	7.29	7.24	8.18	8.13	---	---	5.10	2.12	5.44	3.29
5	7.12	7.01	7.29	7.26	8.21	8.15	9.52	9.40	4.65	2.06	4.89	3.27
6	7.07	7.02	7.32	7.28	8.25	8.18	9.53	9.40	4.49	2.23	4.83	3.28
7	7.08	7.02	7.33	7.27	8.43	8.25	9.54	9.42	4.48	2.43	4.85	3.25
8	7.08	7.03	7.38	7.31	8.56	8.43	9.60	9.43	4.65	2.34	4.59	3.22
9	7.09	7.03	7.41	7.37	8.66	8.56	9.55	9.50	4.73	2.15	4.39	3.14
10	7.08	7.03	7.43	7.38	8.68	8.61	9.56	9.51	4.86	2.18	3.67	3.13
11	7.08	7.03	7.42	7.40	8.71	8.65	9.57	9.52	4.89	2.08	4.03	3.13
12	7.09	7.04	7.45	7.40	8.75	8.68	9.59	9.54	5.30	2.06	4.09	3.22
13	7.09	7.05	7.46	7.40	8.78	8.73	9.62	9.57	5.60	2.05	4.39	3.22
14	7.10	7.06	7.47	7.41	8.79	8.74	9.63	9.59	6.27	2.24	4.42	3.26
15	7.11	7.06	7.48	7.42	8.82	8.78	9.67	9.62	6.58	2.27	4.59	3.26
16	7.12	7.06	7.48	7.43	8.88	8.81	9.69	9.64	6.45	2.23	4.90	3.23
17	7.13	7.04	7.49	7.43	8.89	8.82	9.86	9.67	6.47	2.40	5.31	3.26
18	7.13	7.05	7.49	7.44	8.88	8.87	9.87	9.72	6.37	2.72	5.02	3.22
19	7.14	7.07	7.51	7.46	8.91	8.88	9.92	9.83	5.66	2.84	4.99	3.18
20	7.15	7.08	7.51	7.46	8.96	8.91	9.98	9.92	5.61	3.00	4.73	3.22
21	7.14	7.09	7.53	7.46	9.02	8.94	10.01	9.98	5.44	3.01	4.33	3.25
22	7.16	7.10	7.54	7.47	9.07	9.00	10.02	9.98	5.42	3.01	3.92	3.34
23	7.16	7.12	7.53	7.49	9.11	9.05	10.07	10.02	5.38	2.96	3.73	3.34
24	7.16	7.13	7.54	7.49	9.13	9.07	10.13	10.07	5.51	2.82	4.05	3.42
25	7.18	7.14	7.55	7.52	9.18	9.10	10.11	2.96	5.88	2.75	4.39	3.49
26	7.19	7.15	7.57	7.53	9.18	9.13	6.09	2.86	6.29	2.82	5.14	3.00
27	7.21	7.16	7.57	7.54	9.23	9.16	6.61	2.98	6.43	2.84	5.06	3.50
28	7.21	7.16	7.60	7.56	9.27	9.15	6.60	2.89	6.34	2.82	5.35	3.49
29	7.22	7.18	7.62	7.59	---	---	6.89	2.29	---	---	5.23	3.62
30	7.23	7.19	7.75	7.61	---	---	6.78	2.13	---	---	5.42	3.65
31	7.26	7.19	---	---	---	---	6.84	2.18	---	---	5.93	3.70
MONTH	7.26	6.92	7.75	7.22	---	---	---	---	6.75	2.02	6.60	3.00

GAGE HEIGHT, FEET, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999

DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
	APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER	
1	5.75	3.74	5.47	3.76	5.90	4.19	6.18	4.02	5.47	4.10	5.88	4.01
2	5.49	3.74	5.56	3.74	5.90	4.39	6.18	4.07	4.66	4.08	5.85	4.01
3	6.59	3.80	5.70	3.79	5.73	4.63	5.91	4.13	4.83	4.02	6.05	4.15
4	6.10	3.77	5.65	3.69	5.74	4.92	5.30	4.12	5.08	3.96	6.20	4.25
5	5.30	3.74	5.16	3.65	5.13	4.91	4.68	4.02	5.54	3.95	6.30	4.23

6	5.18	3.92	4.73	3.65	4.93	4.90	5.01	4.00	5.91	3.94	6.58	4.22
7	5.30	4.27	4.55	3.75	5.24	4.92	5.56	4.19	6.21	3.93	6.59	4.30
8	4.84	4.22	4.56	3.97	5.57	5.24	6.13	4.15	6.66	3.94	6.66	4.17
9	4.66	4.16	4.60	4.10	5.81	5.39	6.77	4.07	7.05	4.02	6.38	4.17
10	4.35	4.10	4.79	4.07	6.38	4.95	7.38	4.20	7.06	4.06	5.94	4.12
11	4.41	4.06	5.32	4.07	7.01	4.89	7.70	4.28	6.72	4.02	5.72	4.21
12	5.03	4.14	6.05	4.05	7.26	4.19	7.81	4.37	6.33	4.03	5.36	4.25
13	5.01	4.07	6.86	4.08	7.55	4.09	7.56	4.28	6.02	4		

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1999 California Hydrologic Data Report

11044300 SANTA MARGARITA RIVER AT FALLBROOK PUBLIC UTILITY DISTRICT SUMP, NEAR FALLBROOK, CA

LOCATION.-Lat 33°24'49", long 117°14'25", in NW 1/4 NW 1/4 sec.7, T.9 S., R.4 W., San Diego County, Hydrologic Unit 18070302, on left bank, 0.3 mi upstream from confluence with Sandia Creek, and 2.9 mi north of Fallbrook.

DRAINAGE AREA.-620 mi^2.

PERIOD OF RECORD.-October 1989 to current year.

GAGE.-Water-stage recorder and crest-stage gage. Elevation of gage is 330 ft above sea level, from topographic map.

REMARKS.-Records fair except for estimated daily discharges, which are poor. Flow partly regulated since November 1948 by Vail Lake (station 11042510) and since 1974 by Skinner Reservoir. Flow in Warm Springs Creek, a tributary to Murrieta Creek, slightly regulated beginning in water year 1999 by East Side Reservoir, capacity, 800,000 acre-ft (see station 11042800). See schematic diagram of Santa Margarita River Basin.

EXTREMES FOR PERIOD OF RECORD.-Maximum discharge, 34,000 ft^3/s, estimated, based on regression equation and flood routing of upstream flows, Jan. 16, 1993, gage height, 15.89 ft; no flow several days in 1990.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	6.8	4.4	8.9	5.4	14	6.4	14	7.9	6.5	3.6	5.7	4.9
2	7.0	4.4	7.8	5.2	9.2	6.3	46	6.6	10	4.7	5.2	5.5
3	7.3	4.5	6.8	5.1	8.3	6.4	19	5.6	17	4.3	4.3	7.2
4	8.1	4.1	6.3	4.8	12	7.0	16	6.0	5.5	5.1	3.4	6.0
5	7.2	4.4	8.3	4.7	47	6.2	15	8.3	4.5	6.0	3.9	5.2
6	6.5	4.8	31	4.8	20	5.8	11	14	4.6	4.6	3.4	4.9
7	6.0	5.3	24	4.7	13	6.9	41	13	4.3	3.8	4.2	4.1
8	6.1	21	12	4.8	9.9	7.7	40	15	4.2	7.2	4.9	3.7
9	6.7	31	8.6	4.7	11	7.0	16	7.0	5.3	30	5.0	4.3
10	7.2	19	8.1	5.0	16	6.5	12	5.5	5.6	15	4.9	5.2
11	6.7	11	6.9	5.0	12	8.1	9.5	5.0	7.5	8.3	4.4	5.4
12	7.1	9.2	7.1	5.2	7.9	7.9	49	4.2	6.7	6.0	3.6	5.3
13	7.7	9.1	6.4	7.9	7.9	8.2	31	5.4	6.1	5.5	3.8	4.1
14	6.3	7.7	5.6	5.5	8.4	7.6	17	8.1	6.4	6.0	4.6	4.0
15	6.3	8.7	5.2	5.1	7.4	9.2	10	9.4	6.3	5.7	4.5	3.8
16	6.3	8.6	4.3	5.4	8.5	18	7.7	9.0	6.4	4.9	3.1	4.0
17	6.1	8.6	4.1	5.5	8.1	10	6.2	8.9	8.0	5.0	4.6	4.6
18	5.7	8.9	4.3	5.3	8.0	7.1	6.2	6.3	9.7	5.1	4.2	5.5
19	5.9	6.9	5.3	4.8	8.0	8.0	5.3	4.9	10	5.4	3.5	6.0
20	5.5	7.0	8.0	6.0	7.9	7.4	9.7	4.7	8.9	5.2	2.9	4.4
21	5.5	6.7	10	9.1	7.4	11	8.7	5.0	9.2	5.1	3.9	3.6
22	5.9	6.3	6.8	6.5	7.3	9.9	7.7	5.3	9.5	4.9	4.3	3.6
23	5.6	6.3	6.6	7.2	6.9	11	8.8	5.3	5.7	4.1	3.2	3.9
24	5.4	6.2	5.4	5.7	6.4	10	7.4	5.0	4.7	4.4	3.0	4.0
25	5.9	6.8	5.1	12	6.8	11	8.2	5.3	4.7	4.9	3.2	4.3
26	6.6	7.1	5.5	e65	8.1	14	7.1	5.4	3.9	5.0	3.8	4.7
27	6.7	7.7	5.5	e80	7.2	13	6.0	6.7	3.5	5.4	4.9	4.5
28	9.7	21	5.2	21	7.0	11	7.1	6.3	4.1	5.9	4.5	4.0
29	17	68	4.9	13	---	11	6.5	6.1	4.7	6.1	5.4	3.3
30	5.3	16	5.0	10	---	10	6.6	6.8	3.9	5.6	5.8	2.7
31	4.6	---	5.2	11	---	9.4	---	7.0	---	5.6	4.7	---
TOTAL	210.7	340.7	244.2	345.4	301.6	279.0	455.7	219.0	197.4	198.4	130.8	136.7
MEAN	6.80	11.4	7.88	11.1	10.8	9.00	15.2	7.06	6.58	6.40	4.22	4.56
MAX	17	68	31	80	47	18	49	15	17	30	5.8	7.2
MIN	4.6	4.1	4.1	4.7	6.4	5.8	5.3	4.2	3.5	3.6	2.9	2.7
AC-FT	418	676	484	685	598	553	904	434	392	394	259	271

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1990 - 1999, BY WATER YEAR (WY)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	6.79	7.73	13.9	201	215	123	27.1	19.0	9.09	5.66	4.87	5.26
MAX	15.7	24.4	37.1	1462	860	490	70.4	58.3	25.1	11.4	10.1	9.03
(WY)	1994	1997	1998	1993	1993	1991	1993	1998	1993	1993	1993	1993
MIN	4.31	1.48	1.66	4.65	10.8	2.50	4.51	6.12	2.43	2.11	1.00	1.22
(WY)	1991	1992	1990	1991	1999	1990	1990	1997	1997	1990	1990	1990

SUMMARY STATISTICS	FOR 1998 CALENDAR YEAR		FOR 1999 WATER YEAR		WATER YEARS 1990 - 1999	
ANNUAL TOTAL	31713.6		3059.6			
ANNUAL MEAN	86.9		8.38		52.4	
HIGHEST ANNUAL MEAN					220	1993
LOWEST ANNUAL MEAN					5.99	1990
HIGHEST DAILY MEAN	4800	Feb 24	80	Jan 27	14300	Jan 16 1993
LOWEST DAILY MEAN	2.5	Sep 8	2.7	Sep 30	.00	Aug 1 1990
ANNUAL SEVEN-DAY MINIMUM	3.0	Aug 25	3.4	Aug 19	.05	Jul 31 1990
INSTANTANEOUS PEAK FLOW			194	Jan 26	34000	Jan 16 1993
INSTANTANEOUS PEAK STAGE			2.60	Jan 26	15.89	Jan 16 1993
ANNUAL RUNOFF (AC-FT)	62900		6070		37940	
10 PERCENT EXCEEDS	107		13		50	
50 PERCENT EXCEEDS	8.6		6.3		6.6	
90 PERCENT EXCEEDS	3.6		4.2		2.5	

e Estimated.

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Last modified: **Wed Jun 14 11:27:15 PDT 2000**

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1999 California Hydrologic Data Report

11045300 FALLBROOK CREEK NEAR FALLBROOK, CA

LOCATION.-Lat 33°20'49", long 117°19'01", in SE 1/4 SE 1/4 sec.32, T.9 S., R.4 W., San Diego County, Hydrologic Unit 18070302, on Camp Joseph H. Pendleton Naval Reservation, on right bank, at culvert on DeLuz Road, 0.75 mi upstream from O'Neill Lake, and 4.5 mi southwest of Fallbrook.
DRAINAGE AREA.-6.97 mi^2.
PERIOD OF RECORD.-October 1993 to current year. Discharge records for October 1964 to September 1977 and October 1989 to September 1993 available in files of U.S. Marine Corps at Camp Pendleton.
GAGE.-Water-stage recorder, crest-stage gage, and concrete control with low-water Parshall flume. Elevation of gage is 190 ft above sea level, from topographic map.
REMARKS.-Records good. Slight regulation by two small storage reservoirs upstream from station. See schematic diagram of Santa Margarita River Basin.
EXTREMES FOR PERIOD OF RECORD.-Maximum discharge, 895 ft^3/s, Feb. 23, 1998, gage height, 9.73 ft, from rating curve extended above 140 ft^3/s on basis of culvert computation; no flow for many days in some years.
EXTREMES FOR CURRENT YEAR.-Peak discharges greater than base discharge of 100 ft^3/s, or maximum, from rating curve extended as explained above:

Date	Time	Discharge (ft^3/s)	Gage height (ft)	Date	Time	Discharge (ft^3/s)	Gage height (ft)
Dec. 6	1115	27	1.24				

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.43	.46	.86	.73	1.1	.67	1.5	.48	.33	.23	.16	.01
2	.45	.47	.95	.73	.77	.65	5.5	.48	.38	.22	.14	.01
3	.45	.47	.90	.73	.71	.62	.95	.47	.39	.21	.14	.01
4	.45	.46	.82	.73	1.7	.65	.83	.43	.41	.20	.14	.01
5	.43	.45	1.9	.73	5.9	.65	.78	.43	.42	.18	.14	.01
6	.41	.45	8.1	.74	2.4	.65	.73	.42	.44	.18	.13	.02
7	.39	.45	1.7	.65	1.2	.65	4.0	.42	.44	.17	.13	.01
8	.38	1.3	.92	.65	.94	.65	2.1	.42	.44	.19	.12	.01
9	.37	6.1	.82	.63	.93	.65	.81	.41	.44	.18	.11	.01
10	.36	1.1	.80	.63	2.2	.65	.66	.41	.43	.18	.09	.01
11	.35	.74	.82	.65	.90	.66	.61	.41	.43	.19	.09	.01
12	.38	.73	.90	.65	.72	.65	9.0	.41	.42	.18	.08	.01
13	.40	.69	.74	.65	.68	.66	1.4	.42	.41	.17	.10	.01
14	.41	.65	.65	.65	.66	.65	.84	.42	.41	.17	.09	.01
15	.41	.65	.65	.65	.66	.86	.73	.43	.42	.18	.07	.01
16	.42	.65	.66	.65	.68	1.4	.70	.43	.41	.19	.03	.01
17	.36	.65	.65	.65	.72	.75	.62	.42	.41	.18	.02	.01
18	.35	.65	.64	.65	.73	.69	.60	.42	.38	.18	.01	.01
19	.35	.61	.65	.65	.73	.65	.58	.42	.34	.18	.01	.04
20	.35	.57	.75	.68	.72	.65	.60	.41	.33	.16	.02	.02
21	.36	.58	.74	.83	.73	.65	.65	.40	.34	.15	.02	.02
22	.36	.56	.65	1.0	.71	.65	.65	.41	.33	.12	.02	.02
23	.36	.58	.65	.82	.68	.65	.69	.42	.32	.13	.02	.02
24	.35	.65	.65	.87	.67	.65	.66	.39	.32	.17	.01	.03
25	.37	.65	.65	3.4	.68	.69	.67	.37	.32	.18	.01	.04
26	.37	.65	.64	8.1	.68	1.0	.64	.36	.34	.18	.01	.05
27	.43	.67	.52	6.9	.67	.86	.52	.35	.34	.18	.01	.07
28	.44	.67	.52	1.4	.67	.73	.52	.37	.32	.17	.01	.06
29	.44	4.8	.70	.86	---	.74	.53	.35	.24	.17	.01	.03
30	.45	1.0	.73	.75	---	.74	.52	.35	.23	.16	.01	.01
31	.45	---	.73	.78	---	.63	---	.33	---	.16	.02	---
TOTAL	12.28	29.11	32.06	39.19	30.54	22.10	39.59	12.66	11.18	5.49	1.97	0.60
MEAN	.40	.97	1.03	1.26	1.09	.71	1.32	.41	.37	.18	.064	.020
MAX	.45	6.1	8.1	8.1	5.9	1.4	9.0	.48	.44	.23	.16	.07
MIN	.35	.45	.52	.63	.66	.62	.52	.33	.23	.12	.01	.01
AC-FT	24	58	64	78	61	44	79	25	22	11	3.9	1.2

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1994 - 1999, BY WATER YEAR (WY)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	.18	1.08	1.36	5.84	8.63	6.25	2.37	1.31	.67	.32	.16	.12
MAX	.40	3.35	3.20	18.5	35.9	23.8	5.63	3.28	1.50	.82	.41	.41
(WY)	1999	1997	1997	1995	1998	1995	1998	1998	1995	1998	1995	1998
MIN	.015	.13	.33	.87	1.09	.71	.81	.39	.14	.025	.024	.001
(WY)	1995	1995	1995	1994	1999	1999	1997	1997	1997	1997	1996	1994

SUMMARY STATISTICS FOR 1998 CALENDAR YEAR FOR 1999 WATER YEAR

1999 California Hydrologic Data Report

11044350 SANDIA CREEK NEAR FALLBROOK, CA

LOCATION.-Lat 33°25'28", long 117°14'54", in SW 1/4 NE 1/4 sec.1, T.9 S., R.4 W., San Diego County, Hydrologic Unit 18070302, on left bank, 1.05 mi north of intersection of Sandia and Rock Mountain Roads, 0.8 mi upstream from mouth, and 3.8 mi north of Fallbrook.

DRAINAGE AREA.-21.1 mi^2.

PERIOD OF RECORD.-October 1989 to current year.

REVISED RECORDS.-WDR CA-91-1: 1990(M).

GAGE.-Water-stage recorder and crest-stage gage. Elevation of gage is 380 ft above sea level, from topographic map. Prior to Sept. 30, 1993, at site 0.65 mi downstream at different datum.

REMARKS.-Records fair. No regulation or diversion upstream from station. Natural flow affected by pumping and return flow from irrigated areas. See schematic diagram of Santa Margarita River Basin.

EXTREMES FOR PERIOD OF RECORD.-Maximum discharge, 5,100 ft^3/s, Jan. 16, 1993, gage height, 17.60 ft, site and datum then in use, from floodmarks (may have been affected by backwater from the Santa Margarita River); no flow for many days in summer of 1996.

EXTREMES FOR CURRENT YEAR.-Peak discharges greater than base discharge of 75 ft^3/s, or maximum, from rating curve extended above 536 ft^3/s on basis of slope-area measurement of peak flow:

Date	Time	Discharge (ft^3/s)	Gage height (ft)	Date	Time	Discharge (ft^3/s)	Gage height (ft)
Oct. 21	2230	69	2.65				

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2.8	2.7	4.6	3.3	3.4	2.9	5.3	3.0	1.6	1.2	.25	.44
2	3.1	3.0	4.7	3.0	3.1	3.0	6.1	2.8	2.4	1.1	.21	.70
3	3.1	3.1	4.6	2.5	5.1	2.9	3.5	3.1	2.0	.52	.10	.40
4	2.7	3.2	4.8	2.7	5.0	3.1	3.6	2.7	2.0	.68	.33	.24
5	2.7	3.1	5.3	2.8	6.6	3.2	3.7	2.8	1.9	1.3	.34	.32
6	2.5	3.4	6.5	2.9	6.0	2.7	4.4	2.5	1.9	1.5	.39	.39
7	2.2	2.8	5.2	2.9	4.8	2.7	9.9	2.1	1.8	.96	.39	.53
8	2.3	6.4	5.0	2.8	4.5	3.0	7.7	2.1	1.4	1.4	.17	.72
9	2.4	5.5	4.9	2.8	4.7	3.2	5.8	2.3	.92	.96	.15	.80
10	2.2	4.8	4.7	2.8	5.5	3.0	5.0	2.5	1.3	.32	.47	.63
11	2.3	4.8	4.6	2.8	4.4	3.2	5.7	2.6	1.9	.16	.91	.29
12	2.5	4.7	5.4	2.7	3.7	3.3	13	2.4	.66	.52	.68	.31
13	2.5	4.2	4.1	4.5	3.4	3.3	7.9	2.7	.62	.60	.57	.30
14	2.8	4.1	4.4	2.8	2.8	3.2	5.6	2.6	1.5	.56	.41	.25
15	3.0	4.1	4.4	2.7	3.0	3.9	5.1	2.1	1.8	.38	.44	.28
16	2.9	4.1	4.3	2.5	3.4	3.9	4.3	2.2	1.8	.26	.54	.34
17	2.2	4.0	4.8	2.6	3.4	3.6	3.7	2.1	1.4	.13	.73	.42
18	.77	4.1	3.8	2.9	3.6	3.6	3.0	1.9	1.1	.07	1.1	.51
19	1.0	3.6	3.8	2.9	3.6	3.4	3.0	2.0	.62	.33	1.0	.66
20	1.4	3.1	4.3	3.0	3.5	3.9	2.9	1.9	.60	1.2	.51	.88
21	3.7	2.9	4.3	3.1	3.4	5.6	3.1	1.8	1.3	.45	.27	1.6
22	4.0	3.1	4.6	3.0	3.4	7.6	3.2	1.8	1.5	.43	.20	1.7
23	2.5	3.1	5.0	2.8	3.1	6.6	3.1	1.9	1.3	.25	.26	1.7
24	2.5	3.4	5.1	2.8	3.0	5.2	3.3	1.8	1.3	.10	.70	1.4
25	2.5	3.5	5.6	3.7	2.9	3.3	3.1	1.8	1.5	.07	.36	.74
26	2.7	3.8	2.7	6.3	2.9	3.5	3.2	1.6	.46	.43	.15	.71
27	2.7	3.8	2.7	6.9	2.7	3.4	3.1	1.3	.32	.89	.22	1.8
28	3.0	5.8	2.7	4.1	2.9	2.8	2.8	1.5	.63	1.1	.17	2.0
29	3.1	5.9	2.7	3.0	---	3.0	3.1	1.4	1.1	.70	.13	1.5
30	3.2	4.9	2.8	3.0	---	3.3	3.2	1.6	1.0	.29	.38	.78
31	2.9	---	2.9	3.6	---	2.8	---	1.5	---	.23	.41	---
TOTAL	80.17	119.0	135.3	100.2	107.8	112.1	140.4	66.4	39.63	19.09	12.94	23.34
MEAN	2.59	3.97	4.36	3.23	3.85	3.62	4.68	2.14	1.32	.62	.42	.78
MAX	4.0	6.4	6.5	6.9	6.6	7.6	13	3.1	2.4	1.5	1.1	2.0
MIN	.77	2.7	2.7	2.5	2.7	2.7	2.8	1.3	.32	.07	.10	.24
AC-FT	159	236	268	199	214	222	278	132	79	38	26	46

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1990 - 1999, BY WATER YEAR (WY)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	1.44	2.33	3.64	37.5	34.8	26.4	11.5	6.80	4.28	2.08	1.18	1.05
MAX	2.59	3.97	8.12	237	128	79.8	28.0	18.3	9.49	5.40	2.73	3.21
(WY)	1999	1999	1997	1993	1993	1995	1995	1998	1998	1998	1998	1998
MIN	.53	1.34	1.88	2.77	3.85	3.62	3.73	2.14	1.02	.31	.030	.062
(WY)	1997	1992	1990	1991	1999	1999	1996	1999	1996	1996	1996	1996

SUMMARY STATISTICS	FOR 1998 CALENDAR YEAR		FOR 1999 WATER YEAR		WATER YEARS 1990 - 1999	
ANNUAL TOTAL	6580.47		956.37			
ANNUAL MEAN	18.0		2.62		11.0	
HIGHEST ANNUAL MEAN					36.8	1993
LOWEST ANNUAL MEAN					2.62	1999
HIGHEST DAILY MEAN	589	Feb 23	13	Apr 12	2000	Jan 16 1993
LOWEST DAILY MEAN	.77	Oct 18	.07	Jul 18	.00	Jul 26 1996
ANNUAL SEVEN-DAY MINIMUM	1.7	Aug 27	.25	Jul 30	.00	Aug 14 1996
INSTANTANEOUS PEAK FLOW			69	Oct 21	5100	Jan 16 1993
INSTANTANEOUS PEAK STAGE			2.65	Oct 21	17.60	Jan 16 1993
ANNUAL RUNOFF (AC-FT)	13050		1900		7950	
10 PERCENT EXCEEDS	32		4.8		18	
50 PERCENT EXCEEDS	5.9		2.8		2.8	
90 PERCENT EXCEEDS	2.7		.38		.57	

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1999 California Hydrologic Data Report

11044250 RAINBOW CREEK NEAR FALLBROOK, CA

LOCATION.-Lat 33°24'27", long 117°12'00", NW 1/4 SE 1/4 sec.9, T.9 S., R.3 W., San Diego County, Hydrologic Unit 18070302, on left bank, 1.0 mi upstream from the confluence with Santa Margarita River, and 3.4 mi northeast of Fallbrook.

DRAINAGE AREA.-10.3 mi^2.

PERIOD OF RECORD.-November 1989 to current year.

REVISED RECORDS.-WDR CA-91-1: 1990(M).

GAGE.-Water-stage recorder and crest-stage gage. Elevation of gage is 540 ft above sea level, from topographic map.

REMARKS.-Records fair. No regulation upstream from station. Undetermined amount of water upstream from station used for irrigation by a local nursery. Water is imported for domestic use and irrigation. See schematic diagram of Santa Margarita River Basin.

EXTREMES FOR PERIOD OF RECORD.-Maximum discharge, 8,000 ft^3/s (estimated), Jan. 16, 1993, gage height, unknown, on basis of slope-area measurement of peak flow; maximum recorded gage height, 8.35 ft, Feb. 23, 1998; minimum daily, 0.04 ft^3/s, July 23, 24, July 27 to Aug. 1, and Aug. 3, 1996.

EXTREMES FOR CURRENT YEAR.-Peak discharges greater than base discharge of 100 ft^3/s, or maximum, from rating curve extended above 712 ft^3/s:

Date	Time	Discharge (ft^3/s)	Gage height (ft)	Date	Time	Discharge (ft^3/s)	Gage height (ft)
Jan. 26	1430	101	4.13				

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.60	.60	.90	.97	1.1	.51	6.3	.63	.28	.10	.10	.14
2	.61	.53	.89	.73	.72	.42	3.6	.70	1.2	.10	.09	.33
3	.77	.84	.82	.58	.48	.42	1.2	.63	.47	.14	.08	.39
4	1.2	.50	.63	.43	8.5	1.9	1.1	.54	.39	.13	.08	.21
5	.56	.47	2.2	.45	6.3	1.0	.66	.49	.35	.12	.10	.25
6	.35	.48	8.5	.57	2.2	.92	.62	.46	.30	.09	.12	.20
7	.54	.47	.88	.40	1.4	.97	8.1	.39	.27	.10	.12	.17
8	.43	7.1	.60	.38	1.2	.65	1.8	.47	.23	1.7	.12	.15
9	.61	1.7	.46	1.0	1.4	.61	1.2	.54	.22	.30	.12	.17
10	.48	.77	.68	1.0	2.4	.48	.99	.48	.23	.16	.11	.18
11	.80	.78	.88	1.0	.56	.89	.98	.46	.23	.14	.12	.16
12	.60	.71	.86	1.6	.48	.85	14	.39	.21	.11	.12	.14
13	.53	.53	.56	1.3	.44	.61	1.7	.39	.18	.09	.11	.13
14	.48	.41	1.0	1.4	1.4	.56	1.3	.36	.18	.08	.11	.12
15	.45	.43	.62	1.4	.45	1.8	.94	.35	.17	.08	.12	.13
16	.44	.45	.68	1.3	1.1	.91	.67	.33	.17	.08	.10	.14
17	.38	.45	.63	1.7	.46	.61	.57	.31	.16	.08	.09	.18
18	.34	.52	1.0	1.7	.62	.66	.53	.29	.15	.12	.09	.21
19	.35	.36	2.2	1.8	.61	.58	.76	.30	.16	.14	.12	.19
20	.36	.32	3.6	4.9	.61	.58	.83	.31	.16	.12	.20	.15
21	.37	.32	1.6	6.2	.73	.57	1.1	.31	.16	.10	.37	.14
22	.38	.33	1.2	2.6	.48	.53	1.2	.31	.15	.09	.20	.12
23	.34	.33	2.3	2.3	.51	.39	1.0	.28	.15	.08	.15	.13
24	.34	.34	1.1	1.7	.45	.48	1.3	.27	.14	.08	.15	.13
25	.38	.34	.91	13	.50	.95	.76	.29	.14	.08	.14	.13
26	.40	.33	.81	17	.66	.83	.63	.29	.13	.09	.13	.14
27	.49	.36	.82	10	.52	.50	.72	.29	.14	.09	.12	.14
28	.54	11	.77	1.8	.61	.61	.67	.27	.14	.09	.11	.13
29	.51	5.5	.81	1.2	---	.51	.57	.30	.13	.10	.10	.09
30	.67	1.1	.78	.86	---	.35	.57	.30	.13	.10	.11	.08
31	.92	---	.84	2.4	---	.38	---	.31	---	.11	.13	---
TOTAL	16.22	38.37	40.53	83.67	36.89	22.03	56.37	12.04	7.12	4.99	3.93	4.97
MEAN	.52	1.28	1.31	2.70	1.32	.71	1.88	.39	.24	.16	.13	.17
MAX	1.2	11	8.5	17	8.5	1.9	14	.70	1.2	1.7	.37	.39
MIN	.34	.32	.46	.38	.44	.35	.53	.27	.13	.08	.08	.08
AC-FT	32	76	80	166	73	44	112	24	14	9.9	7.8	9.9

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1990 - 1999, BY WATER YEAR (WY)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	.55	.97	1.24	15.5	15.5	11.5	3.31	1.49	.79	.41	.36	.49
MAX	.95	3.40	2.72	97.3	58.9	55.4	9.20	5.73	2.07	.90	.75	1.25
(WY)	1998	1997	1997	1993	1998	1995	1998	1998	1998	1990	1995	1995
MIN	.34	.26	.46	.65	1.32	.71	.63	.24	.15	.066	.066	.13
(WY)	1997	1993	1991	1991	1999	1999	1997	1996	1997	1996	1997	1996

SUMMARY STATISTICS FOR 1998 CALENDAR YEAR FOR 1999 WATER YEAR W

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11043000 MURRIETA CREEK AT TEMECULA, CA

LOCATION.-Lat 33°28'47", long 117°08'35", in Temecula Grant, Riverside County, Hydrologic Unit 18070302, on right bank, 0.4 mi upstream from confluence with Temecula Creek, 1.0 mi south of Temecula, and 12 mi downstream from Skinner Reservoir on Tucalota Creek.

DRAINAGE AREA.-222 mi^2.

PERIOD OF RECORD.-October 1924 to current year. Prior to September 1930 monthly discharges only, published in WSP 1315-B.

REVISED RECORDS.-WSP 1345: 1952. WSP 1635: 1932, 1937. WSP 1928: Drainage area. WDR CA-93-1: 1991 (P), 1992 (M).

GAGE.-Water-stage recorder. Concrete control since Aug. 30, 1981. Elevation of gage is 970 ft above sea level, from topographic map. See WSP 1735 for history of changes prior to Dec. 16, 1938.

REMARKS.-Records poor. Flow partly regulated since 1974 by Skinner Reservoir, capacity, 43,800 acre-ft. Beginning in water year 1999, flows on Warm Springs Creek, a tributary to Murrieta Creek, are slightly regulated by East Side Reservoir, capacity, 800,000 acre-ft (see station 11042800). Pumping upstream from station for irrigation. Rancho California Water District can discharge into creek, approximately 0.1 mi upstream, to supplement low flow. Varying amounts of backwater caused by beaver dams at times during low-flow periods. See schematic diagram of Santa Margarita River Basin.

EXTREMES FOR PERIOD OF RECORD.-Maximum discharge, 25,000 ft^3/s, Jan. 16, 1993, gage height, 17.24 ft, on basis of slope-area measurement of peak flow; no flow for many days 1989-93.

EXTREMES FOR CURRENT YEAR.-Peak discharges greater than base discharge of 150 ft^3/s, or maximum, from rating curve extended above 6,430 ft^3/s on basis of slope-area measurement of peak flow:

Date	Time	Discharge (ft^3/s)	Gage height (ft)	Date	Time	Discharge (ft^3/s)	Gage height (ft)
Jan. 26	1330	239	4.05	Feb. 4	1930	207	4.03

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2.7	e.50	e2.7	.20	.95	e1.7	4.5	e1.9	2.9	e2.6	2.1	3.5
2	2.7	e.50	1.9	.20	1.6	e1.9	6.9	e1.7	5.0	2.1	2.0	3.6
3	2.7	e.50	2.1	.20	1.4	1.1	e3.4	e2.6	1.1	2.4	2.3	2.9
4	2.7	e.50	3.6	e.21	30	1.1	e7.4	e3.9	1.2	2.3	1.9	2.7
5	2.7	e.50	10	.20	e9.0	1.1	e3.1	e8.1	1.4	2.0	2.6	2.4
6	2.8	e.60	15	.20	3.4	1.2	e2.7	8.0	1.4	2.0	3.0	2.6
7	3.0	e.60	5.1	.21	3.0	1.7	e42	7.6	1.7	2.1	2.9	3.0
8	3.1	6.5	4.1	.21	1.8	2.1	e7.6	3.6	1.9	7.8	3.3	2.5
9	3.3	1.7	4.1	.25	1.9	e1.8	e5.0	3.1	2.1	2.0	3.3	3.3
10	e3.3	.33	3.3	.29	e5.0	e2.0	e2.6	e2.4	2.2	.94	2.7	3.5
11	e3.2	.30	e3.2	.33	2.2	e1.8	e2.0	e2.2	2.2	1.3	3.3	3.6
12	e3.2	.71	e2.3	.33	1.9	e2.5	e61	e3.0	2.2	1.9	3.8	3.7
13	e2.7	.23	e1.6	.33	1.7	e1.7	e14	4.6	2.2	2.6	3.3	2.9
14	2.5	.45	e1.4	.36	1.5	e2.0	e5.5	5.9	2.2	2.2	e2.5	2.5
15	2.9	.62	e1.0	.43	1.1	7.3	e3.5	5.5	2.4	2.4	e2.1	2.1
16	2.9	.69	e1.0	.43	1.0	1.2	e2.1	5.5	2.5	2.5	4.9	2.4
17	2.9	1.1	e1.0	.53	.94	1.7	e1.8	4.4	2.9	2.1	3.2	2.6
18	e2.5	1.1	1.0	.56	1.2	e2.0	e1.0	3.7	2.4	2.1	1.9	2.8
19	e2.6	.90	1.3	.56	1.1	e1.9	e3.8	3.1	2.4	2.5	2.5	2.3
20	e2.5	.89	4.7	.90	1.1	e4.5	e3.9	2.9	2.4	2.8	2.7	1.6
21	2.5	1.1	1.4	.96	1.2	e4.2	e2.1	2.9	2.0	2.5	2.1	1.7
22	2.2	1.2	.21	e.90	1.4	e6.7	e2.7	2.9	1.4	2.6	1.9	1.7
23	2.8	.98	.21	e.90	1.5	e5.0	e1.7	3.0	1.4	2.7	2.1	2.0
24	2.9	.92	.21	e1.2	2.0	3.8	e2.6	3.0	1.4	2.8	2.6	2.1
25	2.9	1.1	.21	13	3.0	4.5	e1.7	3.0	e1.1	3.4	3.0	2.2
26	3.0	.83	.21	39	e2.0	6.1	e1.4	2.9	e1.2	2.9	2.9	2.2
27	2.2	.60	.21	9.8	e1.9	5.4	e1.6	2.9	e1.2	2.4	3.3	2.3
28	e.50	51	.21	3.8	e1.5	4.7	e1.5	2.9	e1.3	2.5	3.2	2.3
29	e.50	30	.20	1.4	---	4.1	e1.4	2.9	e1.2	1.6	2.3	2.2
30	e.60	3.9	.20	1.1	---	3.8	e1.6	2.9	e2.0	1.9	2.2	1.6
31	e.60	---	.20	6.3	---	3.0	---	3.0	---	2.2	3.1	---
TOTAL	77.60	110.85	73.87	85.29	86.29	93.6	202.1	116.0	58.9	76.14	85.0	76.8
MEAN	2.50	3.69	2.38	2.75	3.08	3.02	6.74	3.74	1.96	2.46	2.74	2.56
MAX	3.3	51	15	39	30	7.3	61	8.1	5.0	7.8	4.9	3.7
MIN	.50	.23	.20	.20	.94	1.1	1.0	1.7	1.1	.94	1.9	1.6

AC-FT	154	220	147	169	171	186	401	230.	117	151	169	152

e Estimated.

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1931 - 1973, BY WATER YEAR (WY)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	.58	2.57	7.27	18.2	36.5	32.0	7.85	.92	.55	.41	.40	.65
MAX	1.87	47.3										

USGS

1999 California Hydrologic Data Report

11044800 DE LUZ CREEK NEAR DE LUZ, CA

LOCATION.-Lat 33°25'11", long 117°19'15", in SW 1/4 SE 1/4 sec.5, T.9 S., R.4 W., San Diego County, Hydrologic Unit 18070302, on left bank, 4.85 mi upstream from mouth, and 1.2 mi south of De Luz.

DRAINAGE AREA.-33.0 mi^2.

PERIOD OF RECORD.-October 1992 to current year.

GAGE.-Water-stage recorder, concrete control, and crest-stage gage. Elevation of gage is 270 ft above sea level, from topographic map. February 1951 to September 1965 and October 1989 to September 1991, at site 4.2 mi downstream (published as 11044900, De Luz Creek near Fallbrook).

REMARKS.-Records poor. No regulation or diversion upstream from station. See schematic diagram of Santa Margarita River Basin.

EXTREMES FOR PERIOD OF RECORD.-Maximum discharge, 9,700 ft^3/s, Jan. 16, 1993, gage height, 15.13 ft, on basis of flow-over-road computation; no flow at times in some years.

EXTREMES FOR CURRENT YEAR.-Peak discharges greater than base discharge of 100 ft^3/s, or maximum, from rating curve extended above 385 ft^3/s on basis of flow-over-road computation:

Date	Time	Discharge (ft^3/s)	Gage height (ft)	Date	Time	Discharge (ft^3/s)	Gage height (ft)
Jan. 26	unknown	unknown	unknown				

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	e.70	e2.5	6.3	e2.4	e3.9	e2.5	e8.0	e2.1	e.90	.00	.00	.00
2	e.69	e2.0	4.6	e2.3	e3.7	e2.4	e5.6	e1.8	e1.9	.00	.00	.00
3	e.69	e1.7	2.2	e2.2	e3.6	e2.4	e6.2	e1.6	1.6	.00	.00	.00
4	e.69	1.6	2.4	e2.1	e6.3	e2.3	e5.7	1.8	1.6	.00	.00	.00
5	e.68	1.4	3.9	e2.0	e5.0	e2.4	e3.9	1.5	1.6	.00	.00	.00
6	e.68	1.3	8.7	e2.1	e4.3	e2.3	e3.0	.94	1.2	.00	.00	.00
7	e.68	1.2	4.5	e2.2	e4.0	e2.5	e7.0	1.0	.62	.00	.00	.00
8	e.70	7.0	4.1	e2.2	e3.7	e2.3	e5.0	1.4	.58	.00	.00	.00
9	e.72	2.8	4.2	e2.1	e3.6	e2.2	e4.4	1.7	.62	.00	.00	.00
10	e.74	2.9	3.0	e2.0	4.2	e2.4	e3.8	1.7	.54	.00	.00	.00
11	e.76	4.4	4.1	e2.0	3.7	e2.9	e3.5	1.5	.52	.00	.00	.00
12	e.78	4.3	2.8	e1.9	3.3	e2.8	e10	.98	.44	.00	.00	.00
13	e.80	4.2	2.5	e2.0	3.3	e2.5	e7.2	1.1	.42	.00	.00	.00
14	e.82	3.5	3.2	e2.0	3.0	e2.2	e5.9	1.1	.55	.00	.00	.00
15	.83	e3.1	2.7	e1.9	2.6	e4.5	e4.4	.94	.39	.00	.00	.00
16	.82	e2.9	2.4	e1.8	e2.5	e3.9	e4.0	.79	.45	.00	.00	.00
17	.77	e2.9	2.0	e1.9	e3.0	e3.6	e3.6	.97	.15	.00	.00	.00
18	.85	e2.7	2.0	e1.9	e2.9	e3.4	e3.4	1.0	.20	.00	.00	.00
19	.85	e2.5	2.9	e2.0	e2.9	e3.1	e4.2	.77	.21	.00	.00	.00
20	.91	e2.4	3.9	e5.0	e2.8	e3.0	e3.9	.78	.31	.00	.00	.00
21	e.90	e2.2	4.0	e4.6	e2.6	e2.8	e3.6	e.78	.40	.00	.00	.00
22	e.88	e2.1	3.4	e3.7	e2.6	e2.6	e3.2	e.75	.31	.00	.00	.00
23	e.88	e2.0	3.7	e3.2	e2.5	e2.5	e3.0	e.70	.25	.00	.00	.00
24	e.87	e1.9	3.4	e3.0	e2.4	e2.5	e3.0	e.65	.13	.00	.00	.00
25	e.85	e1.8	2.9	e7.0	e2.5	e3.0	e2.8	e.61	.04	.00	.00	.00
26	e.89	e1.6	e2.7	e15	e2.5	e2.9	e2.7	e.59	.00	.00	.00	.00
27	e.95	7.6	e2.7	e11	e2.4	e2.6	e2.6	e.57	.00	.00	.00	.00
28	e1.2	11	e2.6	e8.0	e2.5	e2.5	e2.5	e.56	.00	.00	.00	.00
29	e1.5	8.6	e2.5	e6.1	---	e2.3	e2.6	e.53	.00	.00	.00	.00
30	e2.2	6.6	e2.3	e3.8	---	e2.4	e2.3	e.48	.00	.00	.00	.00
31	e2.1	---	e2.2	e4.9	---	e2.4	---	e.50	---	.00	.00	---
TOTAL	28.38	102.7	104.8	114.3	92.3	84.1	131.0	32.19	15.93	0.00	0.00	0.00
MEAN	.92	3.42	3.38	3.69	3.30	2.71	4.37	1.04	.53	.000	.000	.000
MAX	2.2	11	8.7	15	6.3	4.5	10	2.1	1.9	.00	.00	.00
MIN	.68	1.2	2.0	1.8	2.4	2.2	2.3	.48	.00	.00	.00	.00
AC-FT	56	204	208	227	183	167	260	64	32	.00	.00	.00

e Estimated.

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1993 - 1999, BY WATER YEAR (WY)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	.42	1.14	3.27	79.1	83.1	44.7	14.5	8.96	3.62	1.34	.54	.22
MAX	1.07	3.42	10.1	365	252	189	37.2	37.0	10.2	5.01	2.38	.84
(WY)	1993	1999	1997	1993	1998	1995	1998	1998	1998	1998	1998	1998
MIN	.000	.000	.33	1.56	3.30	2.71	2.31	.71	.12	.000	.000	.000
(WY)	1995	1995	1995	1994	1999	1999	1997	1997	1997	1996	1994	1994

SUMMARY STATISTICS	FOR 1998 CALENDAR YEAR	FOR 1999 WATER YEAR	WATER YEARS 1993 - 1999
ANNUAL TOTAL	11989.88	705.70	

USGS

1999 California Hydrologic Data Report

11042800 WARM SPRINGS CREEK NEAR MURRIETA, CA

LOCATION.-Lat 33°31'56", long 117°10'34", in Temecula Grant, Riverside County, Hydrologic Unit 18070302, on left bank, at upstream end of Jefferson Road Bridge, 0.6 mi upstream from mouth, and 2.8 mi southeast of Murrieta.

DRAINAGE AREA.-55.4 mi^2.

PERIOD OF RECORD.-October 1987 to Nov. 4, 1991, June 11, 1992, to current year.

GAGE.-Water-stage recorder. Elevation of gage is 1,040 ft above sea level, from topographic map.

REMARKS.-Records fair except for estimated daily discharges, which are poor. Rancho California Water District can discharge into creek from automated pump, approximately 0.1 mi upstream from station. Beginning in water year 1999, flows partly regulated by East Side Reservoir, capacity, 800,000 acre-ft. East Side Reservoir is used to store imported water. Construction of Eastside Reservoir, beginning in 1996, permanently rerouted 2.4 mi^2 of drainage area in Goodhart Canyon out of the Warm Springs Creek Basin and into the Santa Ana River Basin. Compensatory releases to Warm Springs Creek from East Side Reservoir may occur at times. See schematic diagram of Santa Margarita River Basin.

EXTREMES FOR PERIOD OF RECORD.-Maximum discharge, 5,570 ft^3/s, Jan. 17, 1993, gage height, 8.59 ft, from rating curve extended above 2,190 ft^3/s; no flow for many days each year.

EXTREMES FOR CURRENT YEAR.-Peak discharges greater than base discharge of 50 ft^3/s, or maximum, from rating curve extended as explained above:

Date	Time	Discharge (ft^3/s)	Gage height (ft)	Date	Time	Discharge (ft^3/s)	Gage height (ft)
Apr. 7	1400	44	4.34				

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.09	.00	.00	.00	.37	.00	.00	.00	.07	.00
2	.00	.00	.00	.00	.00	.00	.06	.00	.44	.00	.00	.00
3	.00	.00	.02	.00	.01	.00	.01	3.0	.00	.00	.00	.00
4	.00	.00	1.2	.00	2.4	.00	.00	.00	.14	.12	.00	.00
5	.00	.00	2.7	.07	.16	.00	.00	.00	.00	.00	.00	.00
6	.00	.00	e2.5	.38	.00	.00	4.6	.20	.00	.00	.00	.00
7	.00	.00	e1.5	.20	.11	.00	13	.00	.11	.00	.00	.00
8	.00	.07	e1.0	.04	.01	.00	.11	.06	.00	.80	.00	.00
9	.00	.00	e.80	.00	.03	.00	.09	.00	.00	.00	.00	.00
10	.40	.00	e.50	.00	.00	.00	.00	.00	.25	.00	.00	.00
11	.00	.01	e.30	.00	.00	.00	.14	.00	.00	.00	.00	.00
12	.00	.00	e.20	.00	.00	.01	9.4	.00	.00	.12	.00	.00
13	.00	.00	e.25	.15	.00	.00	.92	.00	.00	.00	.00	.01
14	.00	.11	e.40	.00	.00	.00	.50	.00	.00	.00	4.6	.00
15	.00	.01	e2.5	.02	.00	.02	.37	.03	.00	.00	8.0	.00
16	.00	.00	1.1	.00	.00	.00	.14	.26	.06	.00	.04	.00
17	.00	.00	.94	.00	.02	.00	1.5	.00	.00	.00	.00	.00
18	.00	.00	.80	.00	.00	.00	11	.00	.00	.00	.02	.00
19	.00	.00	.92	.00	.00	.00	6.0	.00	.00	.00	.00	.00
20	.00	.00	.01	.00	.00	.00	.03	.00	.00	.00	.00	.00
21	.00	.00	.50	.00	.00	.00	.00	.00	.00	.00	.00	.00
22	.00	.00	1.1	.00	.00	.00	.00	.00	.00	.00	.00	.00
23	.00	.00	1.3	.00	.13	.00	.00	.00	.06	.00	.00	.00
24	.00	.00	.87	.00	.35	.00	.00	.00	.00	.00	.00	.00
25	.00	.00	.01	.00	.02	.00	.00	.00	.00	.00	.00	.00
26	.00	.00	.00	3.3	.00	.00	2.2	.00	.09	.00	.00	.00
27	.00	.17	.00	3.6	.00	.00	.07	.00	.00	.00	.00	.00
28	.00	1.8	.00	.04	.00	.00	.00	.00	.00	.00	.00	.04
29	.00	.80	.02	.00	---	.00	1.6	.00	.00	.00	.00	.00
30	.00	.94	.01	.00	---	.00	.04	.00	.00	.00	.00	.00
31	.00	---	.00	.01	---	.17	---	.00	---	.00	.00	---
TOTAL	0.40	3.91	21.54	7.81	3.24	0.20	52.15	3.55	1.15	1.04	12.73	0.05
MEAN	.013	.13	.69	.25	.12	.006	1.74	.11	.038	.034	.41	.002
MAX	.40	1.8	2.7	3.6	2.4	.17	13	3.0	.44	.80	8.0	.04
MIN	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
AC-FT	.8	7.8	43	15	6.4	.4	103	7.0	2.3	2.1	25	.1

e Estimated.

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1988 - 1999, BY WATER YEAR (WY)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	.074	.14	.62	23.6	21.2	12.1	.98	.47	.27	.067	.034	.008
MAX	.46	.68	2.27	226	116	74.0	6.19	2.99	2.93	.71	.41	.091
(WY)	1993	1997	1993	1993	1998	1991	1998	1998	1998	1998	1999	1997
MIN	.000											

Study of Nutrients and Freshwater within the Santa Margarita River Watershed -

Regional Board staff utilized all the funding which was provided for this study. A considerable amount of additional funding was also supplied by the Regional Board to have all the chemical analyses performed. The literature review portion of the study was done in 1996, whereas the extensive field sampling was conducted throughout the winter, spring and summer of 1997. Staff continues to work on a comprehensive report for this project.

In summary, nearly all the water samples which were collected throughout the watershed, exceeded the numerical nutrient objectives specified within the Water Quality Control Plan for the San Diego Basin (9) (Basin Plan). The Basin Plan specifies that nutrient concentrations in flowing waters should not exceed 0.1 mg/L total phosphate phosphorus nor 1.0 mg/L total nitrogen, more than ten percent of time.

Although the nutrient concentrations clearly exceeded the existing numerical objectives, the impact of these exceedences on the WARM and WILD beneficial uses of the streams is less certain. Filamentous algal growth was found to be quite extensive in all areas where there was sufficient sunlight and non-erosive stream velocities. However, the large algal mats did have as dramatic an effect on dissolved oxygen concentrations as we had expected. During the active growing phase of the algae, pre-dawn dissolved oxygen concentrations were never measured at injurious levels in any area where there was a visible velocity. Also, the expected autumn die-off, and BOD-loading from decaying algae, did not occur. Instead, the algal mats were replaced by cattails and other emergent vegetation as the growing season progressed. The algae mats, and later the emergent vegetation, did create some significant physical restriction to the movement and areas of inhabitation by fish and other larger aquatic life. We have not yet evaluated how seriously this physical restriction impacts the streams.

In some isolated backwater areas of the major streams and the estuary, algal growth did have a serious effect on the dissolved oxygen levels and the aquatic life. The most easterly portion of the estuary was also found to be significantly impacted by non-seasonal freshwater. Nearly all the adverse freshwater and nutrient impacts to the eastern portion of the estuary appear to be related to the discharge from a nearby sewage treatment plant. The Regional Board has issued the U.S. Marine Corps Base, Camp Pendleton, a Cease and Desist Order to either terminate the wastewater discharge or bring it into compliance with receiving water objectives. The base intends to terminate the discharge.

Santa Margarita River Watershed

Draft 1997 Water Quality Study

BY
SAN DIEGO REGIONAL WATER QUALITY CONTROL BOARD
1998

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Introduction

This study investigates the water quality within the Santa Margarita River watershed. The Santa Margarita River is formed by the confluence of Temecula and Murrieta Creeks. Pechanga, Arroyo Seco, Smith, Lancaster and Chihuahua Creeks together with numerous smaller streams are tributary to Temecula Creek; and Warm Springs and Santa Gertrudis Creeks are principal contributors to flow in Murrieta Creek. At the confluence of the Temecula and Murrieta Creeks, the surface waters travel a journey of about 30 miles before reaching the Pacific Ocean. Along the way, Sandia, DeLuz, Rainbow and Fallbrook Creeks together with numerous smaller streams flow into the Santa Margarita River.

Wastewater effluent, sewage discharge, and agricultural runoff have resulted in high concentrations of nutrients (e.g., nitrogen and phosphorus) entering the Santa Margarita River and Santa Margarita River Estuary. There is an especially high nutrient loading from Rainbow Creek, a tributary to the Santa Margarita River. The nutrient loading from Rainbow Creek results in a measurable increase in nutrient levels within that portion of the Santa Margarita River downstream of Rainbow Creek. Nutrients are of special concern due to their stimulatory effects on macroalgae within the Santa Margarita River Estuary. Macroalgal biomass hasbeen a nuisance problem at the Santa Margarita River Estuary during the summer. The decomposition of the macroalgal biomass during the fall season causes water quality concerns when dissolved oxygen within the water column drops to low levels. The low dissolved oxygen levels results in fish and invertebrate mortalities.

Typically, the Santa Margarita River Estuary is shallow and dominated by marine water throughout the dry season and freshwater during periods of substantial precipitation (November through March). In addition, there is release of reclaimed water effluent from several wastewater treatment plants which discharge to the river. Several wastewater treatment plants within U.S.M.C. Base, Camp Pendleton ultimately discharge to the Santa Margarita River (See Figure 10). These discharges are regulated by the San Diego Regional Water Quality Control Board through NPDES permits.

need to separate (background general info) from watershed specific (data driven info)

type stuff on something

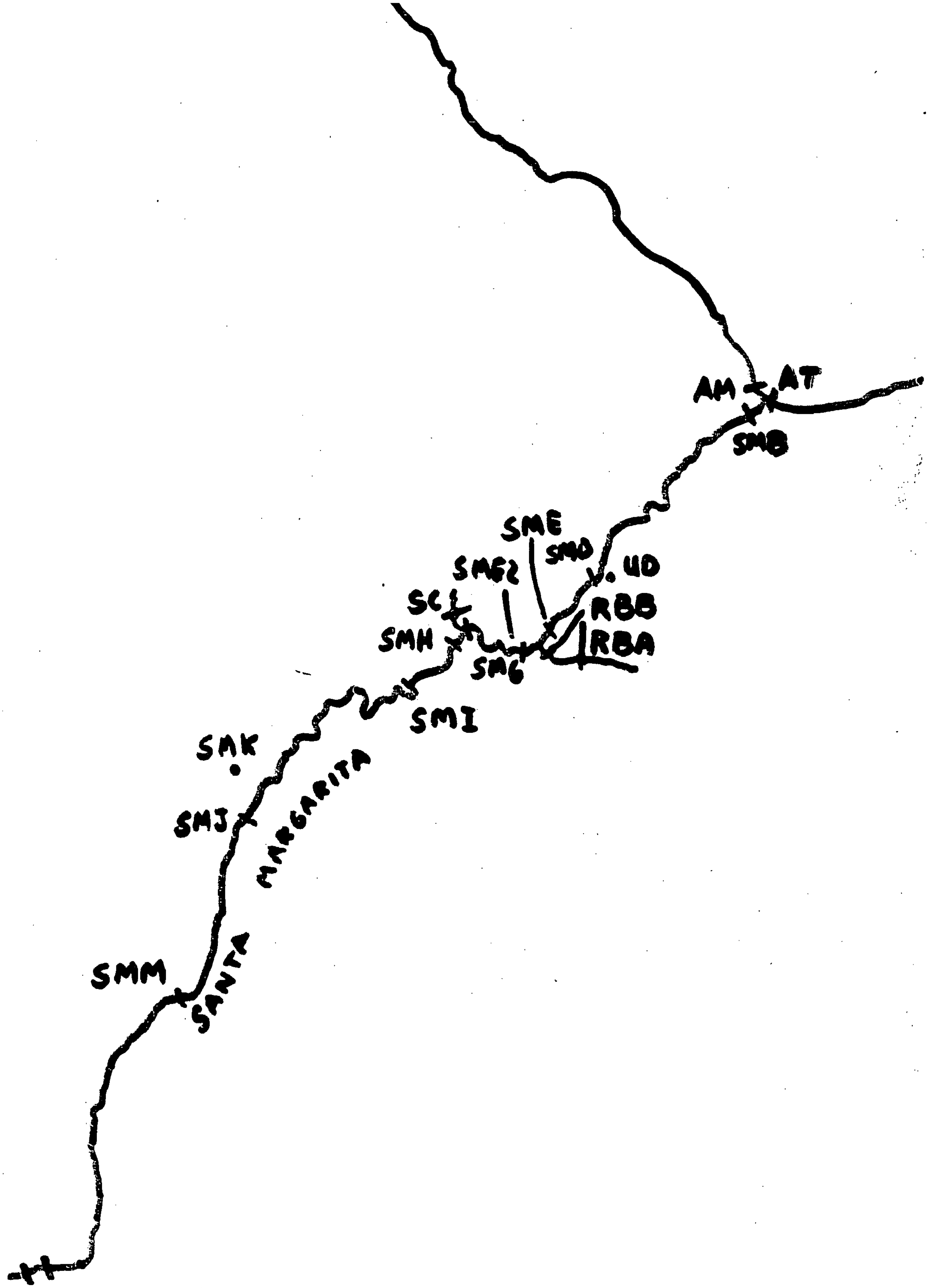
need to add all data including Sep/Oct stuff

Water Quality Monitoring Stations

The Santa Margarita River Watershed was sampled for nutrients from late February through June 1997 and on June 9, 1998. Sampling began upstream at the confluence of Murietta and Temecula Creek and proceeded downstream to the mouth of Santa Margarita River at the Pacific Ocean. During 1997, twenty-six stations were sampled and during June 1998 nine stations were sampled as identified in the figure below:

Figure 1. Santa Margarita River Watershed Water Quality Monitoring Stations From February Through June 1997 and on June 9, 1998.

	1997 Station	1998 Station	Waterbody Sampled	Flows to Station
1		DFG-978-318 MC-WB	Murrietta Creek	AM...
2	**AM**	DFG-978-319 MC-GS	Murrietta Creek	SMB...
3	**AT**	DFG-978-320 TC-I15	Temecula Creek	SMB...
4	**SMB**		Santa Margarita River	SMD...
5	**UD**		Unnamed tributary	SMD...
6	**SMD**	DFG-978-322 SMR-WGR	Santa Margarita River	SME...
7	**SME**		Santa Margarita River	SME2...
8	**RBA**	DFG-978-321 RC-WGR	Rainbow Creek	RBB, SME2...
9	**RBB**		Rainbow Creek	SME2...
10	**SME2**		Santa Margarita River	SMG...
11	**SMG**	DFG-978-323 SMR-SCD	Santa Margarita River	SMH...
12	**SC**	DFG-978-324 SC-SCR	Sandia Creek	SMH...
13	**SMH**		Santa Margarita	SHI...
14	**DLC**		De Luz Creek	SMK...
15	**SMK**		De Luz Creek	SMJ...
16	**SMI**		Santa Margarita	SMJ...
17	**SMJ**		Santa Margarita	SML...
18	**SML**	DFG-978-325 SMR-CP	Santa Margarita	SMM...
19	**FB**		Santa Margarita	SMM...
20	**SMM**		Santa Margarita	SMO...
21	**SMO**	DFG-978-326 SMR-SMB	Santa Margarita	RR, SP...
22	**RR**		Santa Margarita	Pacific Ocean
23	**SP**		Santa Margarita	Pacific Ocean
24	**DUNE**		Santa Margarita	Pacific Ocean
25	**BS**		Santa Margarita	Pacific Ocean
26	**F3**		Santa Margarita	Pacific Ocean
27	**L2**		Santa Margarita	Pacific Ocean


AM
AT
SMB
SME
SMD
UD
SMF2
SC
RBB
RBA
SMH
SMG
SMI
SMK
SMJ
MARGARITA
SANTA
SMM

Methods

Water samples were collected from the sampling stations in polyethylene containers and immediately placed in a cooled ice chests with blue ice. Samples were transported by vehicle to Environmental Engineering Laboratory in Point Loma by 17:00 hours of the same day for analysis.

Results

See Appendices.

Discussion

Total Nitrogen

The Basin Plan objective for nitrogen are such that levels shall be maintained below those which stimulate algae and emergent plant growth. The Basin Plans states that a desired goal is 0.1 mg/L total phosphorus in streams, and a ratio of N:P of 10:1 shall be used when data is lacking. This translates to a desired goal of 1 mg/L nitrate nitrogen or 4.5 mg/L nitrate ion. ***Check this?***

The highest total nitrogen for water samples collected within the Santa Margarita River watershed include stations within Santa Margarita River Estuary (Stations SP, L2, BS, DUNE and F3) and Rainbow Creek (Stations RBB and RBA). These stations had average total nitrogen levels above 10 mg/L. Next, Santa Margarita River Estuary (Station RR), Sandia Creek (Station SC), Fallbrook Creek (Station FB), and the Santa Margarita River (Stations SMH and SMD) had average total nitrogen levels between 5 and 10 mg/L. Santa Margarita River (Stations SMI, SME2, SME, SMG, SML and SMJ) and Temecula Creek (Station AT) had average total nitrogen levels between 3 and 5 mg/L. Santa Margarita River (Stations SMO, SMB, SMP and SMM), DeLuz Creek (Station DLC), Murrieta Creek (Station AM) and the Unnamed Creek (Station UD) had average total nitrogen levels below 3 mg/L. In general, both nitrate and total nitrogen usually followed a similar trend for stations with low to moderate total nitrogen. Both nitrate and total nitrogen generally increased from February to March 1997, peaked in late March then gradually fell from April through June. The nitrate and total nitrogen levels for stations with the high levels of these nutrients were very erratic. At stations with high nutrient input, the discrete input of nitrate and/or total nitrogen seemed to overwhelm any cyclical trend.

On March 28, 1997 an elevated level of total nitrogen was detected in several of the water samples collected within the Santa Margarita River watershed. The spike in total nitrogen levels was detected in the unnamed tributary to the Santa Margarita River (Station UD) and also downstream within the Santa Margarita River (Stations SMD, SME, SMG, SMH and SMI). Interestingly, sampling did not detect a concurrent elevation of nitrate level at these same stations on that day.

However, it was noted that on March 28, 1997 that the total nitrogen at Rainbow Creek (Station RBB) dropped to 2 mg/L from an average of 13 ug/L. It is unclear why total nitrogen at Rainbow Creek (Stations RBB and RBA) dropped and why total nitrogen spiked at certain other stations (e.g., Stations SME, SMD, SMG and DLC). It is unclear if there a relationship between the drop at one place and spike in total nitrogen at another? Also it is unclear why total nitrogen spiked at certain stations while nitrate levels appeared to remain constant?

? organic release from UD?
was there an increase in TP at same time?
Did NH_4 increase?
(sloughing of algal material from streambed?)

Figure 2. Total Nitrogen Levels (in Mg/L) Measured at Various Stations within the Santa Margarita River Watershed during 1997.

STATION	2/28	3/6	3/14	3/21	3/28	4/4	4/10	4/22	5/7	5/15	5/22	6/12	6/25	AVG	STD DEV	MAX
SMM	1.49	2.23	3.49	2.51	0.89	2.35	1.41	1.69	1.43	1.61	0.95		0.84	1.74	0.78	3.49
SMP	1.81													1.81		
UD		0.76	1.61	1.81	4.60	1.71				2.11	1.86	2.11		2.07	1.11	4.60
AM	1.93	0.80	2.07	3.71	1.06	2.72	2.82	2.41	3.6	1.89	1.91	2.04	1.18	2.16	0.89	3.71
DLC				2.91	5.16	2.91	2.21	1.23				0.86		2.54	1.54	5.16
SMB	2.83	2.18	3.2	3.49	2.00	3.59	2.82	2.51	3.32	2.07	2.06	2.46	1.73	2.63	0.62	3.59
SMO	1.32	2.81	1.43	2.59		1.32	1.31	1.35	3.62	5.22	5.70	6.26		2.99	1.93	6.26
AT	3.78	2.25	3.61	3.71	2.23	3.56	4.15	3.4	3.16	3.46	2.86	2.91	2.63	3.21	0.60	4.15
SMJ	6.49	3.85	5.12	5.26	3.13	4.95	4.01	2.71	1.96	2.38	2.16	0.97	0.21	3.32	1.83	6.49
SML	4.30	3.21	4.35	4.01	5.90	4.15	3.31	2.50	1.86	1.83	1.35			3.34	1.37	5.90
SMG	6.07	3.80	5.56	5.68	8.34	5.13	4.19	3.23	2.66	2.70	3.82	2.72	0.31	4.17	2.02	8.34
SME	4.14	3.01		4.19	16.54	4.56	3.01	2.35	2.52	2.49	2.13	2.30	3.26	4.20	3.97	16.54
SME2			7.19	7.1			5.34	3.59	3.65	3.58	4.72	3.86	1.89	4.54	1.75	7.19
SMI	6.4	4.67	6.36	6.6	7.95	5.62	5.33	3.80	3.16	3.23	2.99	2.73	2.02	4.68	1.84	7.95
SMD	3.36	3.51	5.13	4.22	14.26	4.11				2.46				5.29	4.04	14.26
SMH	6.57	4.91	6.56	6.5	8.32									6.57	1.21	8.32
FB	6.79	8.09	8.28	8.57	9.48	8.21	8.87	7.57	6.89	8.10	6.96	6.19	5.88	7.53	1.15	9.48
SC	8.36	6.76	8.55	8.81	9.74	7.91	8.71	7.68	7.09	7.38	7.06	5.89	5.12	7.62	1.27	9.74
RR		7.39	1.37	7.17		9.85	6.64	4.75	17.42					7.80	4.99	17.42
RBA	13.63	8.71	14.66	14.12	9.14	16.37	12.24	8.84	6.21	3.52	20.16	3.02	2.47	10.24	5.52	20.16
RBB	14.19	10.59	15.23	14.61	2.36	14.46	14.81	15.13	12.59	13.77	16.54	15.29	15.26	13.45	3.64	16.54
F3			0.80	17.71				16.59	19.44			22.83		15.47	8.54	22.83
DUNE				12.5					18.64					15.57	4.34	18.64
BS				18.21					17.92					18.06	0.21	18.21
L2												22.64		22.64		22.64
SP	87.20													87.20		

(10 mg/L as nitrogen) NO_3-N

Nitrates (NO^-_3)

Nitrates are the final product of the biochemical oxidation of ammonia. The natural level of ammonia or nitrate in surface water is typically less than 1 mg/L. A level of nitrate greater than 3 mg/L indicates man made runoff sources (e.g., fertilizer, human or animal waste). The maximum contaminant level (MCL) for the nitrate ion is 45 mg/L for surface waters. Waters containing nitrate (NO^-_3) concentrations exceeding 45 mg/L are generally unsuitable for domestic or municipal use.

Historical data shows nitrates elevated in surface waters of Fallbrook Creek and ground waters of Rainbow Basin during the 1950's (DWR, 1956) [1] [2]. During 1997 sampling, the highest nitrate levels include stations within Santa Margarita River Estuary (Stations L2, BS, DUNE and F3) and Rainbow Creek (Stations RBA and RBB) which have average nitrate levels between 9 and 22 mg/L. Sandia Creek (Stations SC), Santa Margarita River Estuary by Interstate 5 (Station RR), Fallbrook Creek (Station FB) and the Santa Margarita below confluence of Rainbow Creek (Station SMH) had levels between 5 and 9 mg/L. Stations SMD, SMI, SME2, SMG, SME, SML and SMJ had levels between 3.1 and 5 mg/L. Temecula Creek (Station AT), Santa Margarita River at Basilone Bridge (Station SMO), Santa Margarita River at the confluence of Temecula and Murrieta Creeks (Station SMB), DeLuz Creek (Station DLC), Murrieta Creek (Station AM), SMM and the Unnamed tributary (Station UD) ~~respective~~ly generally had nitrate levels below 3.1 mg/L.

[1] *Analyses of surface waters within the watershed were investigated in the 1950's including: Cole Canyon Creek, Murrieta Creek, Santa Gertrudis Creek, Warm Springs Creek, Coahuila Creek, Lancaster Creek, Wilson Creek, Arroyo Seco Creek, Chihuahua Creek, Temecula Creek, DeLuz Creek, and the Santa Margarita River. These surface waters had nitrate levels ranging from 1 to 7 ppm. Fallbrook Creek was sampled in 1954 and had a nitrate level of 27 ppm.*

[2] *Historical data shows the nitrate level to be elevated in ground waters of Rainbow Basin as early as 1953. Ground waters from a well in the Rainbow Basin was investigated in 1953 and the nitrate level was 35 ppm.*

Station Identification & Directions to Water Quality Sampling Stations for 1998

Loma Alta Creek at College Blvd
San Diego 1987:H-6
[LAC-CB-T1] (DFG-978-300)

Buena Vista Creek at South Vista Way
San Diego 1106:G-2
[BVC-SVW-T3] (DFG-978-301)

San Luis Rey River at Foussat Road
San Diego 1086: E-4
[SLRR-FR-T1] (DFG-978-302)

Loma Alta Creek at El Camino Real
San Diego 1086: G-7
[LAC-ECR-A] (DFG-978-303)

Sweetwater River at Hwy 79 near Interstate 8
San Diego 1236: A-5
[SR-79] (DFG-978-304)

Sweetwater River upstream of Hwy 94 (Campo Road)
San Diego 1271:J-6
[SR-94] (DFG-978-305)

Sweetwater River downstream of Willow Street
San Diego 1310:F-3
[SR-WS] (DFG-978-306)

San Diego River up stream of Mission Dam
San Diego 1230:F-6
[SDR-MD] (DFG-978-307)

San Diego River at Mission Trails Regional Park
San Diego 1250:C-2
[SDR-MT] (DFG-978-308)

San Diego River ~~at River Valley golf course (Hanalei Hotel).~~ The acess at Hanalei Hotel is difficult due to the downcutting of the river, the concrete debris and trash being piled on the bank, the tangle of oleander bushes, and the attended parking lot entrance. I went a short distance upstream instead, to the Fashion Valley Road xing, where there is an area one can park at for a short while, at the entrance to the gated parking lot. Took water sample upstream of Fashion Valley Road.
San Diego 1268:H-4
~~[SDR-1]~~ [SDR-FVR] (DFG-978-309)

Los Penasquitos Creek upstream of Black Mountain Road
San Diego 1189:D-7
[LPC-BMR] (DFG-978-310)

Los Penasquitos Creek at Cobblestone Creek Road.
San Diego 1190:B-5
[LPC-CCR] (DFG-978-311)

Rattlesnake Creek at Hilleary Park, off Community Road. I parked on the street at the upstream edge of the Park near Community Road xing.
San Diego 1190:E-3
[RC-HP] (DFG-978-312)

Escondido Creek below Harmony Grove Bridge. This site has an urbanized (residential) landuse, the creek has a concrete lining and soft bottom.
[EC-HRB] (DFG-978-313)

Station Identification & Directions to Water Quality Sampling Stations for 1998

Escondido Creek at intersection Elfin Forest and Harmony Grove (end of Elfin Forest Resort). This seemed to be private property, went instead to mile marker 5.25 (midway between 5.0 and 5.5), upstream of Elfin Forest Lake. On Harmony Grove Rd., park along road where there is space. Sample along Escondido Creek.
San Diego 1148:J-2.
[EC-EF] (DFG-978-314)

Encinitas Creek at Green Valley Road.
Park on El Camino Real near La Costa Avenue. Park at the turnout on west side of El Camino Real, south of La Costa Avenue where there is a small parking lot adjacent to a building. (The Green Valley Road is under construction, and there is no safe place to park there.)
~~[EC-GVR]~~ [EC-LCA] (DFG-978-315)

San Marcos Creek at Rancho Santa Fe Road
San Diego 1128:A-6
[SMC-RSFR] (DFG-978-316)

San Marcos Creek at McMahr, Carlsbad drainage
San Diego 1128:E-2
[SMC-M] (DFG-978-317)

I-15 North to Clinton Keith Rd west
Past Palomar St (Washington St) . Murrieta Ck is just after this, but continue to to Calle Del Oso Oro Rd, Make a left, sample at bridge xing on Murrieta Creek.
-Murrieta Creek at Calle Del Oso Rd. This is **new station** for 1998.
Riverside 927:F-4 [MC -WB] (DFG-978-318)
go back Clinton Keith Rd east to 15 south.

I-15 South to Rainbow Glen Rd (Hwy 79 at Rainbow Glen, south part of Temecula). Go upriver on Murrieta Ck to where you can sample, take Front St, behind cement factory
-Murrieta Ck behind cement factory. This is the same as station **AM** for 1997.
Riverside 978:J2 [MC-GS] (DFG-978-319)

Some road construction going on. Only from the cement factory you can find the dirt road behind cement roadblocks. Make an immediate left onto dirt road at yellow gate. (Key may be required). Follow dirt road at left until stream. Sample Temecula Ck.
-Temecula Ck east of confluence, west of I-15. This is the same as station **AT** for 1997.
409:D-4 [TC-I15] (DFG-978-320)

Return to I-15 and head south to Mission Rd (S13) exit. Go west (right) on Mission Rd.
Right on Margarita (it will say Willow Glen Rd, near Macadamia nut sign), Continue on Willow Glen following main road down hill. Sample when you reach Rainbow Creek bridge
- Rainbow Creek at Willow Glen Rd, upstream of metal bridge. This is the same as station **RBA** for 1997.
998:C-6 [RC-WGR] (DFG-978-321)

Continue on Willow Glen Rd
Right on Stage Coach Lane
to SMR xing
- Santa Margarita at Willow Glen Rd (Stage Coach Ln). This is the same as station **SMD** for 1997.
998:C-2 [SMR-WGR] (DFG-978-322)

Backtrack, Get back on Mission Rd (S-13) west into Fallbrook,
North (right) on Main Ave (2 blocks)
Left on View St (1 block)
Right on DeLuz Rd at junction with Sandia Ck Dr
Go (right) north on Sandia Ck Drive.
Sample at xing.
- SMR at DeLuz/ Pico Rd near Sandia Ck. This is the same as station **SMG** for 1997.
997:G-5 ~~[SMR-DP]~~ [SMR-SCD] (DFG-978-323)

Station Identification & Directions to Water Quality Sampling Stations for 1998

After bridge, curve left and go 500 ft past barbed wire fence on left of sharp right curve. Park on left in dirt turnout.
- Sandia Ck at Sandia Ck Rd, 0.5 to 1 mile above confluence This is the same as station **SC** for 1997.
997:F-4 [SC-SCR] (DFG-978-324)

Backtrack south on Sandia Ck Dr over bridge, on De Luz Rd to Mission Rd, go right. At "T" go left. There will be places to eat lunch on right of this street. (Lunch) Right on Ammunition Rd. Turn left into Naval Weapons Base entrance. (You should have called Camp Pendleton about your arrival). Directions to Water Resources Office: Drive thru Base, to reach Water Resources office: Turn left Vandegrift go up one stop Rattlesnake Cyn road , left at Base hqts , to Right on E St. next left on 14th, on top of hill Bldg 1142 Child Development Ctr. Back of last bldg tiny sign on wall.

Continue to Vandergrift. Right on Santa Margarita Rd, continue past the lake and fire station. Just before wire fence on left (before hospital) turn left onto dirt road. Then turn immediate right to road b/w diversion basin and infiltration basin. Follow road to end. Sample below wier.
-Santa Margarita River below diversion weir on Camp Pendleton. This is the same as station **SML** for 1997.
409:A-7 [SMR-CP] (DFG-978-325)

Backtrack past hospital and lake to main road, Vandergrift, make right. Drive about 15 minutes, Right on Stuart Mesa.-
SMR at Stuart Mesa Rd bridge on Camp Pendleton. This is the same as station **SMO** for 1997.
1085:H2 [SMR-SMB] (DFG-978-326)

I-15 North
S 78 West to San Marcos
exit Rancheros Drive west, near San Marcos Blvd. (There was no parking available at Santar Place, it is a Sheriff's parking lot with no stopping and no trespassing pasted all over the place) Go instead to the bridge xing at Rancheros Drive.
Park in lot by Old Spaghetti Factory, Home Town Buffet is on other side of street and City Hall is across the river.
- San Marcos Creek at Rancheros Drive xing, Carlsbad
1109:A-7 [SMC-SP] (DFG-978-329)

Backtrack, Continue on S 78 West,
South on Sycamore Ave, Right on Green Oak Rd, sample a Green Oak Rd xing
- Agua Hedionda Ck at Sycamore Ave
1108:A-5 [AHC-SA] (DFG-978-328)

Backtrack, Continue on S78 West, Escondido Ave north,
South Santa Fe Ave northwest, creek xing is all channelized with grafitti, it's scary, even the bottom is concrete. There is a chain link fence and no way into vertical cement culvert. Not a good prospect for samping and really didn't want to get stuck in there ! Go instead to East Vista Way at at Escondido Avenue. Enter Wildwood Park on East Vista Way and park in parking lot. It is on page 1087:J-6.
-Buena Vista Ck at ~~South Santa Fe Ave~~ Wildwood Park
~~1087:H-6~~ [BVR-ED] (DFG-978-327)

Backtrack, Continue on S78 West
to I-5 North
At Capistraano Beach take
Pacific Coast Hwy (S1) north,
past Three Arch Bay and South Laguna, just past Aliso Pier is Aliso Creek and Country Club Rd.
At Country Club Rd just north of creek park.
-Aliso Ck along Country Club Rd
951:B-7 [AC-CCR] (DFG-978-330)

Backtrack to Pacific Coast Hwy, South on S1
to Crown Valley Pkwy north
to Alicia Pkwy north
Right at Pacific Park Dr.
Aliso Ck at bottom
-Aliso Ck at Pacific Park Dr/ Oso Pkwy
921:F-6 [AC-PPD] (DFG-978-331)

Station Identification & Directions to Water Quality Sampling Stations for 1998

Backtrack to Alicia Pkwy south and Crown Vallley south to
Pacific Coast Hwy (S1) South to
San Diego Frwy (I-5 South)

to Tamarack East, El Camino Real south, first creek
-Agua Hedionda Ck at El Camino Real
1107:B-7 [AHC-ECR] (DFG-978-332)

Take I-15 South, Pala Rd (S 76) east
- San Luis Rey River at old Hwy 395 (Couser Canyon Rd)
1048:H-3 [SLRR-395] (DFG-978-333)

g:\watershe\monitori\spr_98\map_ins.doc

Study of Nutrients and Freshwater within the Santa Margarita River Watershed -

Regional Board staff utilized all the funding which was provided for this study. A considerable amount of additional funding was also supplied by the Regional Board to have all the chemical analyses performed. The literature review portion of the study was done in 1996, whereas the extensive field sampling was conducted throughout the winter, spring and summer of 1997. Staff continues to work on a comprehensive report for this project.

In summary, nearly all the water samples which were collected throughout the watershed, exceeded the numerical nutrient objectives specified within the Water Quality Control Plan for the San Diego Basin (9) (Basin Plan). The Basin Plan specifies that nutrient concentrations in flowing waters should not exceed 0.1 mg/L total phosphate phosphorus nor 1.0 mg/L total nitrogen, more than ten percent of time.

Although the nutrient concentrations clearly exceeded the existing numerical objectives, the impact of these exceedences on the WARM and WILD beneficial uses of the streams is less certain. Filamentous algal growth was found to be quite extensive in all areas where there was sufficient sunlight and non-erosive stream velocities. However, the large algal mats did have as dramatic an effect on dissolved oxygen concentrations as we had expected. During the active growing phase of the algae, pre-dawn dissolved oxygen concentrations were never measured at injurious levels in any area where there was a visible velocity. Also, the expected autumn die-off, and BOD-loading from decaying algae, did not occur. Instead, the algal mats were replaced by cattails and other emergent vegetation as the growing season progressed. The algae mats, and later the emergent vegetation, did create some significant physical restriction to the movement and areas of inhabitation by fish and other larger aquatic life. We have not yet evaluated how seriously this physical restriction impacts the streams.

In some isolated backwater areas of the major streams and the estuary, algal growth did have a serious effect on the dissolved oxygen levels and the aquatic life. The most easterly portion of the estuary was also found to be significantly impacted by non-seasonal freshwater. Nearly all the adverse freshwater and nutrient impacts to the eastern portion of the estuary appear to be related to the discharge from a nearby sewage treatment plant. The Regional Board has issued the U.S. Marine Corps Base, Camp Pendleton, a Cease and Desist Order to either terminate the wastewater discharge or bring it into compliance with receiving water objectives. The base intends to terminate the discharge.

Santa Margarita River Watershed

Draft 1997 Water Quality Study

BY

SAN DIEGO REGIONAL WATER QUALITY CONTROL BOARD

1998

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Introduction

This study investigates the water quality within the Santa Margarita River watershed. The Santa Margarita River is formed by the confluence of Temecula and Murrieta Creeks. Pechanga, Arroyo Seco, Smith, Lancaster and Chihuahua Creeks together with numerous smaller streams are tributary to Temecula Creek; and Warm Springs and Santa Gertrudis Creeks are principal contributors to flow in Murrieta Creek. At the confluence of the Temecula and Murrieta Creeks, the surface waters travel a journey of about 30 miles before reaching the Pacific Ocean. Along the way, Sandia, DeLuz, Rainbow and Fallbrook Creeks together with numerous smaller streams flow into the Santa Margarita River.

Wastewater effluent, sewage discharge, and agricultural runoff have resulted in high concentrations of nutrients (e.g., nitrogen and phosphorus) entering the Santa Margarita River and Santa Margarita River Estuary. There is an especially high nutrient loading from Rainbow Creek, a tributary to the Santa Margarita River. The nutrient loading from Rainbow Creek results in a measurable increase in nutrient levels within that portion of the Santa Margarita River downstream of Rainbow Creek. Nutrients are of special concern due to their stimulatory effects on macroalgae within the Santa Margarita River Estuary. Macroalgal biomass hasbeen a nuisance problem at the Santa Margarita River Estuary during the summer. The decomposition of the macroalgal biomass during the fall season causes water quality concerns when dissolved oxygen within the water column drops to low levels. The low dissolved oxygen levels results in fish and invertebrate mortalities.

Typically, the Santa Margarita River Estuary is shallow and dominated by marine water throughout the dry season and freshwater during periods of substantial precipitation (November through March). In addition, there is release of reclaimed water effluent from several wastewater treatment plants which discharge to the river. Several wastewater treatment plants within U.S.M.C. Base, Camp Pendleton ultimately discharge to the Santa Margarita River (See Figure 10). These discharges are regulated by the San Diego Regional Water Quality Control Board through NPDES permits.

need to separate (background general info) from watershed specific (dates division info)

type stuff on something

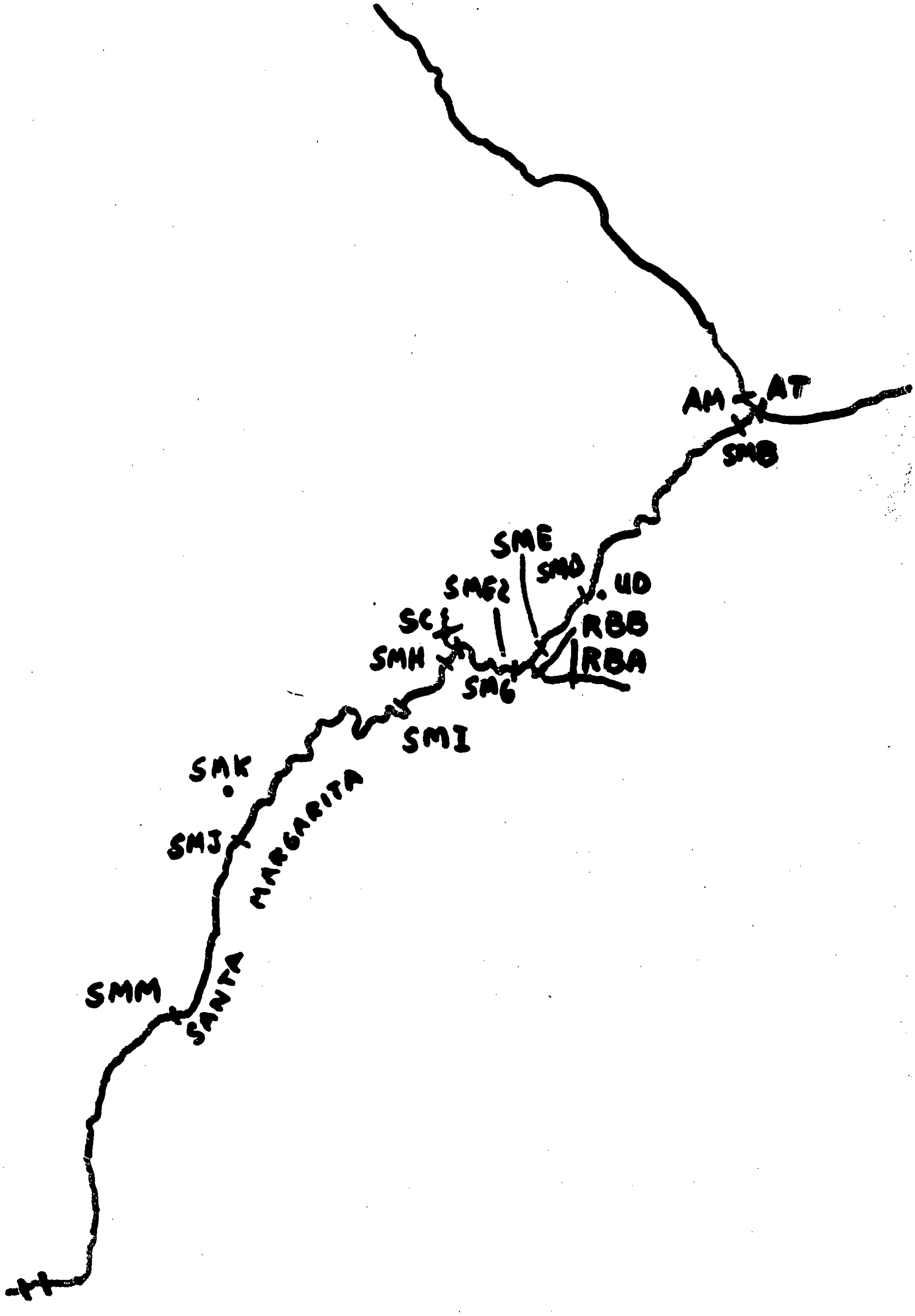
need to add all data including Sep/Oct stuff

Water Quality Monitoring Stations

The Santa Margarita River Watershed was sampled for nutrients from late February through June 1997 and on June 9, 1998. Sampling began upstream at the confluence of Murietta and Temecula Creek and proceeded downstream to the mouth of Santa Margarita River at the Pacific Ocean. During 1997, twenty-six stations were sampled and during June 1998 nine stations were sampled as identified in the figure below:

Figure 1. Santa Margarita River Watershed Water Quality Monitoring Stations From February Through June 1997 and on June 9, 1998.

	1997 STATION	1998 STATION	WATERBODY SAMPLED	FLOWS TO STATION
1		DFG-978-318 MC-WB	Murrietta Creek	AM...
2	**AM**	DFG-978-319 MC-GS	Murrietta Creek	SMB...
3	**AT**	DFG-978-320 TC-I15	Temecula Creek	SMB...
4	**SMB**		Santa Margarita River	SMD...
5	**UD**		Unnamed tributary	SMD...
6	**SMD**	DFG-978-322 SMR-WGR	Santa Margarita River	SME...
7	**SME**		Santa Margarita River	SME2...
8	**RBA**	DFG-978-321 RC-WGR	Rainbow Creek	RBB, SME2...
9	**RBB**		Rainbow Creek	SME2...
10	**SME2**		Santa Margarita River	SMG...
11	**SMG**	DFG-978-323 SMR-SCD	Santa Margarita River	SMH...
12	**SC**	DFG-978-324 SC-SCR	Sandia Creek	SMH...
13	**SMH**		Santa Margarita	SHI...
14	**DLC**		De Luz Creek	SMK...
15	**SMK**		De Luz Creek	SMJ...
16	**SMI**		Santa Margarita	SMJ...
17	**SMJ**		Santa Margarita	SML...
18	**SML**	DFG-978-325 SMR-CP	Santa Margarita	SMM...
19	**FB**		Santa Margarita	SMM...
20	**SMM**		Santa Margarita	SMO...
21	**SMO**	DFG-978-326 SMR-SMB	Santa Margarita	RR, SP...
22	**RR**		Santa Margarita	Pacific Ocean
23	**SP**		Santa Margarita	Pacific Ocean
24	**DUNE**		Santa Margarita	Pacific Ocean
25	**BS**		Santa Margarita	Pacific Ocean
26	**F3**		Santa Margarita	Pacific Ocean
27	**L2**		Santa Margarita	Pacific Ocean


AM
AT
SMB
SME
SMD
SMF2
UD
SC
RBB
SMH
RBA
SMG
SMI
SMK
SMJ
MARGARITA
SANTA
SMM

Methods

Water samples were collected from the sampling stations in polyethylene containers and immediately placed in a cooled ice chests with blue ice. Samples were transported by vehicle to Environmental Engineering Laboratory in Point Loma by 17:00 hours of the same day for analysis.

Results

See Appendices.

Discussion

Total Nitrogen

The Basin Plan objective for nitrogen are such that levels shall be maintained below those which stimulate algae and emergent plant growth. The Basin Plans states that a desired goal is 0.1 mg/L total phosphorus in streams, and a ratio of N:P of 10:1 shall be used when data is lacking. This translates to a desired goal of 1 mg/L nitrate nitrogen or 4.5 mg/L nitrate ion. ***Check this?***

The highest total nitrogen for water samples collected within the Santa Margarita River watershed include stations within Santa Margarita River Estuary (Stations SP, L2, BS, DUNE and F3) and Rainbow Creek (Stations RBB and RBA). These stations had average total nitrogen levels above 10 mg/L. Next, Santa Margarita River Estuary (Station RR), Sandia Creek (Station SC), Fallbrook Creek (Station FB), and the Santa Margarita River (Stations SMH and SMD) had average total nitrogen levels between 5 and 10 mg/L. Santa Margarita River (Stations SMI, SME2, SME, SMG, SML and SMJ) and Temecula Creek (Station AT) had average total nitrogen levels between 3 and 5 mg/L. Santa Margarita River (Stations SMO, SMB, SMP and SMM), DeLuz Creek (Station DLC), Murrieta Creek (Station AM) and the Unnamed Creek (Station UD) had average total nitrogen levels below 3 mg/L. In general, both nitrate and total nitrogen usually followed a similar trend for stations with low to moderate total nitrogen. Both nitrate and total nitrogen generally increased from February to March 1997, peaked in late March then gradually fell from April through June. The nitrate and total nitrogen levels for stations with the high levels of these nutrients were very erratic. At stations with high nutrient input, the discrete input of nitrate and/or total nitrogen seemed to overwhelm any cyclical trend.

On March 28, 1997 an elevated level of total nitrogen was detected in several of the water samples collected within the Santa Margarita River watershed. The spike in total nitrogen levels was detected in the unnamed tributary to the Santa Margarita River (Station UD) and also downstream within the Santa Margarita River (Stations SMD, SME, SMG, SMH and SMI). Interestingly, sampling did not detect a concurrent elevation of nitrate level at these same stations on that day.

However, it was noted that on March 28, 1997 that the total nitrogen at Rainbow Creek (Station RBB) dropped to 2 mg/L from an average of 13 ug/L. It is unclear why total nitrogen at Rainbow Creek (Stations RBB and RBA) dropped and why total nitrogen spiked at certain other stations (e.g., Stations SME, SMD, SMG and DLC). It is unclear if there a relationship between the drop at one place and spike in total nitrogen at another? Also it is unclear why total nitrogen spiked at certain stations while nitrate levels appeared to remain constant?

? Organic release from UD?
was there an increase in TP at same time?
Did NH_4 increase?
(sloughing of algal material from streambed?)

Figure 2. Total Nitrogen Levels (in Mg/L) Measured at Various Stations within the Santa Margarita River Watershed during 1997.

STATION	2/28	3/6	3/14	3/21	3/28	4/4	4/10	4/22	5/7	5/15	5/22	6/12	6/25	AVG	STD DEV	MAX
SMM	1.49	2.23	3.49	2.51	0.89	2.35	1.41	1.69	1.43	1.61	0.95		0.84	1.74	0.78	3.49
SMP	1.81													1.81		
UD		0.76	1.61	1.81	4.60	1.71				2.11	1.86	2.11		2.07	1.11	4.60
AM	1.93	0.80	2.07	3.71	1.06	2.72	2.82	2.41	3.6	1.89	1.91	2.04	1.18	2.16	0.89	3.71
DLC				2.91	5.16	2.91	2.21	1.23				0.86		2.54	1.54	5.16
SMB	2.83	2.18	3.2	3.49	2.00	3.59	2.82	2.51	3.32	2.07	2.06	2.46	1.73	2.63	0.62	3.59
SMO	1.32	2.81	1.43	2.59		1.32	1.31	1.35	3.62	5.22	5.70	6.26		2.99	1.93	6.26
AT	3.78	2.25	3.61	3.71	2.23	3.56	4.15	3.4	3.16	3.46	2.86	2.91	2.63	3.21	0.60	4.15
SMJ	6.49	3.85	5.12	5.26	3.13	4.95	4.01	2.71	1.96	2.38	2.16	0.97	0.21	3.32	1.83	6.49
SML	4.30	3.21	4.35	4.01	5.90	4.15	3.31	2.50	1.86	1.83	1.35			3.34	1.37	5.90
SMG	6.07	3.80	5.56	5.68	8.34	5.13	4.19	3.23	2.66	2.70	3.82	2.72	0.31	4.17	2.02	8.34
SME	4.14	3.01		4.19	16.54	4.56	3.01	2.35	2.52	2.49	2.13	2.30	3.26	4.20	3.97	16.54
SME2			7.19	7.1			5.34	3.59	3.65	3.58	4.72	3.86	1.89	4.54	1.75	7.19
SMI	6.4	4.67	6.36	6.6	7.95	5.62	5.33	3.80	3.16	3.23	2.99	2.73	2.02	4.68	1.84	7.95
SMD	3.36	3.51	5.13	4.22	14.26	4.11				2.46				5.29	4.04	14.26
SMH	6.57	4.91	6.56	6.5	8.32									6.57	1.21	8.32
FB	6.79	8.09	8.28	8.57	9.48	8.21	8.87	7.57	6.89	8.10	6.96	6.19	5.88	7.53	1.15	9.48
SC	8.36	6.76	8.55	8.81	9.74	7.91	8.71	7.68	7.09	7.38	7.06	5.89	5.12	7.62	1.27	9.74
RR		7.39	1.37	7.17		9.85	6.64	4.75	17.42					7.80	4.99	17.42
RBA	13.63	8.71	14.66	14.12	9.14	16.37	12.24	8.84	6.21	3.62	20.16	3.02	2.47	10.24	5.52	20.16
RBB	14.19	10.59	15.23	14.61	2.36	14.46	14.81	16.13	12.59	13.77	16.54	15.29	15.26	13.45	3.64	16.54
F3			0.80	17.71				16.59	19.44			22.83		15.47	8.54	22.83
DUNE				12.5					18.64					15.57	4.34	18.64
BS				18.21					17.92					18.06	0.21	18.21
L2												22.64		22.64		22.64
SP	87.20													87.20		

(10 mg/L as nitrogen) NO_3-N

Nitrates (NO^-_3)

Nitrates are the final product of the biochemical oxidation of ammonia. The natural level of ammonia or nitrate in surface water is typically less than 1 mg/L. A level of nitrate greater than 3 mg/L indicates man made runoff sources (e.g., fertilizer, human or animal waste). The maximum contaminant level (MCL) for the nitrate ion is 45 mg/L for surface waters. Waters containing nitrate (NO^-_3) concentrations exceeding 45 mg/L are generally unsuitable for domestic or municipal use.

Historical data shows nitrates elevated in surface waters of Fallbrook Creek and ground waters of Rainbow Basin during the 1950's (DWR, 1956) [1] [2]. During 1997 sampling, the highest nitrate levels include stations within Santa Margarita River Estuary (Stations L2, BS, DUNE and F3) and Rainbow Creek (Stations RBA and RBB) which have average nitrate levels between 9 and 22 mg/L. Sandia Creek (Stations SC), Santa Margarita River Estuary by Interstate 5 (Station RR), Fallbrook Creek (Station FB) and the Santa Margarita below confluence of Rainbow Creek (Station SMH) had levels between 5 and 9 mg/L. Stations SMD, SMI, SME2, SMG, SME, SML and SMJ had levels between 3.1 and 5 mg/L. Temecula Creek (Station AT), Santa Margarita River at Basilone Bridge (Station SMO), Santa Margarita River at the confluence of Temecula and Murrieta Creeks (Station SMB), DeLuz Creek (Station DLC), Murrieta Creek (Station AM), SMM and the Unnamed tributary (Station UD) ~~respective~~ly generally had nitrate levels below 3.1 mg/L.

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[1] *Analyses of surface waters within the watershed were investigated in the 1950's including: Cole Canyon Creek, Murrieta Creek, Santa Gertrudis Creek, Warm Springs Creek, Coahuila Creek, Lancaster Creek, Wilson Creek, Arroyo Seco Creek, Chihuahua Creek, Temecula Creek, DeLuz Creek, and the Santa Margarita River. These surface waters had nitrate levels ranging from 1 to 7 ppm. Fallbrook Creek was sampled in 1954 and had a nitrate level of 27 ppm.*

[2] *Historical data shows the nitrate level to be elevated in ground waters of Rainbow Basin as early as 1953. Ground waters from a well in the Rainbow Basin was investigated in 1953 and the nitrate level was 35 ppm.*

Station Identification & Directions to Water Quality Sampling Stations for 1998

Loma Alta Creek at College Blvd
San Diego 1987:H-6
[LAC-CB-T1] (DFG-978-300)

Buena Vista Creek at South Vista Way
San Diego 1106:G-2
[BVC-SVW-T3] (DFG-978-301)

San Luis Rey River at Foussat Road
San Diego 1086: E-4
[SLRR-FR-T1] (DFG-978-302)

Loma Alta Creek at El Camino Real
San Diego 1086: G-7
[LAC-ECR-A] (DFG-978-303)

Sweetwater River at Hwy 79 near Interstate 8
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[SR-79] (DFG-978-304)

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Sweetwater River downstream of Willow Street
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San Diego River up stream of Mission Dam
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[SDR-MD] (DFG-978-307)

San Diego River at Mission Trails Regional Park
San Diego 1250:C-2
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San Diego River ~~at River Valley golf course (Hanalei Hotel).~~ The acess at Hanalei Hotel is difficult due to the downcutting of the river, the concrete debris and trash being piled on the bank, the tangle of oleander bushes, and the attended parking lot entrance. I went a short distance upstream instead, to the Fashion Valley Road xing, where there is an area one can park at for a short while, at the entrance to the gated parking lot. Took water sample upstream of Fashion Valley Road.
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Los Penasquitos Creek at Cobblestone Creek Road.
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Rattlesnake Creek at Hilleary Park, off Community Road. I parked on the street at the upstream edge of the Park near Community Road xing.
San Diego 1190:E-3
[RC-HP] (DFG-978-312)

Escondido Creek below Harmony Grove Bridge. This site has an urbanized (residential) landuse, the creek has a concrete lining and soft bottom.
[EC-HRB] (DFG-978-313)

Station Identification & Directions to Water Quality Sampling Stations for 1998

Escondido Creek at intersection Elfin Forest and Harmony Grove (end of Elfin Forest Resort). This seemed to be private property, went instead to mile marker 5.25 (midway between 5.0 and 5.5), upstream of Elfin Forest Lake. On Harmony Grove Rd., park along road where there is space. Sample along Escondido Creek.
San Diego 1148:J-2.
[EC-EF] (DFG-978-314)

Encinitas Creek at Green Valley Road.
Park on El Camino Real near La Costa Avenue. Park at the turnout on west side of El Camino Real, south of La Costa Avenue where there is a small parking lot adjacent to a building. (The Green Valley Road is under construction, and there is no safe place to park there.)
~~[EC-GVR]~~ [EC-LCA] (DFG-978-315)

San Marcos Creek at Rancho Santa Fe Road
San Diego 1128:A-6
[SMC-RSFR] (DFG-978-316)

San Marcos Creek at McMahr, Carlsbad drainage
San Diego 1128:E-2
[SMC-M] (DFG-978-317)

I-15 North to Clinton Keith Rd west
Past Palomar St (Washington St) . Murrieta Ck is just after this, but continue to to Calle Del Oso Oro Rd, Make a left, sample at bridge xing on Murrieta Creek.
-Murrieta Creek at Calle Del Oso Rd. This is **new station** for 1998.
Riverside 927:F-4 [MC -WB] (DFG-978-318)
go back Clinton Keith Rd east to 15 south.

I-15 South to Rainbow Glen Rd (Hwy 79 at Rainbow Glen, south part of Temecula). Go upriver on Murrieta Ck to where you can sample, take Front St, behind cement factory
-Murrieta Ck behind cement factory. This is the same as station **AM** for 1997.
Riverside 978:J2 [MC-GS] (DFG-978-319)

Some road construction going on. Only from the cement factory you can find the dirt road behind cement roadblocks. Make an immediate left onto dirt road at yellow gate. (Key may be required). Follow dirt road at left until stream. Sample Temecula Ck.
-Temecula Ck east of confluence, west of I-15. This is the same as station **AT** for 1997.
409:D-4 [TC-I15] (DFG-978-320)

Return to I-15 and head south to Mission Rd (S13) exit. Go west (right) on Mission Rd.
Right on Margarita (it will say Willow Glen Rd, near Macadamia nut sign), Continue on Willow Glen following main road down hill. Sample when you reach Rainbow Creek bridge
- Rainbow Creek at Willow Glen Rd, upstream of metal bridge. This is the same as station **RBA** for 1997.
998:C-6 [RC-WGR] (DFG-978-321)

Continue on Willow Glen Rd
Right on Stage Coach Lane
to SMR xing
- Santa Margarita at Willow Glen Rd (Stage Coach Ln). This is the same as station **SMD** for 1997.
998:C-2 [SMR-WGR] (DFG-978-322)

Backtrack, Get back on Mission Rd (S-13) west into Fallbrook,
North (right) on Main Ave (2 blocks)
Left on View St (1 block)
Right on DeLuz Rd at junction with Sandia Ck Dr
Go (right) north on Sandia Ck Drive.
Sample at xing.
- SMR at DeLuz/ Pico Rd near Sandia Ck. This is the same as station **SMG** for 1997.
997:G-5 ~~[SMR-DP]~~ [SMR-SCD] (DFG-978-323)

Station Identification & Directions to Water Quality Sampling Stations for 1998

After bridge, curve left and go 500 ft past barbed wire fence on left of sharp right curve. Park on left in dirt turnout.
- Sandia Ck at Sandia Ck Rd, 0.5 to 1 mile above confluence This is the same as station **SC** for 1997.
997:F-4 [SC-SCR] (DFG-978-324)

Backtrack south on Sandia Ck Dr over bridge, on De Luz Rd to Mission Rd, go right. At "T" go left. There will be places to eat lunch on right of this street. (Lunch) Right on Ammunition Rd. Turn left into Naval Weapons Base entrance. (You should have called Camp Pendleton about your arrival). Directions to Water Resources Office: Drive thru Base, to reach Water Resources office: Turn left Vandegrift go up one stop Rattlesnake Cyn road , left at Base hqts , to Right on E St. next left on 14th, on top of hill Bldg 1142 Child Development Ctr. Back of last bldg tiny sign on wall.

Continue to Vandergrift. Right on Santa Margarita Rd, continue past the lake and fire station. Just before wire fence on left (before hospital) turn left onto dirt road. Then turn immediate right to road b/w diversion basin and infiltration basin. Follow road to end. Sample below wier.
-Santa Margarita River below diversion weir on Camp Pendleton. This is the same as station **SML** for 1997.
409:A-7 [SMR-CP] (DFG-978-325)

Backtrack past hospital and lake to main road, Vandergrift, make right. Drive about 15 minutes, Right on Stuart Mesa.-
SMR at Stuart Mesa Rd bridge on Camp Pendleton. This is the same as station **SMO** for 1997.
1085:H2 [SMR-SMB] (DFG-978-326)

I-15 North
S 78 West to San Marcos
exit Rancheros Drive west, near San Marcos Blvd. (There was no parking available at Santar Place, it is a Sheriff's parking lot with no stopping and no trespassing pasted all over the place) Go instead to the bridge xing at Rancheros Drive.
Park in lot by Old Spaghetti Factory, Home Town Buffet is on other side of street and City Hall is across the river.
- San Marcos Creek at Rancheros Drive xing, Carlsbad
1109:A-7 [SMC-SP] (DFG-978-329)

Backtrack, Continue on S 78 West,
South on Sycamore Ave, Right on Green Oak Rd, sample a Green Oak Rd xing
- Agua Hedionda Ck at Sycamore Ave
1108:A-5 [AHC-SA] (DFG-978-328)

Backtrack, Continue on S78 West, Escondido Ave north,
South Santa Fe Ave northwest, creek xing is all channelized with grafitti, it's scary, even the bottom is concrete. There is a chain link fence and no way into vertical cement culvert. Not a good prospect for samping and really didn't want to get stuck in there ! Go instead to East Vista Way at at Escondido Avenue. Enter Wildwood Park on East Vista Way and park in parking lot. It is on page 1087:J-6.
-Buena Vista Ck at ~~South Santa Fe Ave~~ Wildwood Park
~~1087:H-6~~ [BVR-ED] (DFG-978-327)

Backtrack, Continue on S78 West
to I-5 North
At Capistraano Beach take
Pacific Coast Hwy (S1) north,
past Three Arch Bay and South Laguna, just past Aliso Pier is Aliso Creek and Country Club Rd.
At Country Club Rd just north of creek park.
-Aliso Ck along Country Club Rd
951:B-7 [AC-CCR] (DFG-978-330)

Backtrack to Pacific Coast Hwy, South on S1
to Crown Valley Pkwy north
to Alicia Pkwy north
Right at Pacific Park Dr.
Aliso Ck at bottom
-Aliso Ck at Pacific Park Dr/ Oso Pkwy
921:F-6 [AC-PPD] (DFG-978-331)

Backtrack to Alicia Pkwy south and Crown Vallley south to
Pacific Coast Hwy (S1) South to
San Diego Frwy (I-5 South)

to Tamarack East, El Camino Real south, first creek
-Agua Hedionda Ck at El Camino Real
1107:B-7 [AHC-ECR] (DFG-978-332)

Take I-15 South, Pala Rd (S 76) east
- San Luis Rey River at old Hwy 395 (Couser Canyon Rd)
1048:H-3 [SLRR-395] (DFG-978-333)

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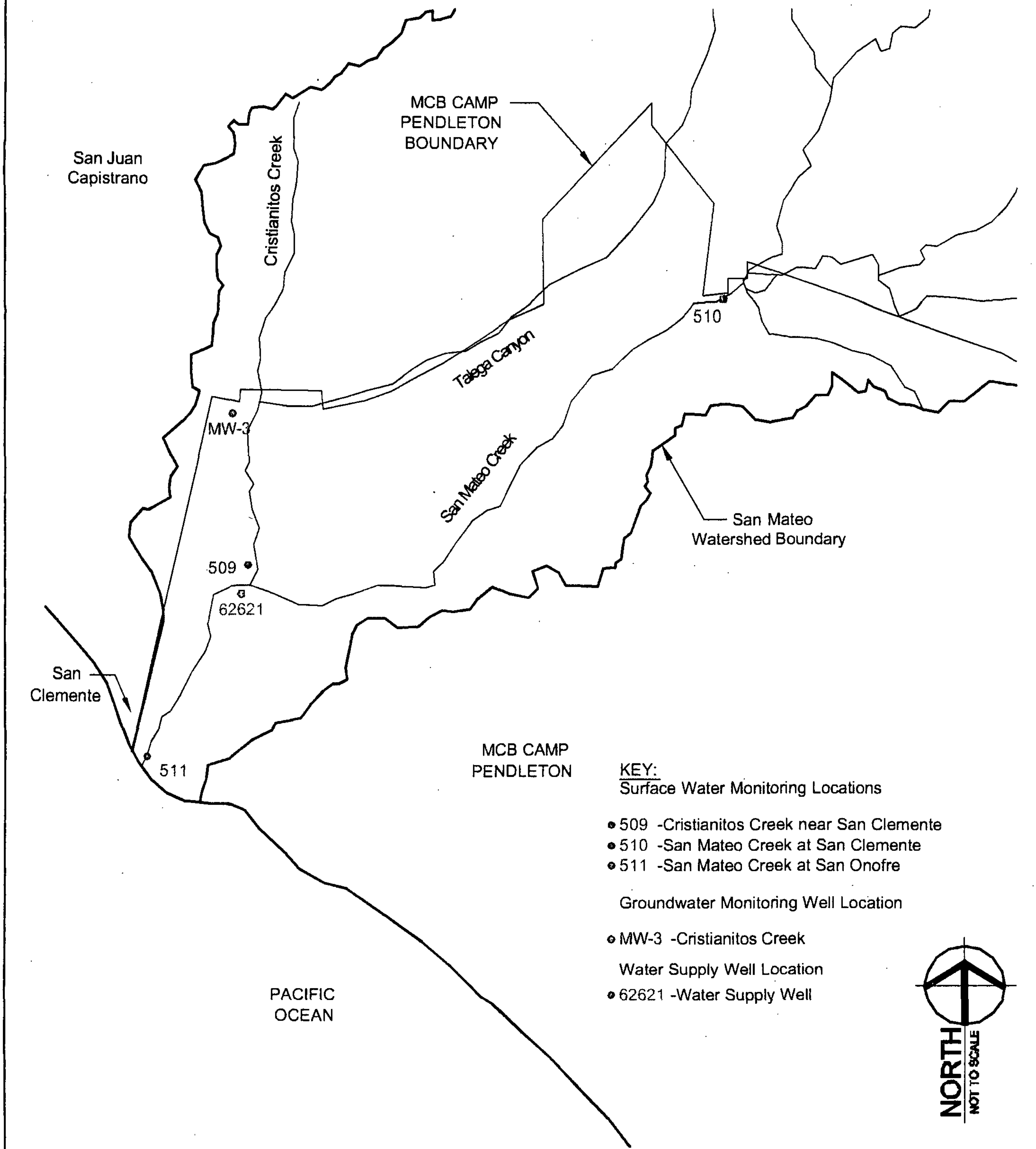


KEY:
Surface Water Monitoring Locations

- 509 -Cristianitos Creek near San Clemente
- 510 -San Mateo Creek at San Clemente
- 511 -San Mateo Creek at San Onofre

Groundwater Monitoring Well Location

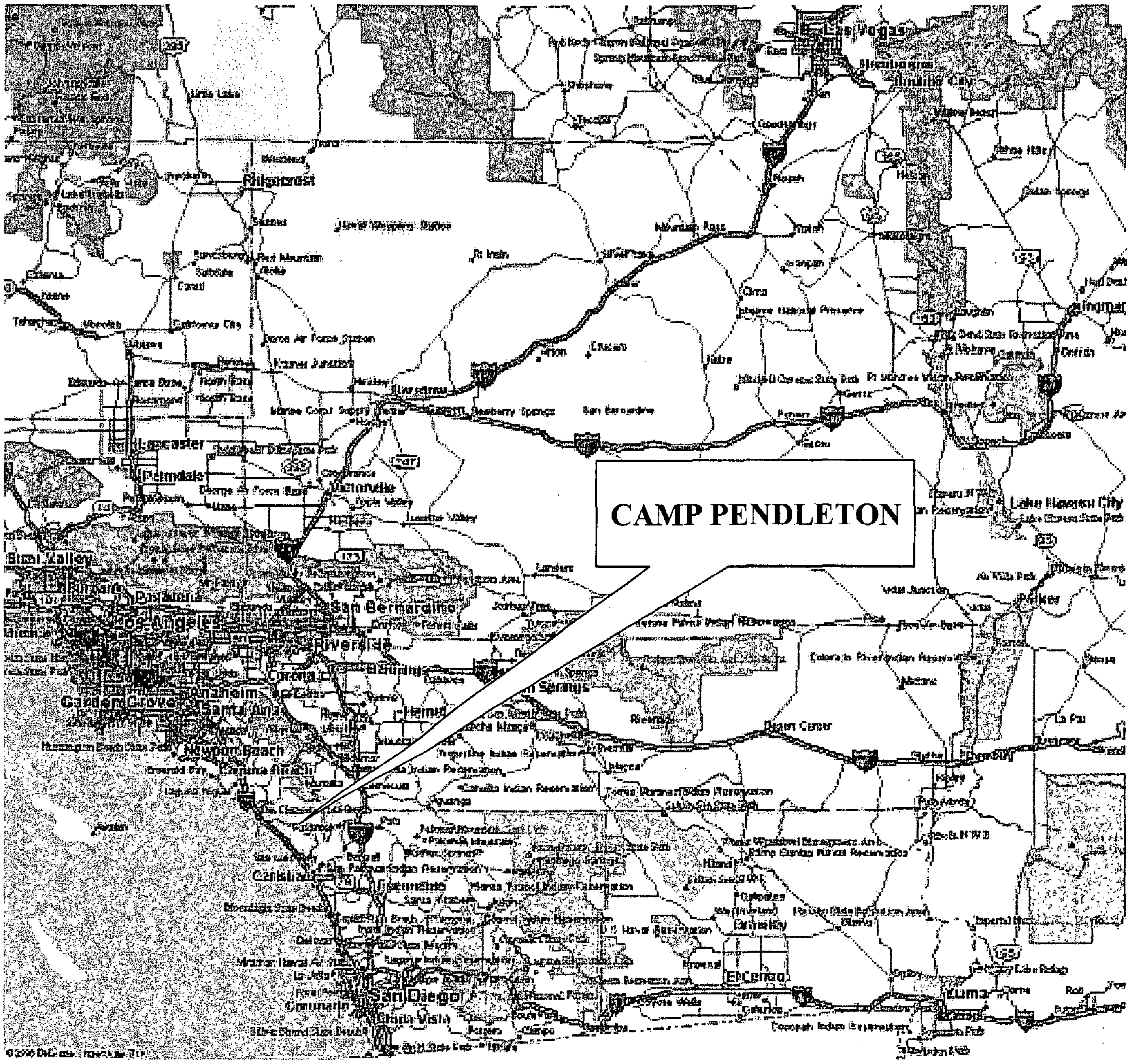
- MW-3 -Cristianitos Creek

Water Supply Well Location

- 62621 -Water Supply Well

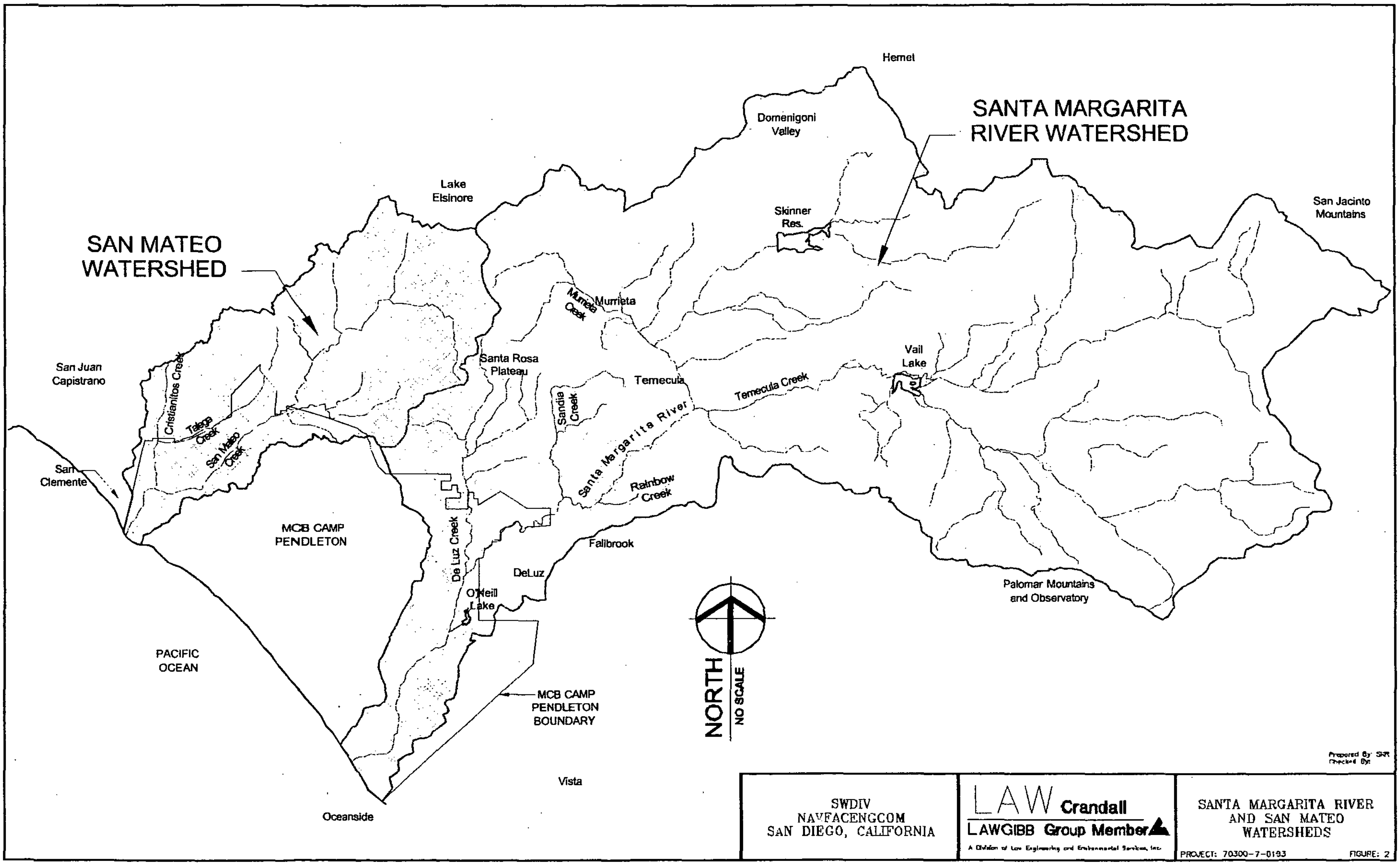
Prepared By: SKR
Checked By:

SWDIV NAVFACENGCOM SAN DIEGO, CALIFORNIA	LAW Crandall LAWGIBB Group Member A Division of Law Engineering and Environmental Services, Inc.	MONITORING LOCATIONS SAN MATEO WATERSHED
		PROJECT: 70300-7-0193 FIGURE: 3



Prepared By: SKR
Checked By:

SWDIV NAVFACENGCOM SAN DIEGO, CALIFORNIA	LAW Crandall LAWGIBB Group Member A Division of Law Engineering and Environmental Services, Inc.	LOCATION MAP
		Project: 70300-7-0193 Figure: 1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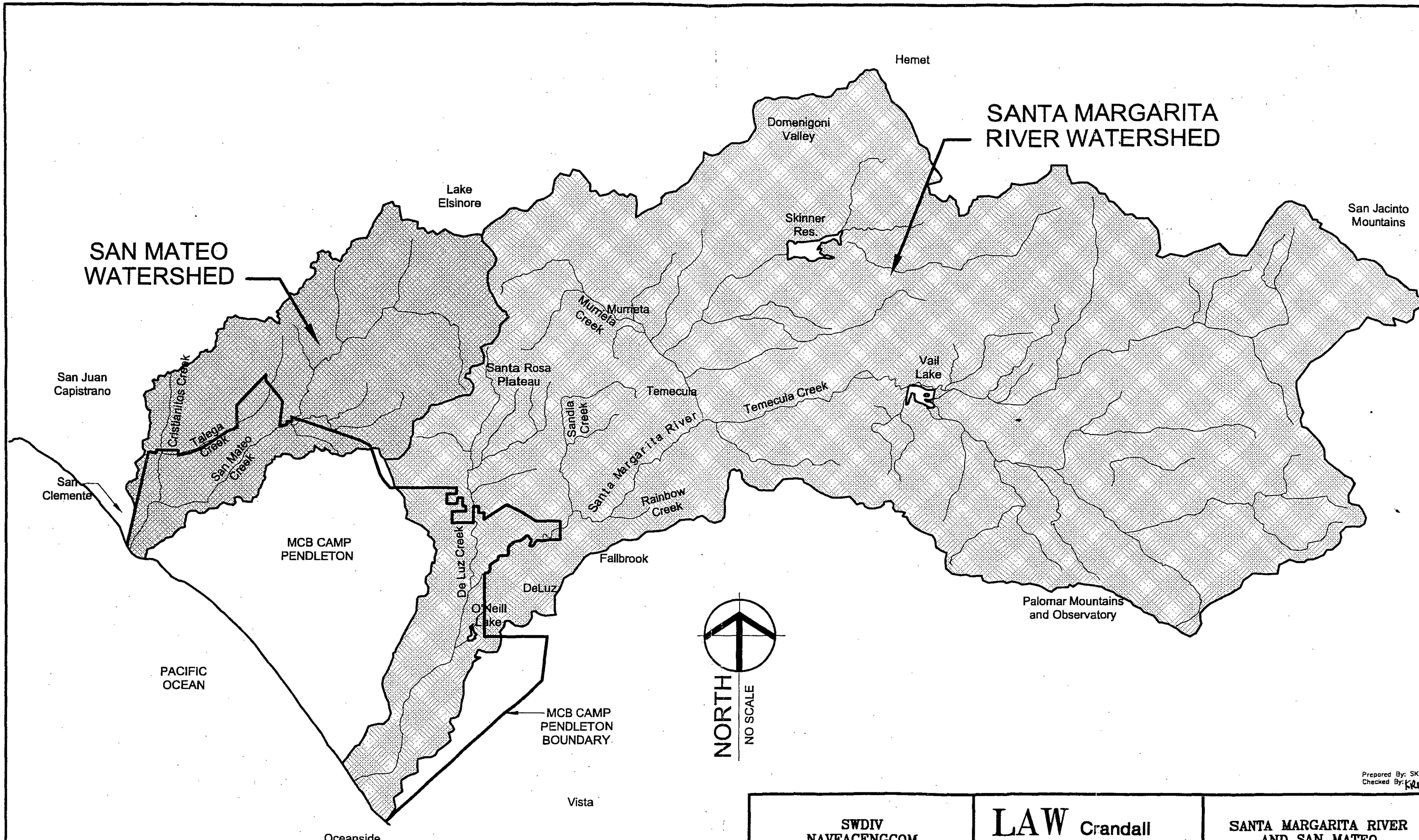
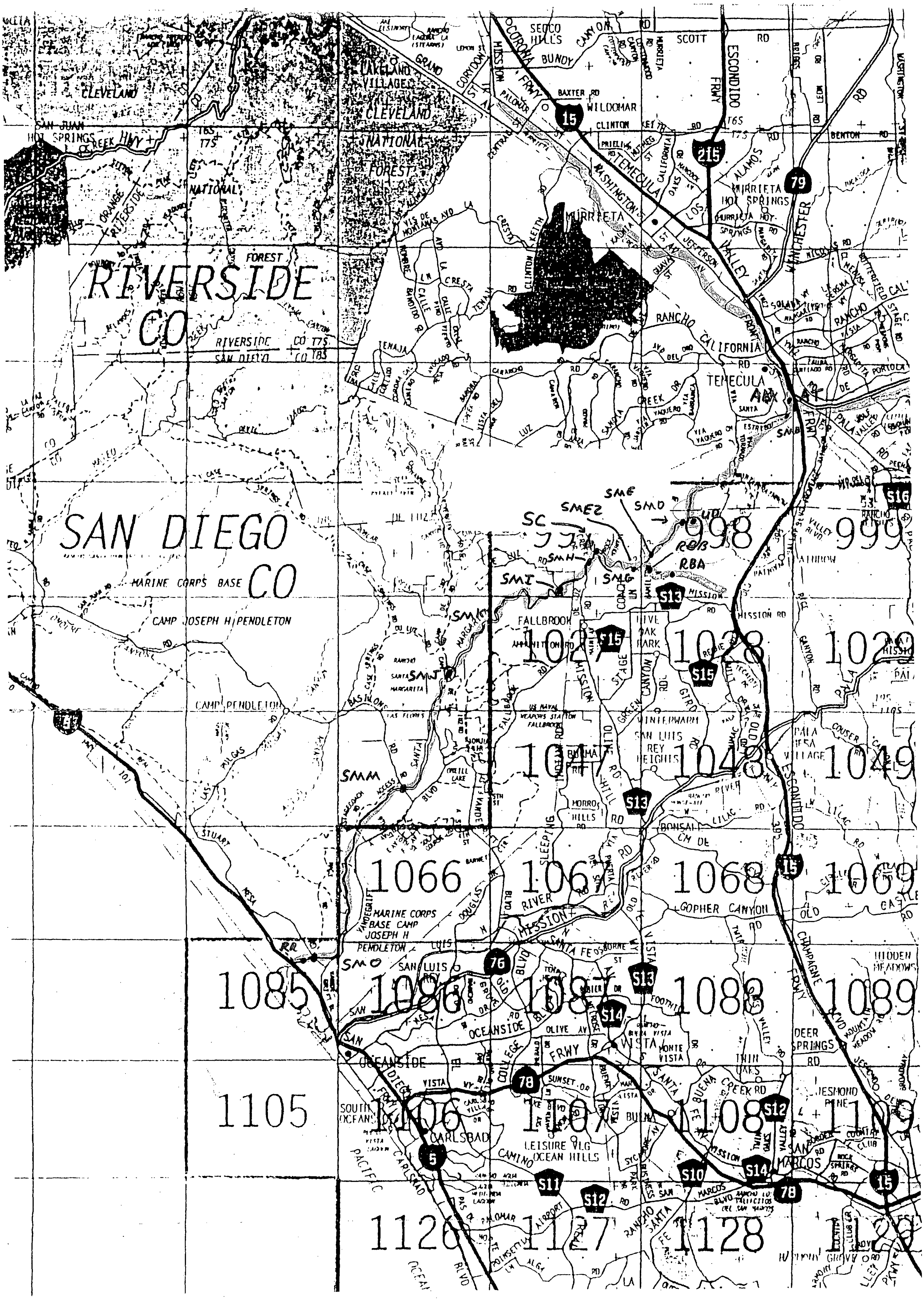
RIVER WATERSHED
SAN MATEO
WATERSHED
Hemet
Domenigoni
Valley
Lake
Elsinore
Skinner
Res.
San Jacinto
Mountains
Murrieta
Murrieta
Creek
San Juan
Capistrano
Cristianitos Creek
Talega
Creek
San Mateo
Creek
San
Clemente
Santa Rosa
Plateau
Temecula
Sandia
Creek
Santa Margarita River
Temecula Creek
Vail
Lake
Rainbow
Creek
Fallbrook
MCB CAMP
PENDLETON
De Luz Creek
DeLuz
O'Neill
Lake
Palomar Mountains
and Observatory
PACIFIC
OCEAN
MCB CAMP
PENDLETON
BOUNDARY
NORTH
NO SCALE
Vista
Oceanside
SWDIV
NAVFACENGCOM
SAN DIEGO, CALIFORNIA
LAW Crandall
LAWGIBB Group Member
SANTA MARGARITA RIVER
AND SAN MATEO
WATERSHEDS
PROJECT: 70300-7-0193
FIGURE: 2



Prepared By: SKR
Checked By: KRM

SWDIV NAVFACENGCOM SAN DIEGO, CALIFORNIA	LAW Crandall LAWGIBB Group Member A Division of Law Engineering and Environmental Services, Inc.	SANTA MARGARITA RIVER AND SAN MATEO WATERSHEDS PROJECT: 70300-7-0193 FIGURE: 2



RIVERSIDE CO
SAN DIEGO CO
RIVERSIDE CO
SAN DIEGO CO
CLEVELAND NATIONAL FOREST
LAKELAND VILLAGES
SEDCO HILLS
WILDOMAR
MURRIETA
MURRIETA HOT SPRINGS
TEMECULA
MARINE CORPS BASE
CAMP JOSEPH H PENDLETON
CAMP PENDLETON
FALLBROOK
LIVE OAK PARK
WINTERWARM
SAN LUIS REY HEIGHTS
PALA MESA VILLAGE
BONSALL
MORRO HILLS
MARINE CORPS BASE CAMP JOSEPH H PENDLETON
SAN LUIS REY
OCEANSIDE
SOUTH OCEANSIDE
CARLSBAD
LEISURE VLG OCEAN HILLS
VISTA
SAN MARCOS
DEER SPRINGS
HIDDEN MEADOWS
JESMOND DENE
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Table 11 Summary Statistics
Santa Margarita River Watershed

Date	ID	Matrix	Alkalinity	Arsenic	Bicarbonate	BOD	Boron	Calcium	Carbonate	Chloride
09-Dec-97	501001	surface water	116	ND	115	2.5	ND	71.4	ND	147
03-Mar-98	501002	surface water	157	ND	155		ND	90	2.3	120
26-May-98	501003	surface water	178	ND	176	ND	ND	92.3	1.94	189
04-Aug-98	501004	surface water	196	ND	192		0.219	99.7	3.53	162
09-Nov-98	501005	surface water	180	ND	178	2.14	0.244	118	1.43	176
10-Feb-99	501006	surface water	186	ND	183		0.19	89.1	2.55	136
11-May-99	501007	surface water	185	ND	183	ND	0.215	87.4	1.84	135
09-Dec-97	502001	surface water	154	ND	151	ND	ND	141	2.83	267
03-Mar-98	502002	surface water	135	ND	133		ND	110	1.98	158
26-May-98	502003	surface water	159	ND	157	ND	ND	95.3	1.99	225
04-Aug-98	502004	surface water	177	ND	175		0.161	108	2.32	227
09-Nov-98	502005	surface water	158	ND	156	ND	0.197	112	2.32	192
10-Feb-99	502006	surface water	172	ND	168		0.141	104	3.71	179
11-May-99	502007	surface water	166	ND	164	ND	ND	108	1.77	175
09-Dec-97	503001	surface water	162	ND	160	ND	ND	122	1.73	213
03-Mar-98	503002	surface water	79.5	ND	78.7		ND	46	0.757	70.7
26-May-98	503003	surface water	114	ND	104	4.02	ND	65.6	0.642	128
04-Aug-98	503004	surface water	242	ND	240		0.125	114	1.92	189
09-Nov-98	503005	surface water	163	ND	162	ND	0.2	112	1.13	169
10-Feb-99	503006	surface water	174	ND	172		0.173	91	2.18	136
11-May-99	503007	surface water	222	ND	221	ND	ND	112	1.04	166
09-Dec-97	504001	surface water	164	ND	163	2.38	ND	85.3	1.08	148
03-Mar-98	504002	surface water	173	ND	170		ND	85	2.48	115
26-May-98	504003	surface water	211	ND	195	ND	ND	97.9	0.862	197
04-Aug-98	504004	surface water	205	ND	203		0.228	83.4	1.7	98.3
09-Nov-98	504005	surface water	159	ND	158	6.72	0.377	61.3	ND	109
10-Feb-99	504006	surface water	154	ND	153		0.345	47.9	1.09	96.6
11-May-99	504007	surface water	237	ND	235	ND	0.197	105	2.11	95.1
09-Dec-97	505001	surface water	127	ND	126	2.67	ND	50.7	ND	134
03-Mar-98	505002	surface water	169	ND	167		ND	76	2.32	133
26-May-98	505003	surface water	201	ND	200	ND	ND	100	0.9	212
04-Aug-98	505004	surface water	140	ND	139		0.175	58.7	0.736	78.2
09-Nov-98	505005	surface water	114	ND	114	10	0.389	37.5	ND	104
10-Feb-99	505006	surface water	122	0.0387	121		0.378	36.2	0.687	90.8
11-May-99	505007	surface water	185	ND	184	2.11	0.44	53.5	1.09	124
09-Dec-97	506001	surface water	140	ND	139	ND	ND	103	1.3	224

Table 11 Summary Statistics
Santa Margarita River Watershed

Date	ID	Matrix	Alkalinity	Arsenic	Bicarbonate	BOD	Boron	Calcium	Carbonate	Chloride
03-Mar-98	506002	surface water	82.4	ND	81.4		ND	51	0.941	62.3
26-May-98	506003	surface water	119	0.026	118	ND	ND	50.8	0.944	98.7
04-Aug-98	506004	surface water	170	ND	168		0.154	84.4	2.23	143
09-Nov-98	506005	surface water	170	ND	168	ND	0.218	103	2.13	164
10-Feb-99	506006	surface water	175	ND	172		0.146	88.4	2.57	141
11-May-99	506007	surface water	174	ND	172	ND	0.123	94.2	1.9	142
09-Dec-97	507001	surface water	121	ND	120	2.48	ND	46.6	ND	126
03-Mar-98	507002	surface water	220	ND	217		ND	71	3.02	105
26-May-98	507003	surface water	269	ND	267	ND	ND	70.3	1.78	145
04-Aug-98	507004	surface water	363	ND	359		0.326	89.6	3.62	172
09-Nov-98	507005	surface water	179	ND	178	8.02	0.23	66.7	0.623	133
10-Feb-99	507006	surface water	204	ND	202		0.176	51.8	2.08	90.8
11-May-99	507007	surface water	266	ND	264	ND	0.144	65.2	1.93	112
09-Dec-97	508001	surface water	145	ND	143	ND	ND	85.7	2.18	183
03-Mar-98	508002	surface water	128	ND	126		ND	77	1.5	105
26-May-98	508003	surface water	166	ND	164	ND	ND	72	2.08	164
04-Aug-98	508004	surface water	191	ND	186		0.203	91.6	4.6	159
09-Nov-98	508005	surface water	162	ND	158	ND	0.202	88.3	3.91	160
10-Feb-99	508006	surface water	192	ND	188		0.169	84.7	3.61	139
11-May-99	508007	surface water	233	ND	231	3.06	0.219	94.7	1.73	172
05-Jan-98	101001	ground water	148	ND	148	ND		102	ND	168
06-Mar-98	101002	ground water	328	ND	319		ND	61	8.65	28.1
27-May-98	101003	ground water	380	0.033	380	ND	ND	94.4	ND	139
05-Aug-98	101004	ground water	502	ND	500		0.224	72.4	1.45	52.3
10-Nov-98	101005	ground water	418	ND	417	ND	0.282	107	1.13	120
12-Feb-99	101006	ground water	434	ND	433		0.237	107	1.15	133
12-May-99	101007	ground water	394	ND	393	ND	0.272	119	1.17	133
05-Jan-98	102001	ground water	388	ND	384	ND		130	3.96	175
12-Mar-98	102002	ground water	141	0.028	140		ND	97	1.34	150
27-May-98	102003	ground water	124	0.027	124	ND	ND	62.8	ND	83.6
05-Aug-98	102004	ground water	144	ND	143		0.0276	67.4	0.575	117
10-Nov-98	102005	ground water	141	ND	141	ND	0.162	83.6	ND	149
12-Feb-99	102006	ground water	171	ND	171		0.142	86.3	ND	149
12-May-99	102007	ground water	164	ND	166	ND	0.133	84.3	ND	134

Table 11 Summary Statistics

Santa Margarita River Watershed

Date	ID	Matrix	Alkalinity	Arsenic	Bicarbonate	BOD	Boron	Calcium	Carbonate	Chloride
statistical distribution			N	NP	N	NP	N	N	N	N
mean			194.0414286		191.8871429		0.215358	85.30571	2.018084746	142.3786
standard deviation			84.82408821		84.57484109		0.08539	23.12952	1.286521617	43.74784
number of samples			70	5	70	11	38	70	59	70
maximum			502	0.0387	500	10	0.44	141	8.65	267
minimum			79.5	0.026	78.7	2.11	0.0276	36.2	0.575	28.1
number of samples including ND's			70	70	70	70	70	70	70	70
% ND's			0%	93%	0%	84%	46%	0%	16%	0%
data type			A	D	A	D	C	A	C	A
variance			7195.12594		7152.903745		0.007291	534.9747	1.655137872	1913.874
DL			1	0.01	1	2	0.1	0.1	0.5	1
MCL				0.05						250
h							0.457143		0.157142857	
γ							0.547917		0.718194613	
λ							0.871708		0.246161757	
adjusted mean							0.114799		1.644390337	
adjusted variance							0.018892		2.222437653	
adjusted standard deviation							0.137447		1.490784241	
α			0.05		0.05		0.05	0.05	0.05	0.05
ν			69		69		69	69	69	69
t			1.997		1.997		1.997	1.997	1.997	1.997
UPL			364.6407971	0.025	361.9852221	2	0.392869	131.8241	4.646610086	230.3648

Table 11 Summary Statistics
Santa Margarita River Watershed

Date	ID	Conductivity	Copper	Cyanide	Fecal Coliform	Fluoride	Hardness	Hydroxide	Iron	Lead
09-Dec-97	501001	849	0.007	ND	>1600	ND	259	ND	9.89	ND
03-Mar-98	501002	1016	ND		110	0.29	348	ND	0.9	ND
26-May-98	501003	1070	ND	ND	220	0.301	344	ND	0.134	ND
04-Aug-98	501004	1280	ND		170	0.319	483	ND	0.149	ND
09-Nov-98	501005	1410	ND	ND	>1600	0.336	570	ND	1.48	ND
10-Feb-99	501006	1180	ND		900	0.297	460	ND	0.932	ND
11-May-99	501007	1230	ND	ND	>23	0.326	376	ND	ND	ND
09-Dec-97	502001	1620	ND	ND	300	ND	555	ND	0.257	ND
03-Mar-98	502002	1155	ND		220	0.273	442	ND	5.5	ND
26-May-98	502003	1150	ND	ND	1600	0.316	442	ND	0.765	ND
04-Aug-98	502004	1290	ND		900	0.307	525	ND	0.103	ND
09-Nov-98	502005	1370	ND	ND	1600	0.298	551	ND	0.451	ND
10-Feb-99	502006	1300	ND		220	0.283	559	ND	0.336	ND
11-May-99	502007	1360	ND	ND	>23	0.285	466	ND	ND	ND
09-Dec-97	503001	1470	ND	ND	1600	ND	515	ND	0.047	0.027
03-Mar-98	503002	641	ND		300	0.203	208	ND	0.7	ND
26-May-98	503003	848	0.008	ND	1600	0.325	354	ND	0.486	0.00106
04-Aug-98	503004	1400	0.0063		17	0.239	564	ND	ND	ND
09-Nov-98	503005	1460	0.0058	ND	>1600	0.35	562	ND	0.156	ND
10-Feb-99	503006	1240	0.00511		>1600	0.294	445	ND	0.214	ND
11-May-99	503007	1420	ND	ND	>23	0.242	492	ND	ND	ND
09-Dec-97	504001	934	ND	ND	>1600	ND	247	ND	3	0.019
03-Mar-98	504002	983	ND		110	0.32	320	ND	1.4	ND
26-May-98	504003	1120	ND	ND	<2	1.12	310	ND	0.447	ND
04-Aug-98	504004	977	ND		<2	0.353	295	ND	0.221	ND
09-Nov-98	504005	860	ND	ND	>1600	0.352	230	ND	0.564	ND
10-Feb-99	504006	776	0.005		1600	0.292	192	ND	3.46	0.00107
11-May-99	504007	1140	ND	ND	>23	0.281	353	ND	0.0668	0.00286
09-Dec-97	505001	755	ND	ND	>1600	0.236	174	ND	2.21	ND
03-Mar-98	505002	1000	ND		90	0.343	342	ND	1.4	ND
26-May-98	505003	1260	ND	ND	30	0.502	339	ND	0.184	ND
04-Aug-98	505004	812	ND		50	0.313	277	ND	0.244	ND
09-Nov-98	505005	755	0.0075	ND	>1600	0.356	537	ND	0.98	ND
10-Feb-99	505006	697	0.00706		>1600	0.279	148	ND	6.47	0.00188
11-May-99	505007	1020	ND	ND	>23	0.526	201	ND	2.12	0.0012
09-Dec-97	506001	1220	ND	ND	900	ND	408	ND	0.243	0.023

Table 11 Summary Statistics
Santa Margarita River Watershed

Date	ID	Conductivity	Copper	Cyanide	Fecal Coliform	Fluoride	Hardness	Hydroxide	Iron	Lead
03-Mar-98	506002	544	ND		300	0.215	200	ND	4.2	ND
26-May-98	506003	670	ND	ND	900	1.14	251	ND	0.971	ND
04-Aug-98	506004	1030	ND		140	0.277	428	ND	0.678	ND
09-Nov-98	506005	1230	ND	ND	500	0.282	396	ND	1.2	ND
10-Feb-99	506006	1120	ND		50	0.255	467	ND	0.427	ND
11-May-99	506007	1180	ND	ND	>23	0.279	394	ND	0.247	ND
09-Dec-97	507001	740	ND	ND	>1600	ND	217	ND	3.34	0.024
03-Mar-98	507002	935	ND		110	0.429	328	ND	0.7	ND
26-May-98	507003	1080	ND	ND	30	0.403	364	ND	0.137	ND
04-Aug-98	507004	1450	ND		280	0.586	497	ND	0.149	ND
09-Nov-98	507005	1150	ND	ND	>1600	0.37	426	ND	1.92	ND
10-Feb-99	507006	875	ND		30	0.322	284	ND	0.511	0.00107
11-May-99	507007	1120	ND	ND	>23	0.476	322	ND	0.236	ND
09-Dec-97	508001	1070	0.01	ND	1600	ND	350	ND	2.47	ND
03-Mar-98	508002	814	ND		13	0.239	290	ND	3	ND
26-May-98	508003	902	ND	ND	17	0.331	331	ND	1.14	0.00104
04-Aug-98	508004	1140	ND		900	0.367	431	ND	0.283	ND
09-Nov-98	508005	1150	ND	ND	70	0.354	335	ND	0.1	ND
10-Feb-99	508006	1130	ND		17	0.326	432	ND	0.136	0.00373
11-May-99	508007	1350	ND	ND	6.9	0.382	363	ND	0.5	ND
05-Jan-98	101001	1140	0.04	ND	<2	0.304	418	ND	48.7	0.052
06-Mar-98	101002	734	0.016		80	1.36	229	ND	8.76	ND
27-May-98	101003	990	0.054	ND	<2	1.17	305	ND	23.7	0.00247
05-Aug-98	101004	907	0.0191		<2	1.21	287	ND	8.51	ND
10-Nov-98	101005	1380	0.017	ND	<2	1.07	480	ND	4.74	0.00175
12-Feb-99	101006	1450	0.0136		<2	0.908	486	ND	5.22	ND
12-May-99	101007	1470	0.0146	ND	<2	0.867	450	ND	5.56	0.00104
05-Jan-98	102001	1470	0.03	ND	ND	0.745	518	ND	9.1	0.021
12-Mar-98	102002	1080	ND		60	0.3	385	ND	4.16	0.00182
27-May-98	102003	702	0.011	ND	<2	0.321	252	ND	15.8	0.00541
05-Aug-98	102004	873	0.0097		<2	0.263	287	ND	12.2	0.0045
10-Nov-98	102005	1110	ND	ND	<2	0.343	393	ND	1.6	0.00862
12-Feb-99	102006	1450	ND		<2	0.279	421	ND	2.83	0.00254
12-May-99	102007	1120	ND	ND	<2	0.27	364	ND	1.05	0.00306

23 grab samples
out

Table 11 Summary Statistics

Santa Margarita River Watershed

Date	ID	Conductivity	Copper	Cyanide	Fecal Coliform	Fluoride	Hardness	Hydroxide	Iron	Lead
statistical distribution		N	NP	NP	N	N	N	NP	N	NP
mean		1094.628571			464.2342105	0.428571	375.3428571		3.330073	
standard deviation		248.617171			571.4059078	0.279379	110.0352889		7.023338	
number of samples		70	19	0	38	63	70	0	66	23
maximum		1620	0.054	0	1600	1.36	570	0	48.7	0.052
minimum		544	0.005	0	6.9	0.203	148	0	0.047	0.00104
number of samples incluc		70	70	70	70	70	70	70	70	70
% ND's		0%	73%	100%	46%	10%	0%	100%	6%	67%
data type		A	D	D	C	B	A	D	B	D
variance		61810.49772			326504.7115	0.078053	12107.7648		49.32727	
DL		1	0.005	0.005	none	0.1	1	0.5	0.05	0.001
MCL		900	1	0.2					0.3	0.015
h										
γ										
λ										
adjusted mean										
adjusted variance										
adjusted standard deviati										
α		0.05			0.05	0.05	0.05		0.05	
ν		69			69	69	69		69	
t		1.997			1.997	1.997	1.997		1.997	
UPL		1594.650832	0.5	0.1	1620.24875	0.990902	596.6473379	0.5	17.46153	0.0075

Table 11 Summary Statistics
Santa Margarita River Watershed

Date	ID	Magnesium	Manganese	Mercury	Nitrate	Nitrogen	Oil & Grease	pH	Phosphorus	Potassium
09-Dec-97	501001	27.3	0.252	ND	1.94	0.379	ND	7.85	0.27	6.47
03-Mar-98	501002	34	0.06		3.6		ND	8.19	0.481	4
26-May-98	501003	40.8	0.024	ND	4.58	0.7	ND	8.07	0.263	4.75
04-Aug-98	501004	49	0.0776		2.27		ND	8.29	0.04	4.47
09-Nov-98	501005	50.9	0.143	ND	4.2	1.36	ND		0.188	7.14
10-Feb-99	501006	40.7	0.0454		4.76		ND	8.09	0.165	4.63
11-May-99	501007	38.9	0.0274	ND	1.83	0.59	ND	7.95	0.076	3.26
09-Dec-97	502001	61.9	0.051	ND	4.92	0.38	ND	8.21	0.063	3.35
03-Mar-98	502002	48	0.12		7.63		ND	8.2	0.225	3
26-May-98	502003	50.6	0.028	ND	5.56	ND	ND	8.13	0.014	3.09
04-Aug-98	502004	52.5	0.0153		4.36		ND	8.15	0.03	3.08
09-Nov-98	502005	55	0.0282	ND	5.33	0.781	ND		ND	3.35
10-Feb-99	502006	52	0.0118		5.15		ND	8.33	ND	2.72
11-May-99	502007	51.6	ND	ND	2.77	0.507	ND	8.24	0.022	2.47
09-Dec-97	503001	51.1	0.027	ND	1.3	0.483	ND	7.98	1.13	10.8
03-Mar-98	503002	20	0.05		4.95		ND	8.12	0.612	3
26-May-98	503003	29.1	0.055	ND	10.3	2.7	ND	7.78	1.14	7.21
04-Aug-98	503004	55.4	0.0329		4.54		ND	7.93	0.48	5.38
09-Nov-98	503005	51.5	0.048	ND	13.2	1.66	ND		0.917	9.35
10-Feb-99	503006	43.8	0.0168		9.34		0.98	8.06	0.713	7.56
11-May-99	503007	53.6	ND	ND	8.6	0.535	0.962	7.98	0.446	5.06
09-Dec-97	504001	18.7	0.251	ND	1.32	0.434	ND	7.7	0.254	4.25
03-Mar-98	504002	28	0.1		1.88		ND	8.27	0.511	5
26-May-98	504003	32.2	0.075	ND	0.868	0.8	ND	7.64	0.101	6.11
04-Aug-98	504004	24.2	0.108		0.82		ND	7.95	0.07	3.32
09-Nov-98	504005	16.7	0.0656	ND	1.22	1.57	ND		0.25	9.73
10-Feb-99	504006	14.7	0.0786		0.381		ND	7.78	0.256	5.96
11-May-99	504007	22.4	0.0417	ND	2.08	ND	ND	7.89	0.085	1.53
09-Dec-97	505001	13.8	0.126	ND	0.872	0.483	ND	7.63	0.266	4.67
03-Mar-98	505002	28	0.07		1.42		ND	8.29	0.53	5
26-May-98	505003	38.2	0.058	ND	0.724	0.8	ND	7.64	0.092	7.91
04-Aug-98	505004	22.6	0.0633		0.29		ND	7.75	0.04	3.6
09-Nov-98	505005	12.4	0.0882	ND	1.21	1.8	ND		0.04	11.8
10-Feb-99	505006	13.2	0.0891		0.153		1.2	7.58	0.255	6.76
11-May-99	505007	16.8	0.308	ND	0.153	0.546	ND	7.65	0.161	4.67
09-Dec-97	506001	43.5	0.157	ND	5.44	0.447	ND	7.94	0.089	3.04

Date	ID	Magnesium	Manganese	Mercury	Nitrate	Nitrogen	Oil & Grease	pH	Phosphorus	Potassium
03-Mar-98	506002	20	0.11		3.89		ND	7.97	0.151	ND
26-May-98	506003	24.3	0.039	ND	2.45	0.6	1.33	7.93	0.014	1.68
04-Aug-98	506004	38.7	0.0407		2.2		ND	8.15	0.08	1.61
09-Nov-98	506005	48.8	0.0488	ND	4.46	0.619	ND		0.04	2.35
10-Feb-99	506006	41.7	0.0139		4.21		ND	8.13	ND	2.04
11-May-99	506007	43.7	0.0215	ND	2.06	0.509	ND	8.2	0.046	1.79
09-Dec-97	507001	25.7	0.194	ND	0.501	0.222	ND	7.82	0.297	4.15
03-Mar-98	507002	37	0.14		1.91		ND	8.19	0.456	2
26-May-98	507003	46.5	0.063	ND	0.356	0.8	ND	7.85	0.154	2.22
04-Aug-98	507004	58.9	0.13		0.07		ND	8.03	0.36	2
09-Nov-98	507005	41.8	0.559	ND	1.15	1.75	ND		0.704	6.69
10-Feb-99	507006	32.2	0.107		1.94		0.952	7.91	0.259	2.81
11-May-99	507007	41.6	0.185	ND	0.089	0.545	ND	7.86	0.356	ND
09-Dec-97	508001	34.3	0.14	ND	1.4	0.2	ND	8.06	0.208	5.4
03-Mar-98	508002	30	0.07		3.59		ND	8.11	0.378	3
26-May-98	508003	33.8	0.037	ND	2.19	0.7	ND	8.13	0.095	2.47
04-Aug-98	508004	39.8	0.0287		0.24		ND	8.42	0.13	3.93
09-Nov-98	508005	41	0.0154	ND	0.393	0.453	ND		0.036	3.75
10-Feb-99	508006	38	ND		1.19		ND	8.24	0.033	2.9
11-May-99	508007	34.9	0.237	ND	0.1	0.404	ND	7.55	0.118	3.06
05-Jan-98	101001	50.3	0.612	ND	ND	0.125	ND	7.1	0.295	11
06-Mar-98	101002	24.3	0.391		1.31		ND	7.81	0.565	3.92
27-May-98	101003	38.1	1.16	ND	1.43	ND	ND	7.08	0.604	5.17
05-Aug-98	101004	27.7	0.592		0.88		ND	7.46	0.17	2.66
10-Nov-98	101005	42.4	0.458	ND	0.177	0.456	ND		0.181	3.31
12-Feb-99	101006	42.6	1.12		ND		ND	7.33	0.189	3.4
12-May-99	101007	46.2	0.897	ND	ND	0.227	1.13	7.24	0.156	3.59
05-Jan-98	102001	47.7	2.33	ND	0.131	ND	ND	7.41	0.307	4.71
12-Mar-98	102002	39.7	0.043		40		ND	7.22	0.029	2.48
27-May-98	102003	28.4	0.182	ND	2.08	ND	ND	6.91	0.08	3.65
05-Aug-98	102004	30.7	0.162		ND		ND	7.25	2.31	3.82
10-Nov-98	102005	38	0.029	ND	0.301	0.362	ND		0.033	2.18
12-Feb-99	102006	40.1	0.0343		2.22		ND	7.37	0.036	2.44
12-May-99	102007	39.4	0.0132	ND	1.93	ND	ND	7.24	0.027	1.89

Table 11 Summary Statistics
Santa Margarita River Watershed

Date	ID	Magnesium	Manganese	Mercury	Nitrate	Nitrogen	Oil & Grease	pH	Phosphorus	Potassium
statistical distribution		N	N	NP	N	NP	NP	N	N	N
mean		37.02	0.193976119		3.254682			7.853833	0.286149254	4.346470588
standard deviation		12.24109969	0.356603926		5.31137			0.360687	0.357075166	2.351754991
number of samples		70	67	0	66	34	6	60	67	68
maximum		61.9	2.33	0	40	2.7	1.33	8.42	2.31	11.8
minimum		12.4	0.0118	0	0.07	0.125	0.952	6.91	0.014	1.53
number of samples incluc		70	70	70	70	70	70	70	70	70
% ND's		0%	4%	100%	6%	51%	91%	14%	4%	3%
data type		A	B	D	B	D	D	B	B	B
variance		149.8445217	0.12716636		28.21065			0.130095	0.127502674	5.530751536
DL		0.2	0.01	0.0002	0.05	0.1	1	none	0.01	0.3
MCL			0.05	0.002	45	10				
h										
γ										
λ										
adjusted mean										
adjusted variance										
adjusted standard deviati										
α		0.05	0.05		0.05			0.05	0.05	0.05
v		69	69		69			69	69	69
t		1.997	1.997		1.997			1.997	1.997	1.997
UPL		61.63946744	0.91140894	0.001	13.94154	5	1	8.580103	1.004530137	9.077332026

Table 11 Summary Statistics
Santa Margarita River Watershed

Date	ID	Sodium	Sulfate	Surfactants	Total Coliform	TDS	TOC	Zinc
09-Dec-97	501001	62.4	131	ND	>1600	432	6.21	0.037
03-Mar-98	501002	100	179	0.112	>1600	680	5.87	ND
26-May-98	501003	99.9	197	ND	>1600	764	8.06	ND
04-Aug-98	501004	108	292	ND	>1600	846	2.87	ND
09-Nov-98	501005	111	294	ND	>1600	963	5.85	ND
10-Feb-99	501006	92.3	222	ND	>1600	771	6.37	ND
11-May-99	501007	106	247	0.116	>23	787	2.13	ND
09-Dec-97	502001	96.7	239	ND	>1600	1010	4.27	0.017
03-Mar-98	502002	99	222	ND	>1600	786	5.04	ND
26-May-98	502003	87.5	249	ND	1600	814	3.03	ND
04-Aug-98	502004	96.4	265	ND	>1600	850	1.66	ND
09-Nov-98	502005	98.3	296	ND	>1600	925	2.66	ND
10-Feb-99	502006	90.3	240	ND	500	854	1.53	0.0111
11-May-99	502007	87.8	262	0.116	>23	879	1.5	ND
09-Dec-97	503001	103	269	ND	>1600	910	11.1	0.015
03-Mar-98	503002	69	108	ND	>1600	453	8.45	ND
26-May-98	503003	83.2	134	ND	>1600	662	10.3	ND
04-Aug-98	503004	100	252	ND	>1600	884	3.42	ND
09-Nov-98	503005	120	326	0.113	>1600	1010	58.9	ND
10-Feb-99	503006	102	250	ND	>1600	806	7.31	ND
11-May-99	503007	96	254	ND	>23	848	5.77	ND
09-Dec-97	504001	78.4	123	ND	>1600	476	8.77	0.021
03-Mar-98	504002	110	164	0.108	>1600	668	6.09	ND
26-May-98	504003	122	273	ND	>1600	803	8.53	ND
04-Aug-98	504004	84.6	203	ND	500	622	2.05	ND
09-Nov-98	504005	99.7	135	0.358	>1600	570	15.6	0.0144
10-Feb-99	504006	89.5	108	ND	>1600	499	6.59	0.0205
11-May-99	504007	94.7	216	ND	>23	761	3.2	ND
09-Dec-97	505001	73.9	75.4	ND	>1600	387	8.68	0.019
03-Mar-98	505002	100	164	ND	>1600	658	6.07	ND
26-May-98	505003	141	260	ND	>1600	879	6.01	ND
04-Aug-98	505004	78.2	194	ND	>1600	506	3.83	0.0144
09-Nov-98	505005	91.9	115	0.516	>1600	498	20.4	0.216
10-Feb-99	505006	88.3	93	0.224	>1600	425	8.95	0.0423
11-May-99	505007	134	134	ND	>23	602	2.26	ND
09-Dec-97	506001	72.7	189	ND	>1600	740	7.28	0.013

Table 11 Summary Statistics

Santa Margarita River Watershed

Date	ID	Sodium	Sulfate	Surfactants	Total Coliform	TDS	TOC	Zinc
03-Mar-98	506002	53	83.5	ND	1600	336	3.47	ND
26-May-98	506003	57.3	106	ND	300	455	4.79	ND
04-Aug-98	506004	153	188	ND	900	662	2.86	ND
09-Nov-98	506005	87.7	260	ND	>1600	821	1.47	ND
10-Feb-99	506006	78.7	189	ND	500	700	3.18	ND
11-May-99	506007	83.2	210	ND	>23	723	2.62	ND
09-Dec-97	507001	62.7	102	ND	>1600	387	10.6	0.033
03-Mar-98	507002	120	142	0.126	1600	655	13.7	ND
26-May-98	507003	115	143	ND	>1600	741	10.2	ND
04-Aug-98	507004	101	240	ND	1600	918	7.54	ND
09-Nov-98	507005	110	264	0.135	>1600	746	15.8	0.0148
10-Feb-99	507006	83.7	121	ND	900	536	8.37	ND
11-May-99	507007	109	152	0.165	>23	689	14	ND
09-Dec-97	508001	78.8	157	ND	>1600	660	7.5	0.022
03-Mar-98	508002	80	132	ND	1600	522	5.64	ND
26-May-98	508003	78.9	171	ND	220	642	2.89	ND
04-Aug-98	508004	77.8	224	ND	900	748	5.09	ND
09-Nov-98	508005	94.5	278	ND	900	785	2.31	ND
10-Feb-99	508006	90.8	193	ND	500	717	1.94	ND
11-May-99	508007	134	193	ND	23	786	13.7	ND
05-Jan-98	101001	85.3	205	0.109	280	687	4.18	0.13
06-Mar-98	101002	100	50.5	ND	4	524	0.5	0.025
27-May-98	101003	127	101	ND	>1600	665	6.33	0.063
05-Aug-98	101004	66	68	ND	>1600	650	0.5	0.0163
10-Nov-98	101005	150	201	ND	7	869	2.54	0.015
12-Feb-99	101006	146	168	ND	<2	846	0.5	0.0114
12-May-99	101007	143	189	ND	<2	916	9.62	ND
05-Jan-98	102001	152	191	ND	2	897	8.65	0.039
12-Mar-98	102002	78.8	510	ND	17	741	0.5	0.011
27-May-98	102003	61.3	99.9	ND	>1600	509	7.03	0.035
05-Aug-98	102004	55.1	136	ND	>1600	582	1.77	0.0276
10-Nov-98	102005	80	226	ND	<2	699	2.29	0.016
12-Feb-99	102006	82.4	185	ND	27	695	1.34	ND
12-May-99	102007	77.9	194	ND	14	701	0.5	ND

Table 11 Summary Statistics
Santa Margarita River Watershed

Date	ID	Sodium	Sulfate	Surfactants	Total Coliform	TDS	TOC	Zinc
statistical distribution		N	N	NP	NP	N	N	NP
mean		96.02286	192.1043			703.4	6.579	
standard deviation		23.69359	74.95967			160.7609	7.601389	
number of samples		70	70	12	23	70	70	26
maximum		153	510	0.516	1600	1010	58.9	0.216
minimum		53	50.5	0.108	2	336	0.5	0.011
number of samples incluc		70	70	70	70	70	70	70
% ND's		0%	0%	83%	67%	0%	0%	63%
data type		A	A	D	D	A	B	D
variance		561.3861	5618.952			25844.07	57.78112	
DL		0.3	5	0.1	none	10	1	0.01
MCL			250	0.5		500		5
h							ND=DL/2	
γ							########	
λ							########	
adjusted mean							########	
adjusted variance							########	
adjusted standard deviati							########	
α		0.05	0.05			0.05	0.05	
v		69	69			69	69	
t		1.997	1.997			1.997	1.997	
UPL		143.6757	342.8642	0.25	none	1026.725	21.86702	2.5

Table 10 Summary Statistics
San Mateo Watershed

Date	ID	Matrix	Alkalinity	Arsenic	Bicarbonate	BOD	Boron	Calcium	Carbonate	Chloride
03-Mar-98	509002	surface water	163	ND	160		ND	83	2.45	78
26-May-98	509003	surface water	194	ND	190	ND	ND	76.9	3.34	101
04-Aug-98	509004	surface water	184	ND	182		0.291	81	2.25	92
19-Feb-99	509006	surface water	208	ND	203		0.423	98.9	4.9	125
11-May-99	509007	surface water	180	ND	178	ND	0.386	95.8	1.84	121
03-Mar-98	510002	surface water	103	ND	102		ND	34	1.23	28.2
04-Jun-98	510003	surface water	134	ND	131	ND	ND	36.3	3.02	84.9
04-Aug-98	510004	surface water	189	ND	183		0.112	47.9	5.57	56.6
19-Nov-98	510005	surface water	182	ND	179	ND	ND	51.8	3.13	60.8
19-Feb-99	510006	surface water	170	ND	167		0.138	48.3	3.27	55.2
11-May-99	510007	surface water	175	ND	172	ND	ND	46.9	2.57	50.2
09-Dec-97	511001	surface water	143	ND	143	ND	ND	81.1	ND	128
03-Mar-98	511002	surface water	111	ND	110		ND	45	1.42	36.8
26-May-98	511003	surface water	149	ND	148	ND	ND	43.2	0.941	93.1
04-Aug-98	511004	surface water	164	ND	164		0.2	68.5	0.509	72.8
09-Nov-98	511005	surface water	156	ND	156	ND	0.216	83.5	ND	88.2
10-Feb-99	511006	surface water	164	ND	163		0.255	84	1.16	88.8
11-May-99	511007	surface water	151	ND	150	ND	0.192	87	0.708	82.9
05-Jan-98	103001	ground water	184	ND	184	ND		96.5	ND	142
06-Mar-98	103002	ground water	191	ND	188		ND	62	2.8	30.4
27-May-98	103003	ground water	166	0.045	166	ND	ND	73.8	ND	93.6
05-Aug-98	103004	ground water	209	0.0991	209		0.256	94.4	ND	65.2
10-Nov-98	103005	ground water	168	ND	168	ND	0.268	89.3	ND	120
12-Feb-99	103006	ground water	171	ND	171		0.268	83.3	ND	111
12-May-99	103007	ground water	189	ND	188	ND	0.322	94.8	1.14	112

Table 10 Summary Statistics
San Mateo Watershed

Date	ID	Matrix	Alkalinity	Arsenic	Bicarbonate	BOD	Boron	Calcium	Carbonate	Chloride
statistical distribution			N	NP	N	NP	N	N	N	N
mean			167.92		166.2		0.255923	71.488	2.3471111	84.708
standard deviation			26.1341411		25.59622368		0.088577	21.12992	1.4007514	31.429377
number of samples			25	2	25	0	13	25	18	25
maximum			209	0.0991	209	0	0.423	98.9	5.57	142
minimum			103	0.045	102	0	0.112	34	0.509	28.2
number of samples with ND's			25	25	25	13	24	25	25	25
% ND's			0%	92%	0%	100%	46%	0%	28%	0%
data type			A	D	A	D	C	A	C	A
variance							0.007846	446.4736	1.9621045	
DL			1	0.01	1	2	0.1	0.1	0.5	1
MCL				0.05						250
h							0.458333		0.28	
γ							0.322718		0.5750904	
λ							0.82211		0.460895	
adjusted mean							0.127737		1.4957868	
adjusted variance							0.027833		3.5345951	
adjusted standard deviation							0.166832		1.8800519	
α			0.05		0.05		0.05	0.05	0.05	0.05
ν			24		24		24	24	24	24
t			2.064		2.064		2.064	2.064	2.064	2.064
UPL			222.929107	0.025	220.0768579	2	0.485078	115.9638	5.4825466	150.86292

Table 10 Summary Statistics

San Mateo Watershed

Date	ID	Conductivity	Copper	Cyanide	Fecal Coliform	Fluoride	Hardness	Hydroxide	Iron	Lead
03-Mar-98	509002	719	ND		<2	0.386	330	ND	4	ND
26-May-98	509003	824	ND	ND	13	0.342	270	ND	0.11	ND
04-Aug-98	509004	874	ND		2	0.446	295	ND	0.478	ND
19-Feb-99	509006	1110	ND		<2	0.453	389	ND	0.382	0.00587
11-May-99	509007	1140	ND	ND	170	0.458	321	ND	0.835	ND
03-Mar-98	510002	332	ND		30	0.271	106	ND	0.8	ND
04-Jun-98	510003	394	ND	ND	110	0.334	142	ND	0.058	ND
04-Aug-98	510004	573	ND		130	0.334	204	ND	0.0618	0.00223
19-Nov-98	510005	629	ND	ND	4	0.301	222	ND	ND	ND
19-Feb-99	510006	572	ND		<2	0.31	201	ND	0.487	0.00616
11-May-99	510007	588	ND	ND	4	0.327	184	ND	ND	ND
09-Dec-97	511001	860	ND	ND	2	0.05	287	ND	0.068	ND
03-Mar-98	511002	434	ND		<2	0.295	145	ND	2.1	ND
26-May-98	511003	496	ND	ND	<2	0.278	166	ND	0.119	ND
04-Aug-98	511004	739	ND		<2	0.296	277	ND	0.0894	ND
09-Nov-98	511005	886	ND	ND	500	0.275	335	ND	0.5	ND
10-Feb-99	511006	934	ND		13	0.251	353	ND	ND	0.00133
11-May-99	511007	932	ND	ND	30	0.254	305	ND	ND	ND
05-Jan-98	103001	1030	0.026	ND	140	0.471	344	ND	31.1	0.026
06-Mar-98	103002	508	0.062		<2	0.459	202	ND	78	0.02
27-May-98	103003	544	0.036	ND	2	0.361	241	ND	45.1	0.0123
05-Aug-98	103004	679	0.0825			0.378	322	ND	104	0.0354
10-Nov-98	103005	952	0.014	ND	<2	0.265	357	ND	14.5	0.0037
12-Feb-99	103006	915	0.0192		30	0.267	318	ND	18.3	0.00635
12-May-99	103007	1070	0.0302	ND	<2	0.322	347	ND	34	0.0119

Table 10 Summary Statistics

San Mateo Watershed

Date	ID	Conductivity	Copper	Cyanide	Fecal Coliform	Fluoride	Hardness	Hydroxide	Iron	Lead
statistical distribution		N	NP	NP	NP	N	N	NP	N	NP
mean		749.36				0.32736	266.52		15.95658	
standard deviation		235.035437				0.091152	79.410914		28.52907	
number of samples		25	7	0	15	25	25	0	21	11
maximum		1140	0.0825	0	500	0.471	389	0	104	0.0354
minimum		332	0.014	0	2	0.05	106	0	0.058	0.00133
number of samples with N		25	25	13	25	25	25	25	25	25
% ND's		0%	72%	100%	40%	0%	0%	100%	16%	56%
data type		A	D	D	C	B	A	D	C	D
variance									813.9076	
DL		1	0.005	0.005	none	0.1	1	0.5	0.05	0.001
MCL		900	1	0.2					0.3	0.015
h						ND=DL/2			0.16	
γ						########			3.216781	
λ									use Trimmed	
adjusted mean									4.352247	
adjusted variance									75.81187	
adjusted standard deviati									8.707001	
α		0.05				0.05	0.05		0.05	
ν		24				24	24		24	
t		2.064				2.064	2.064		2.064	
UPL		1244.080276	0.5	0.1		0.519224	433.67007	0.5	22.74641	0.0075

Table 10 Summary Statistics

San Mateo Watershed

Date	ID	Magnesium	Manganese	Mercury	Nitrate	Nitrogen	Oil & Grease	pH	Phosphorus	Potassium
03-Mar-98	509002	24	0.11		0.298		ND	8.16	0.227	2
26-May-98	509003	24	0.017	ND	ND	ND	ND	8.27	0.012	1.75
04-Aug-98	509004	20.9	0.202		ND		ND	8.12	0.19	1.88
19-Feb-99	509006	26.2	0.0346		0.14		1.5	8.4	0.027	2.16
11-May-99	509007	26.1	0.0606	ND	ND	ND	ND	8.32	0.016	ND
03-Mar-98	510002	11	0.02		0.434		ND	7.89	0.108	ND
04-Jun-98	510003	13.3	0.007	ND	0.168		ND	8.61	ND	0.95
04-Aug-98	510004	18.4	0.0122		ND		ND	8.51	0.02	0.651
19-Nov-98	510005	21.6	ND	ND	ND		ND		ND	0.839
19-Feb-99	510006	18.7	ND		ND		ND	8.29	ND	ND
11-May-99	510007	17.5	ND	ND	ND	ND	ND	8.29	0.015	ND
09-Dec-97	511001	22.6	0.176	ND	7.72	ND	ND	7.3	0.027	1.45
03-Mar-98	511002	14	0.04		1.98		ND	8.13	0.373	ND
26-May-98	511003	15.5	ND	ND	1.27	ND	ND	7.83	0.021	0.955
04-Aug-98	511004	21.2	0.0283		7.6		ND	7.52	0.1	2.08
09-Nov-98	511005	25.7	0.0821	ND	11.8	0.526	ND		0.071	2.15
10-Feb-99	511006	26.3	ND		11.9		ND	7.3	ND	1.33
11-May-99	511007	24.3	ND	ND	12.5	ND	ND	7.18	0.038	1.18
05-Jan-98	103001	30.3	6.01	ND	ND	0.219		6.89	3.12	7.67
06-Mar-98	103002	31.7	8.04		ND		ND	7.56	0.736	16.2
27-May-98	103003	28.4	6.91	ND	ND	0.7	ND	6.65	1.27	9.08
05-Aug-98	103004	45.8	11.8		1.7		ND	7.21	0.05	18.6
10-Nov-98	103005	28.6	2.53	ND	ND	0.831	ND		0.323	4.94
12-Feb-99	103006	27.9	3.83		ND		ND	6.99	0.394	5.5
12-May-99	103007	33.4	5.64	ND	ND	1.11	1.22	6.85	0.829	7.37

Table 10 Summary Statistics
San Mateo Watershed

Date	ID	Magnesium	Manganese	Mercury	Nitrate	Nitrogen	Oil & Grease	pH	Phosphorus	Potassium
statistical distribution		N	N	NP	NP	NP	NP	N	LOG	LOG
mean		23.896	2.39735789					7.739545	0.379380952	4.43675
standard deviation		7.41105481	3.58646224					0.610967	0.709704338	5.1163733
number of samples		25	19	0	12	5	2	22	21	20
maximum		45.8	11.8	0	12.5	1.11	1.5	8.61	3.12	18.6
minimum		11	0.007	0	0.14	0.219	1.22	6.65	0.012	0.651
number of samples with N		25	25	15	25	12	25	22	25	25
% ND's		0%	24%	100%	52%	58%	92%	0%	16%	20%
data type		A	C	D	D	D	D	A	C	C
variance			12.8627114						0.503680248	26.177276
DL		0.2	0.01	0.0002	0.05	0.1	1	none	0.01	0.3
MCL			0.05	0.002	45	10				
h			0.24						0.16	0.2
γ			2.25682282						3.691525956	1.5296987
λ			use Trimmed						use Trimmed	use Trimmed
adjusted mean			0.2556						0.118352941	1.9876667
adjusted variance			0.47086842						0.017610618	1.9863404
adjusted standard deviation			0.68619852						0.132705002	1.4093759
α		0.05	0.05					0.05	0.05	0.05
ν		24	24					24	24	24
t		2.064	2.064					2.064	2.064	2.064
UPL		39.4953459	1.70870725	0.001	22.5	5	1	9.028923	0.398701727	4.9684553

Table 10 Summary Statistics
San Mateo Watershed

Date	ID	Sodium	Sulfate	Surfactants	Total Coliform	TDS	TOC	Zinc
03-Mar-98	509002	70	125	ND	900	478	4.75	ND
26-May-98	509003	74.3	127	ND	80	553	4.62	ND
04-Aug-98	509004	48.8	174	ND	>1600	545	1.41	0.0184
19-Feb-99	509006	107	199	ND	30	711	5.29	ND
11-May-99	509007	104	219	0.106	280	703	2.51	ND
03-Mar-98	510002	33	26.6	ND	900	206	2.8	0.09
04-Jun-98	510003	39.5	35.9	ND	300	283	4.31	ND
04-Aug-98	510004	62.2	55.2	ND	220	366	1.81	ND
19-Nov-98	510005	51.5	58	ND	11	391	1.7	0.0109
19-Feb-99	510006	48.3	52.8	ND	60	358	2.83	0.0104
11-May-99	510007	45	50	ND	70	361	ND	ND
09-Dec-97	511001	60.8	123	ND		360	4.21	ND
03-Mar-98	511002	42	47	ND	240	273	5.84	ND
26-May-98	511003	45.1	78.8	ND	170	327	2.48	ND
04-Aug-98	511004	120	119	ND	300	470	3.53	ND
09-Nov-98	511005	67.4	171	ND	900	595	ND	ND
10-Feb-99	511006	68.6	148	ND	59	586	3.69	ND
11-May-99	511007	60.6	157	ND	>1600	583	1.45	ND
05-Jan-98	103001	104	139	ND	ND	618	3.34	0.113
06-Mar-98	103002	58.5	31.6	ND	80	461	5.97	0.25
27-May-98	103003	48.4	71.1	ND	70	393	7.1	0.14
05-Aug-98	103004		80.4	ND	>1600	454	5.17	0.307
10-Nov-98	103005	67.2	137	ND	2	611	ND	0.046
12-Feb-99	103006	77.6	146	ND	900	585	ND	0.0596
12-May-99	103007	90	180	ND	2	676	1.7	0.109

Table 10 Summary Statistics
San Mateo Watershed

Date	ID	Sodium	Sulfate	Surfactants	Total Coliform	TDS	TOC	Zinc
statistical distribution		N	N	NP	NP	N	N	NP
mean		66.408333	110.056			477.88	3.643333	
standard deviation		23.579374	57.12032			142.3702	1.658371	
number of samples		24	25	1	20	25	21	11
maximum		120	219	0.106	900	711	7.1	0.307
minimum		33	26.6	0.106	2	206	1.41	0.0104
number of samples with N		24	25	25	25	25	25	25
% ND's		0%	0%	96%	20%	0%	16%	56%
data type		A	A	D	C	A	C	D
variance							2.750193	
DL		0.3	5	0.1	none	10	1	0.01
MCL			250	0.5		500		5
h							0.16	
γ							0.393604	
λ							0.22694	
adjusted mean							3.043455	
adjusted variance							4.335871	
adjusted standard deviati							2.082276	
α		0.05	0.05		0.05	0.05	0.05	
v		24	24		24	24	24	
t		2.064	2.064		2.064	2.064	2.064	
UPL		116.07973	230.2871	0.25	0	777.5515	7.442411	2.5