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(PG&E, 2003a)

BEFORE THE FEDERAL ENERGY REGULATORY COMMISSION

POE HYDROELECTRIC PROJECT
FERC NO. 2107

APPLICATION FOR NEW LICENSE

FINAL: December 2003

VOLUME 3 of 4

APPENDICES

PG&E

POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDICES

Report E3

FISH, WILDLIFE, AND BOTANICAL RESOURCES

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Section E3.2 Wildlife Resources

Section E3.3 Botanical Resources

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APPENDIX B-1

Flow Duration Curves

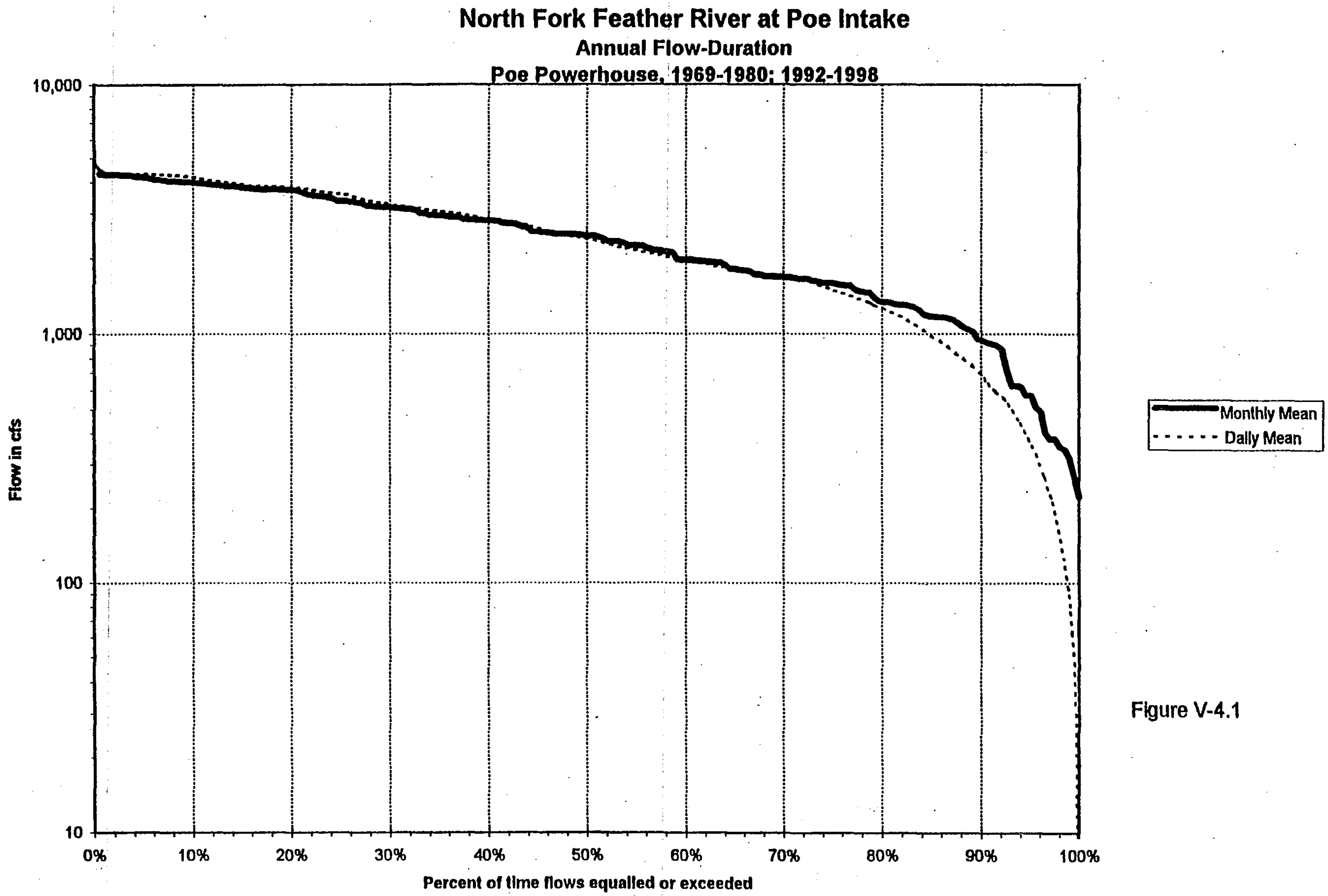

North Fork Feather River at Poe Intake
Annual Flow-Duration
Poe Powerhouse, 1969-1980; 1992-1998
10,000
1,000
100
10
Flow in cfs
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time flows equalled or exceeded
Monthly Mean
Daily Mean

Figure V-4.1

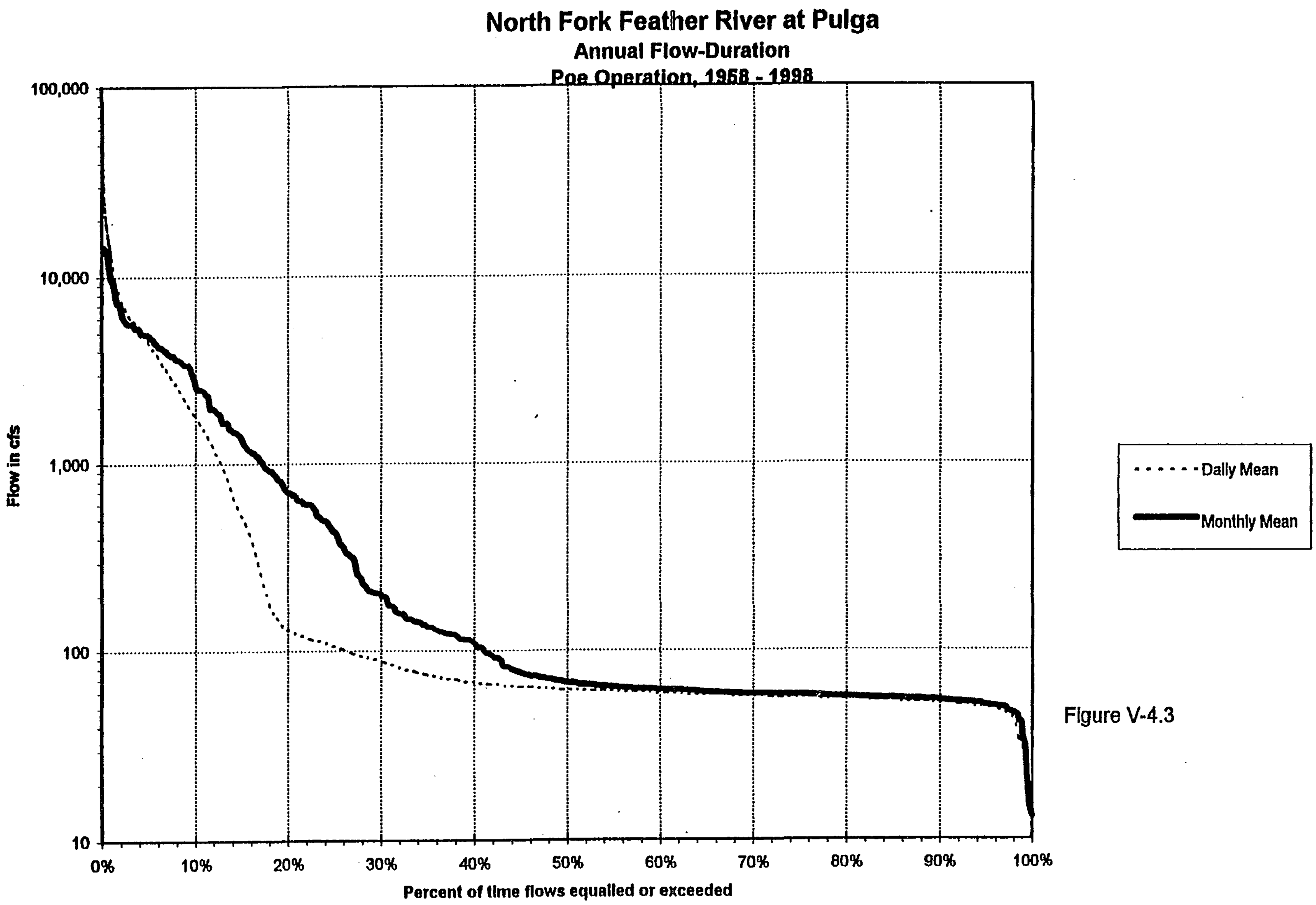

North Fork Feather River at Pulga
Annual Flow-Duration
Poe Operation, 1958 - 1998
100,000
10,000
1,000
100
10
Flow in cfs
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time flows equalled or exceeded
Daily Mean
Monthly Mean

Figure V-4.3

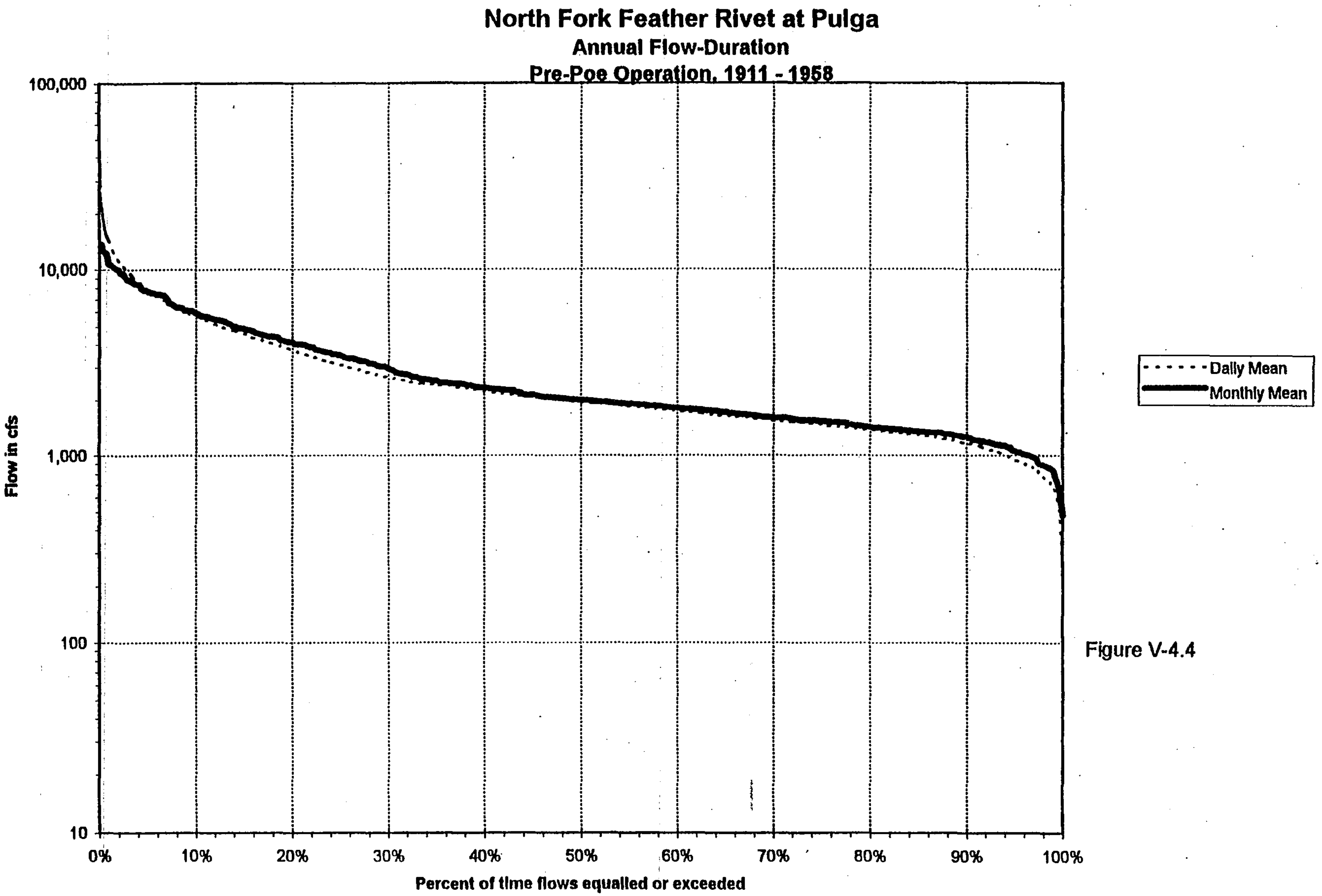

North Fork Feather Rivet at Pulga
Annual Flow-Duration
Pre-Poe Operation, 1911 - 1958
100,000
10,000
1,000
100
10
Flow in cfs
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time flows equalled or exceeded
Daily Mean
Monthly Mean

Figure V-4.4

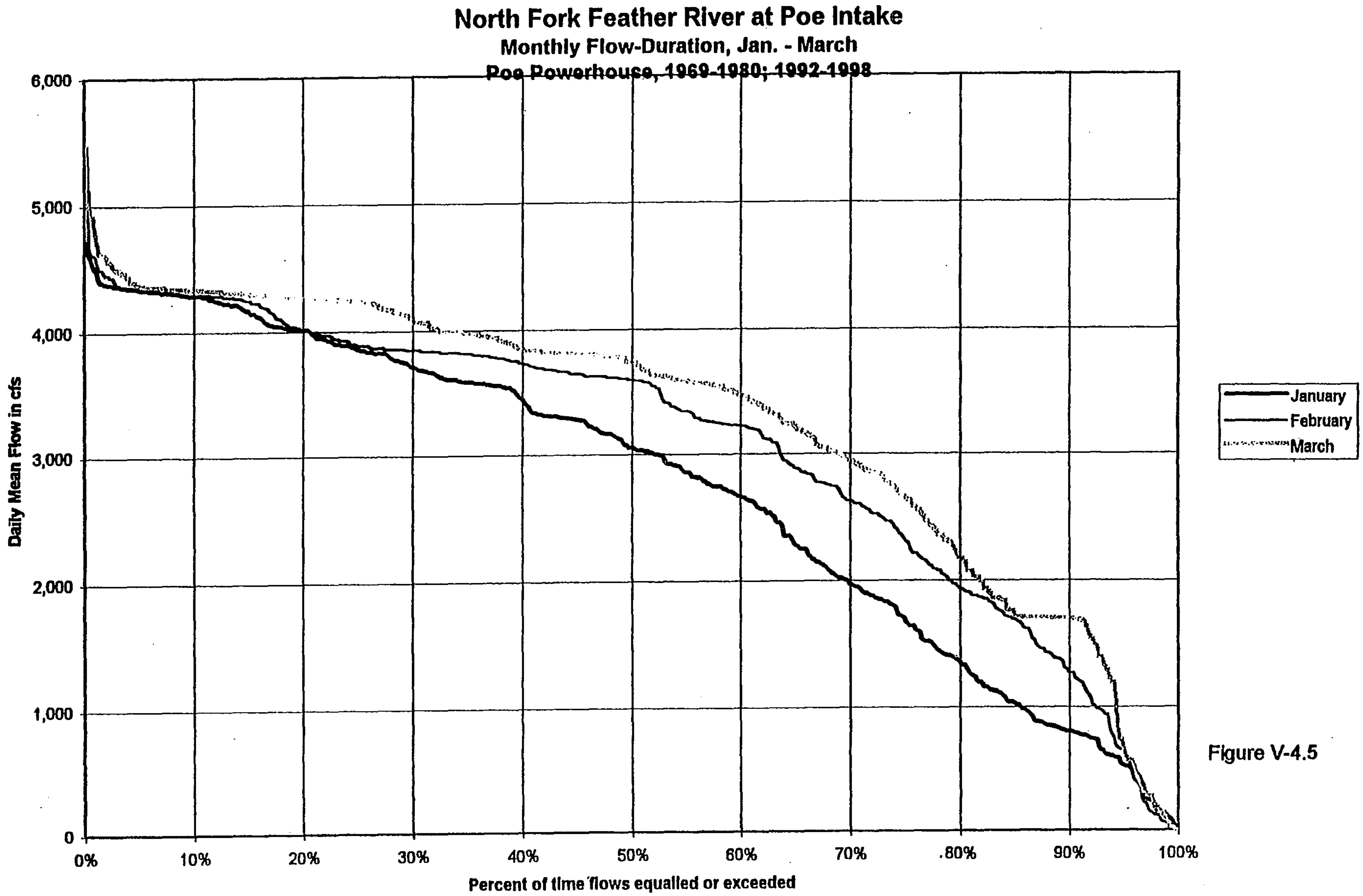

North Fork Feather River at Poe Intake
Monthly Flow-Duration, Jan. - March
Poe Powerhouse, 1969-1980; 1992-1998
Daily Mean Flow in cfs
6,000
5,000
4,000
3,000
2,000
1,000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time flows equalled or exceeded
January
February
March

Figure V-4.5

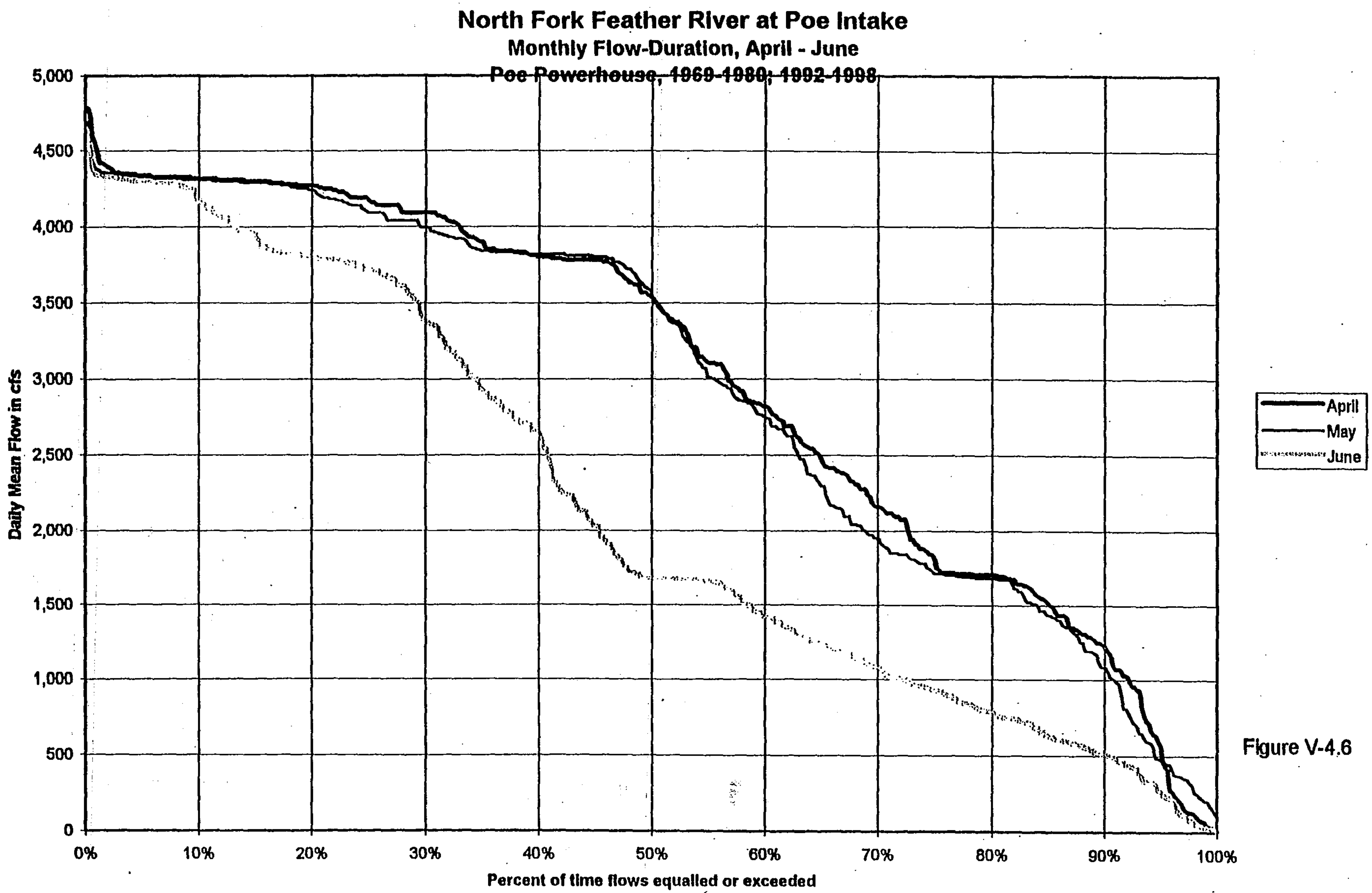

North Fork Feather River at Poe Intake
Monthly Flow-Duration, April - June
Poe Powerhouse, 1969-1980; 1992-1998
Daily Mean Flow in cfs
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time flows equalled or exceeded
April
May
June

Figure V-4.6

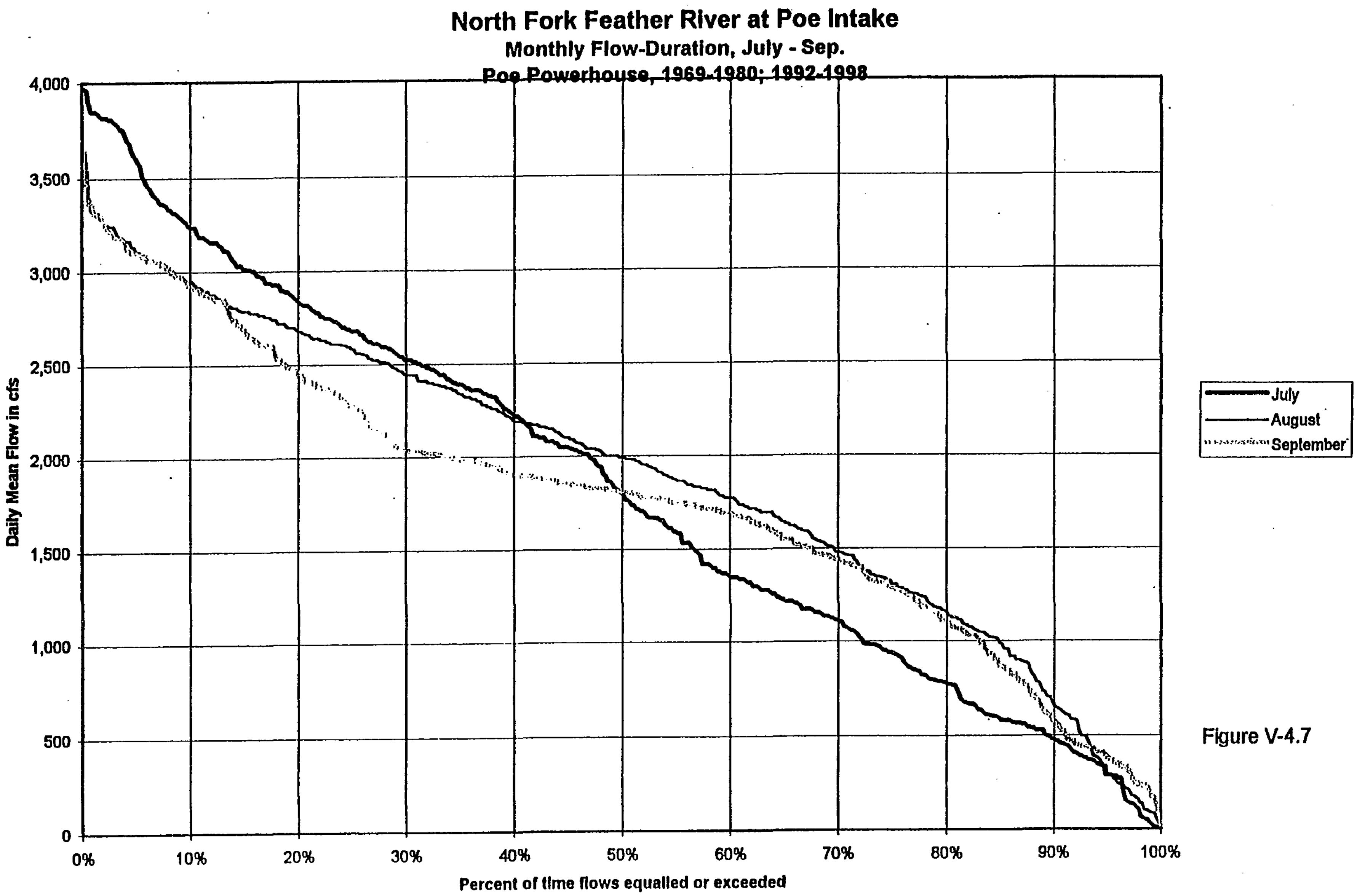

North Fork Feather River at Poe Intake
Monthly Flow-Duration, July - Sep.
Poe Powerhouse, 1969-1980; 1992-1998
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Daily Mean Flow in cfs
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time flows equalled or exceeded
July
August
September

Figure V-4.7

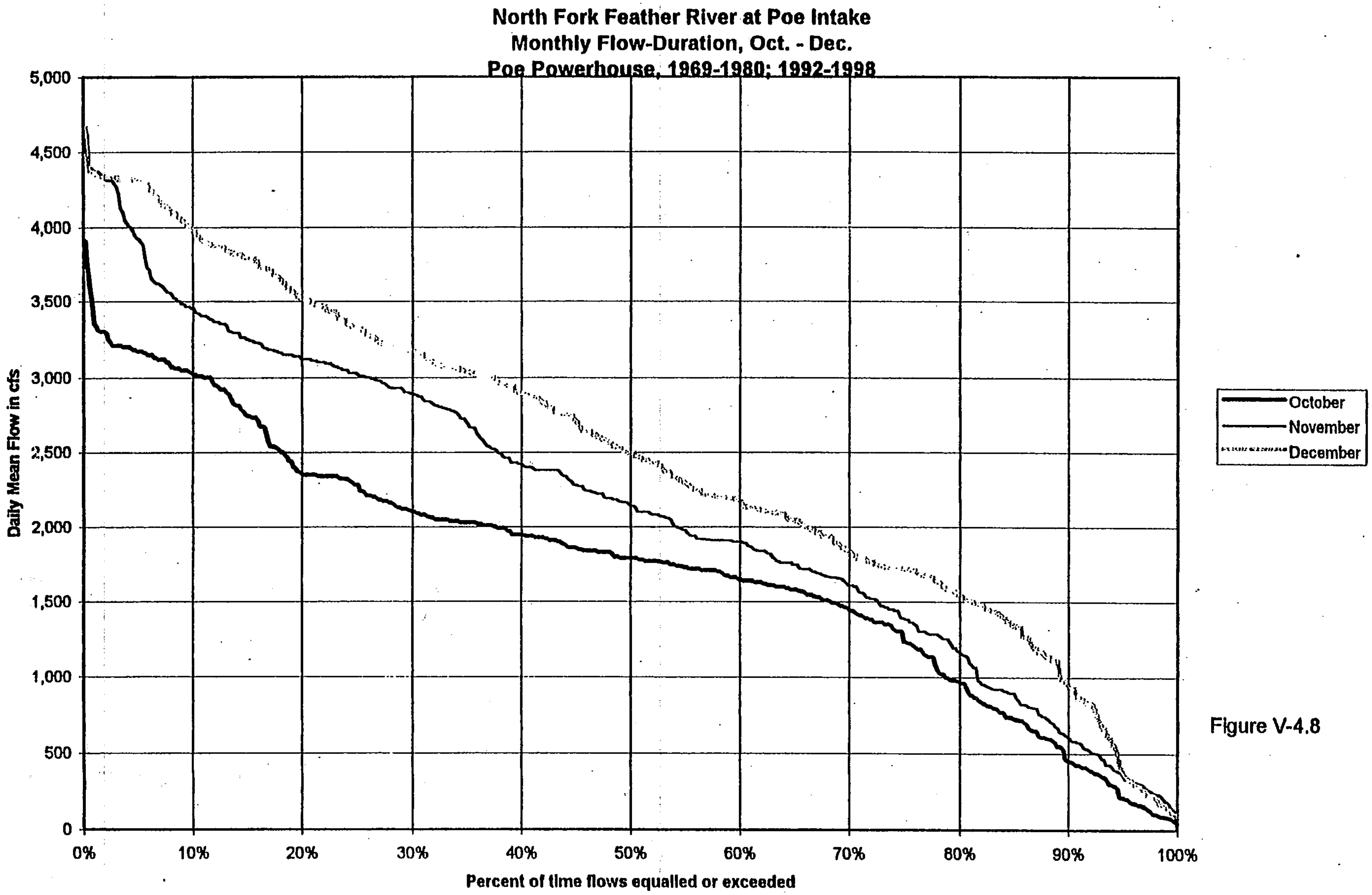
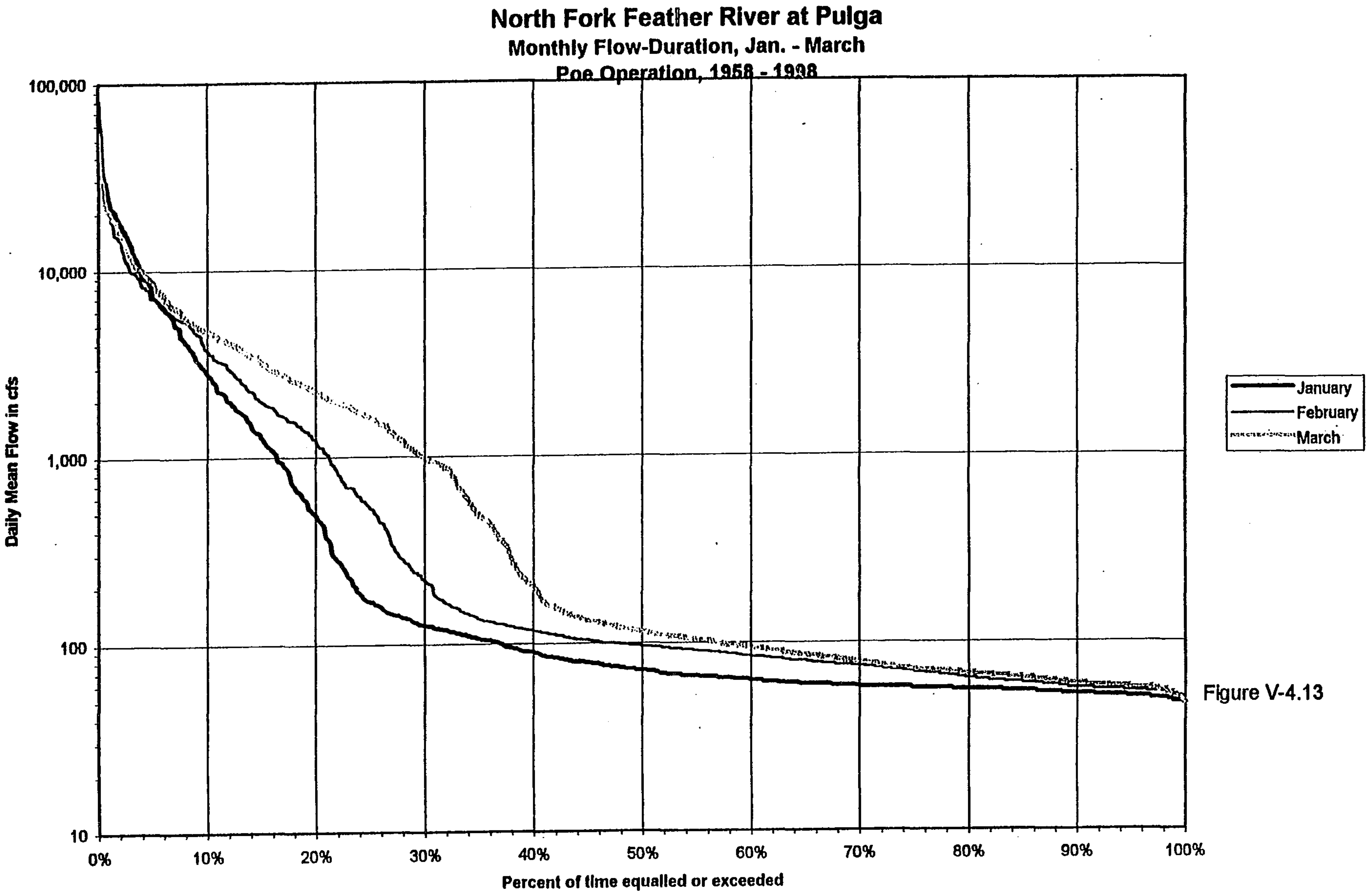

North Fork Feather River at Poe Intake
Monthly Flow-Duration, Oct. - Dec.
Poe Powerhouse, 1969-1980; 1992-1998
Daily Mean Flow in cfs
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time flows equalled or exceeded
October
November
December

Figure V-4.8



North Fork Feather River at Pulga
Monthly Flow-Duration, Jan. - March
Poe Operation, 1958 - 1998
Daily Mean Flow in cfs
100,000
10,000
1,000
100
10
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time equalled or exceeded
January
February
March

Figure V-4.13

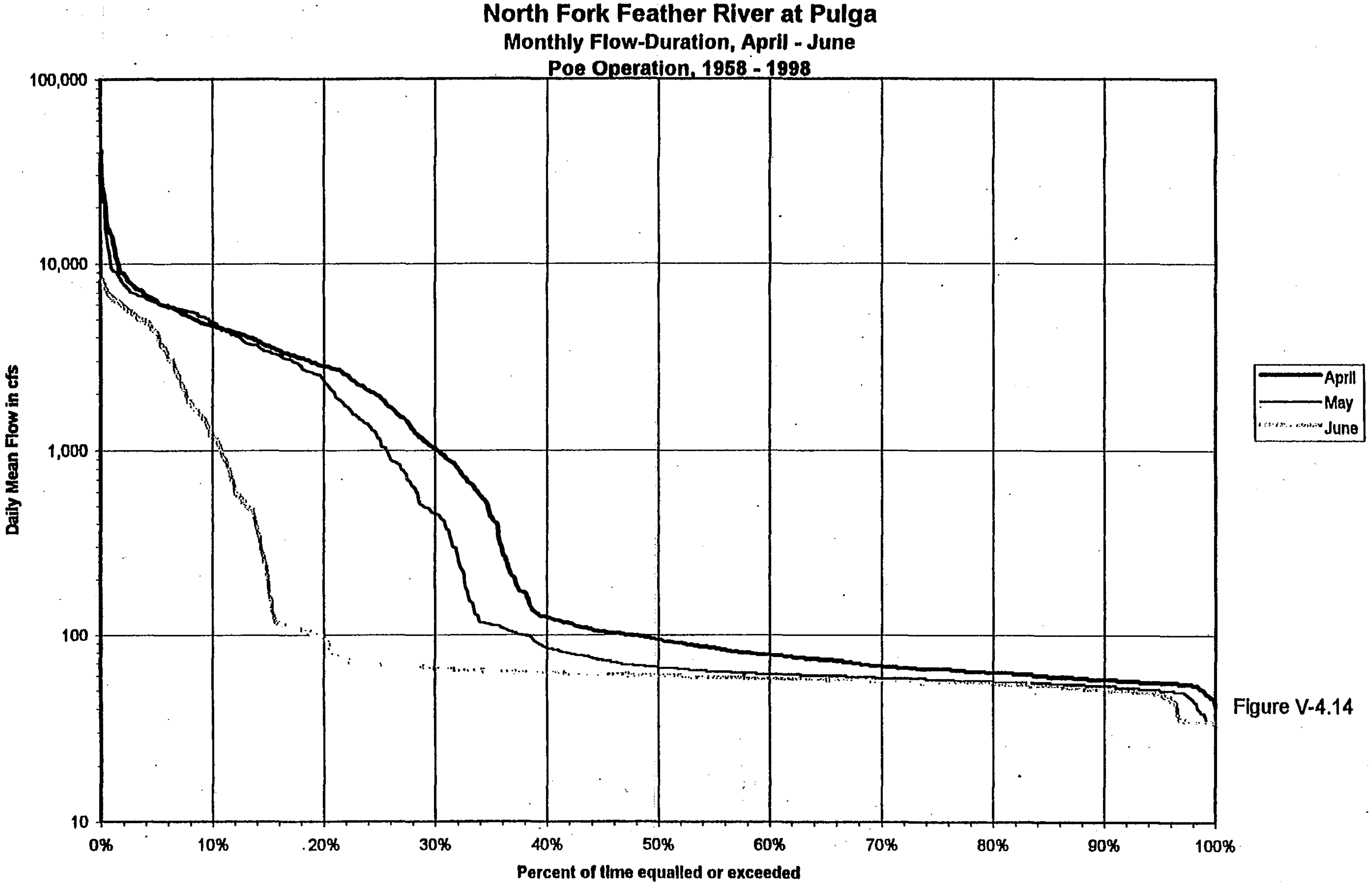

North Fork Feather River at Pulga
Monthly Flow-Duration, April - June
Poe Operation, 1958 - 1998
Daily Mean Flow in cfs
100,000
10,000
1,000
100
10
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time equalled or exceeded
April
May
June

Figure V-4.14

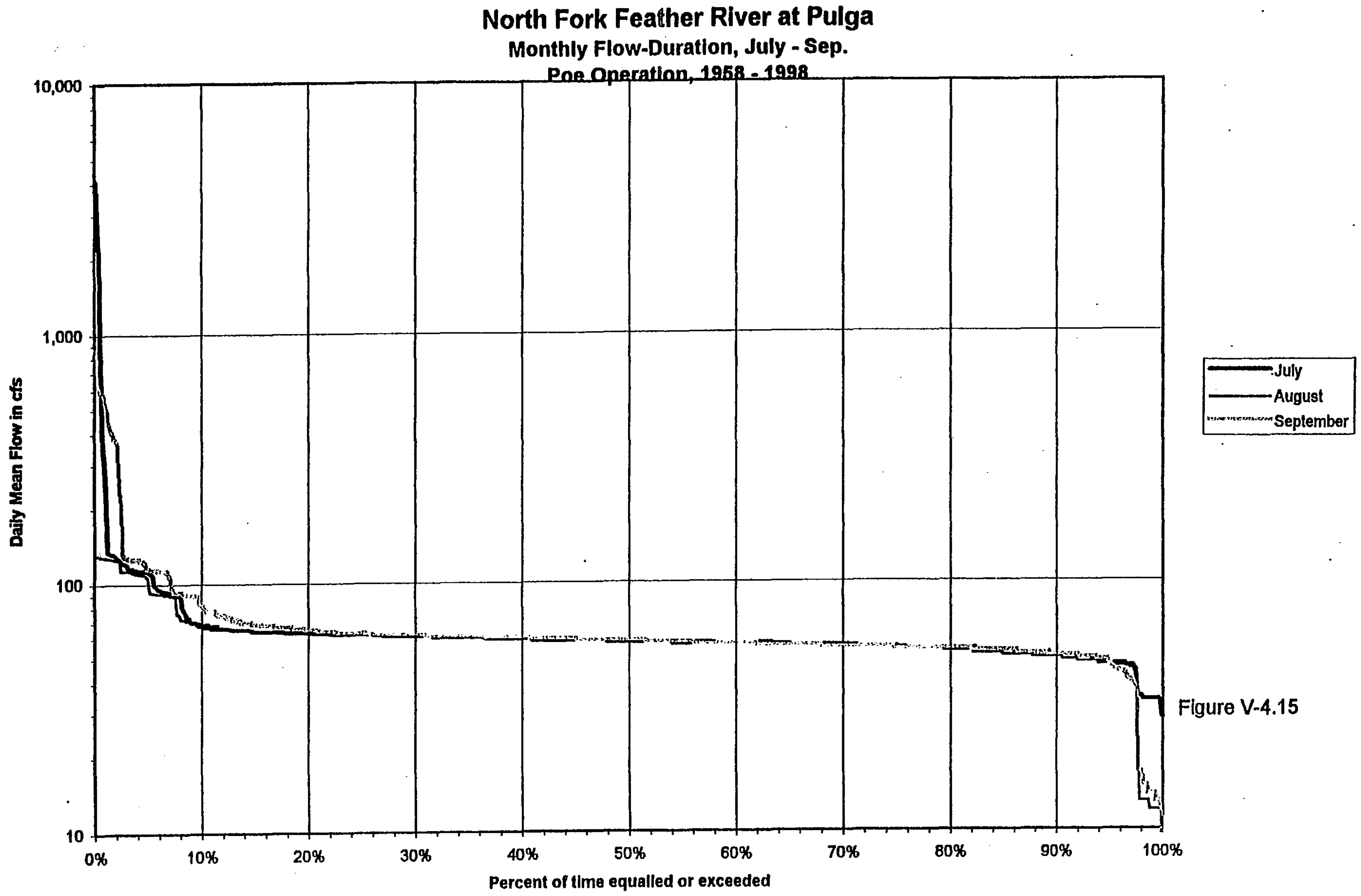

North Fork Feather River at Pulga
Monthly Flow-Duration, July - Sep.
Poe Operation, 1958 - 1998
10,000
1,000
100
10
Daily Mean Flow in cfs
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time equalled or exceeded
July
August
September

Figure V-4.15

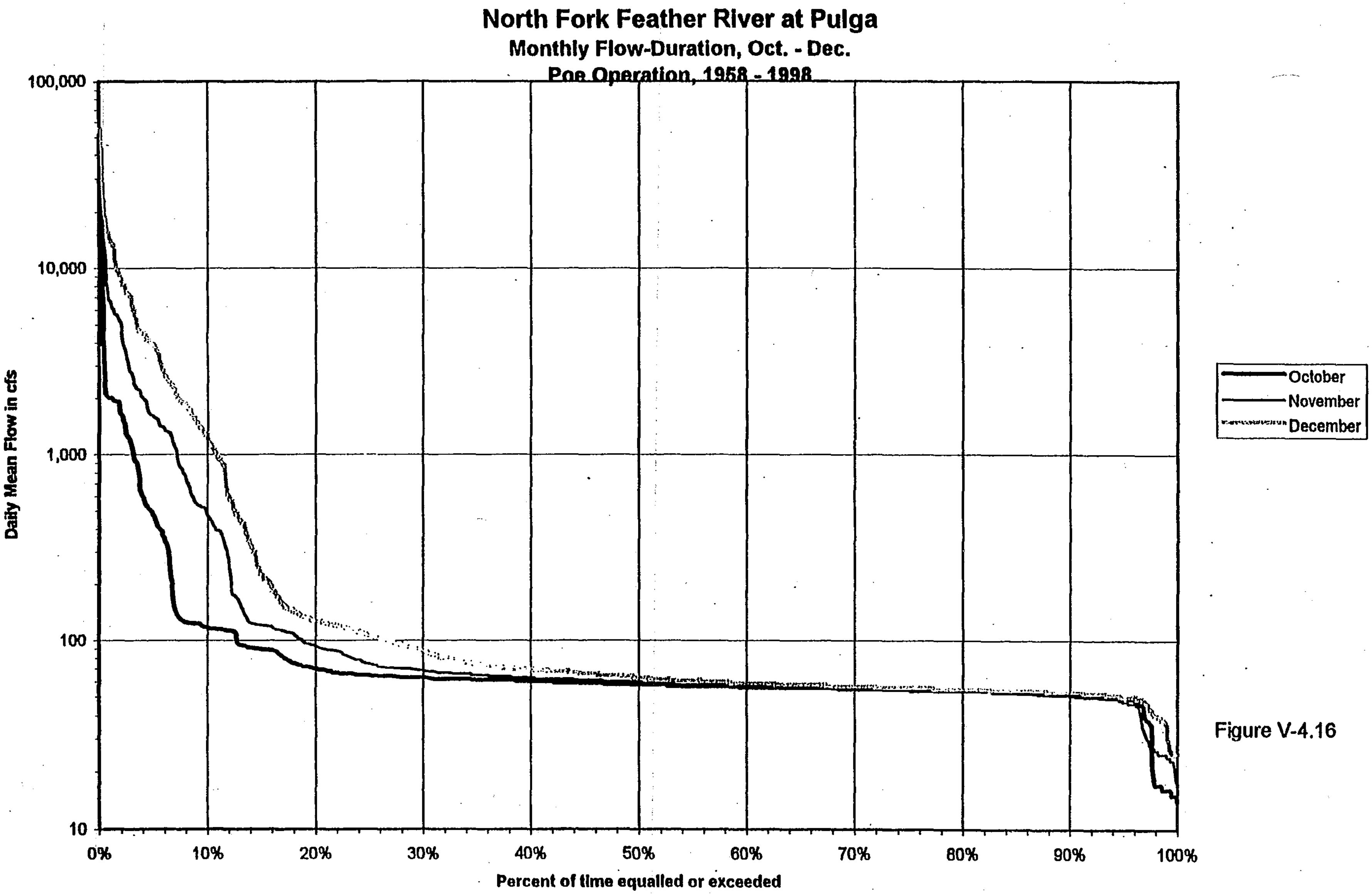

North Fork Feather River at Pulga
Monthly Flow-Duration, Oct. - Dec.
Poe Operation, 1958 - 1998
100,000
10,000
1,000
100
10
Daily Mean Flow in cfs
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time equalled or exceeded
October
November
December

Figure V-4.16

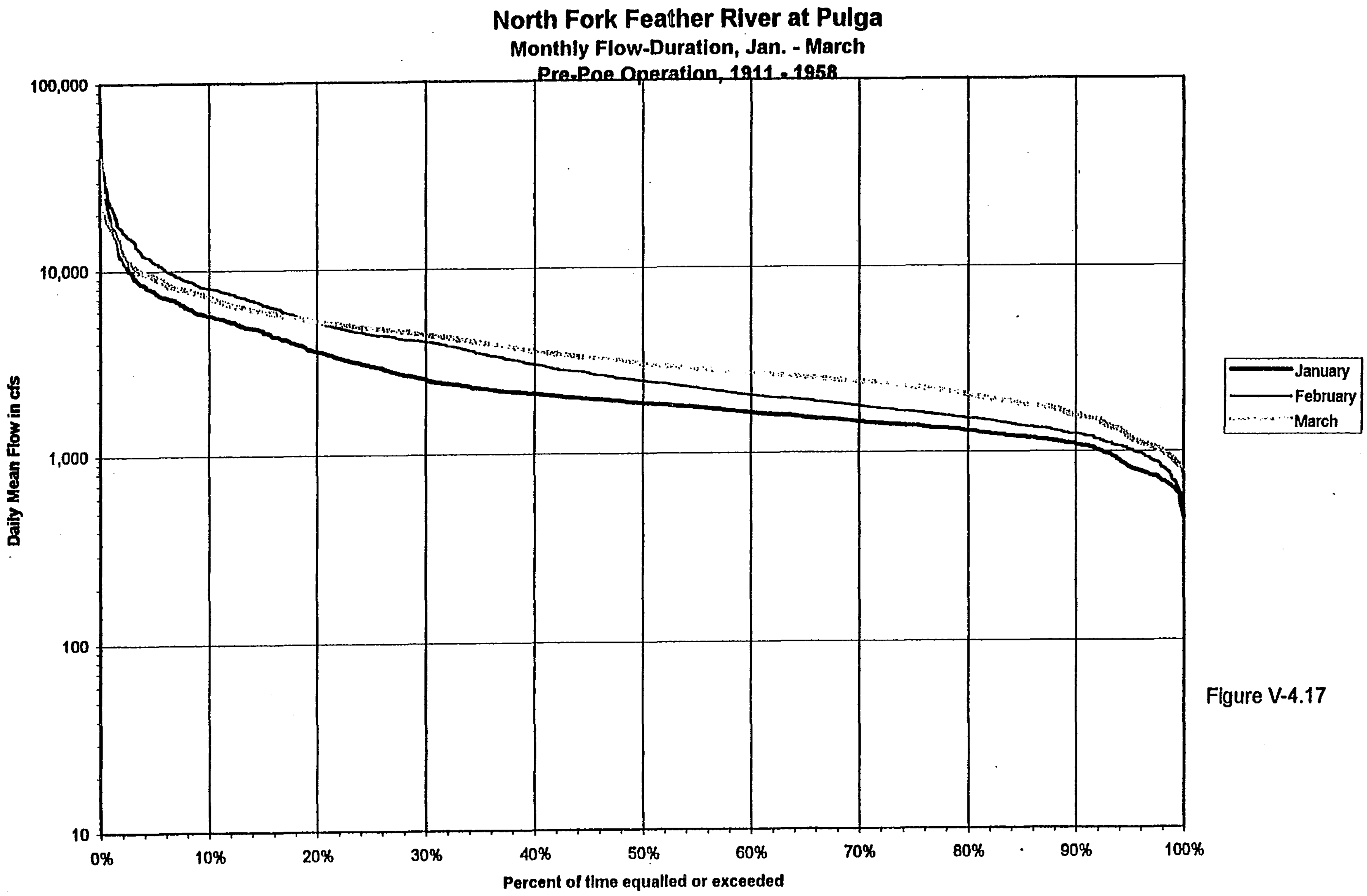

North Fork Feather River at Pulga
Monthly Flow-Duration, Jan. - March
Pre-Poe Operation, 1911 - 1958
100,000
10,000
1,000
100
10
Daily Mean Flow in cfs
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time equalled or exceeded
January
February
March

Figure V-4.17

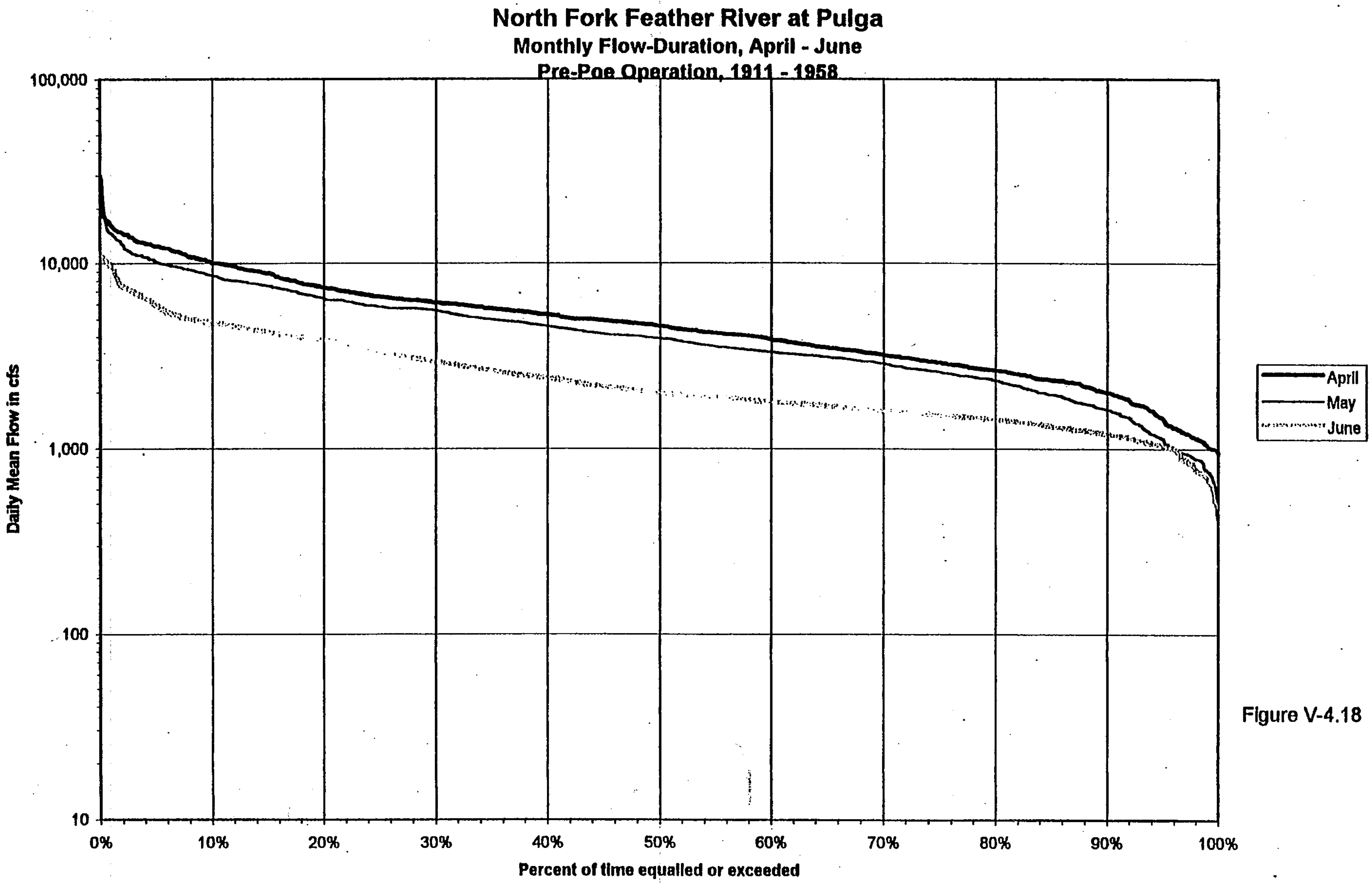
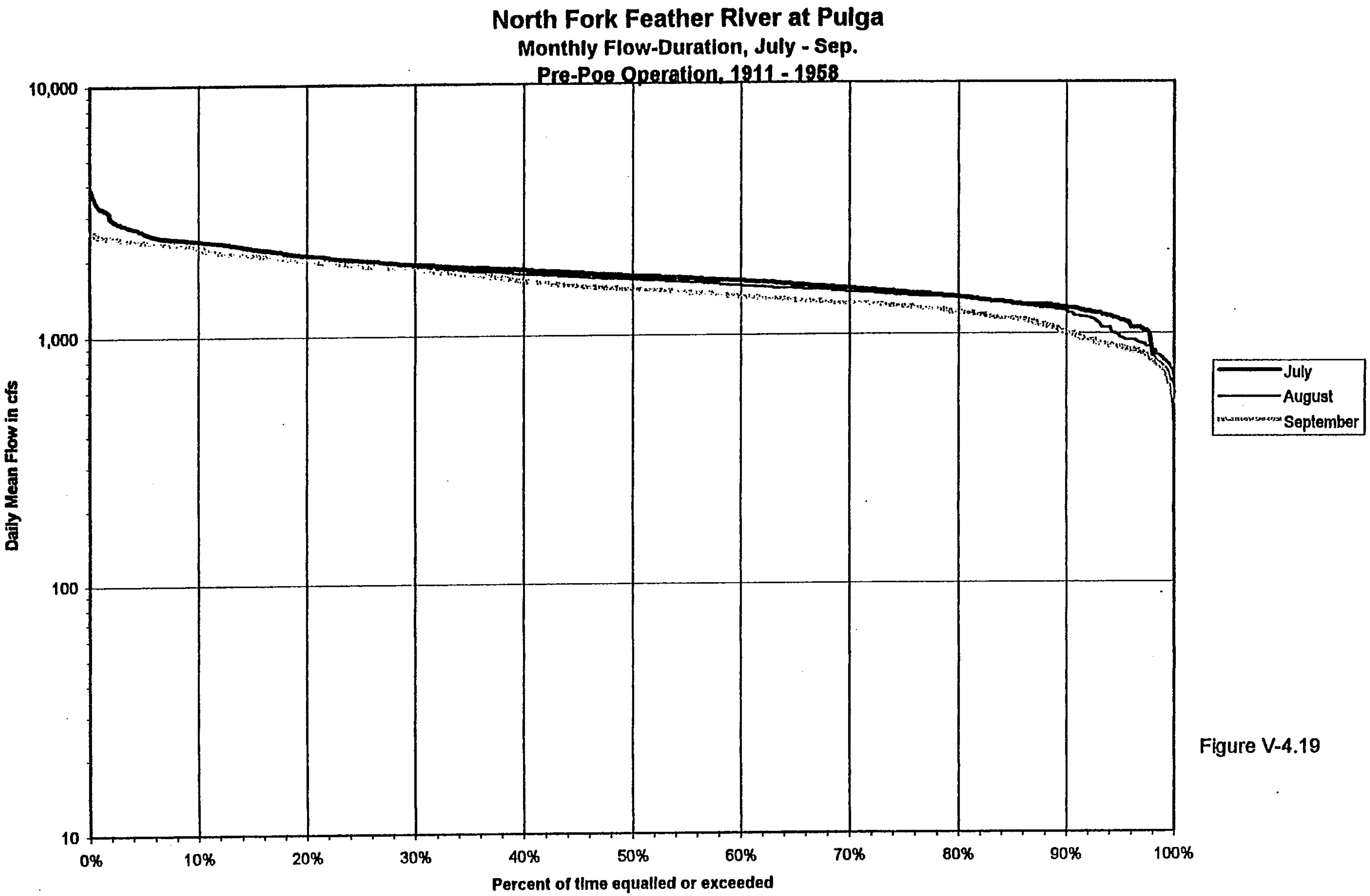

North Fork Feather River at Pulga
Monthly Flow-Duration, April - June
Pre-Poe Operation, 1911 - 1958
100,000
10,000
1,000
100
10
Daily Mean Flow in cfs
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time equalled or exceeded
April
May
June

Figure V-4.18



North Fork Feather River at Pulga
Monthly Flow-Duration, July - Sep.
Pre-Poe Operation, 1911 - 1958
10,000
1,000
100
10
Daily Mean Flow in cfs
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time equalled or exceeded
July
August
September

Figure V-4.19

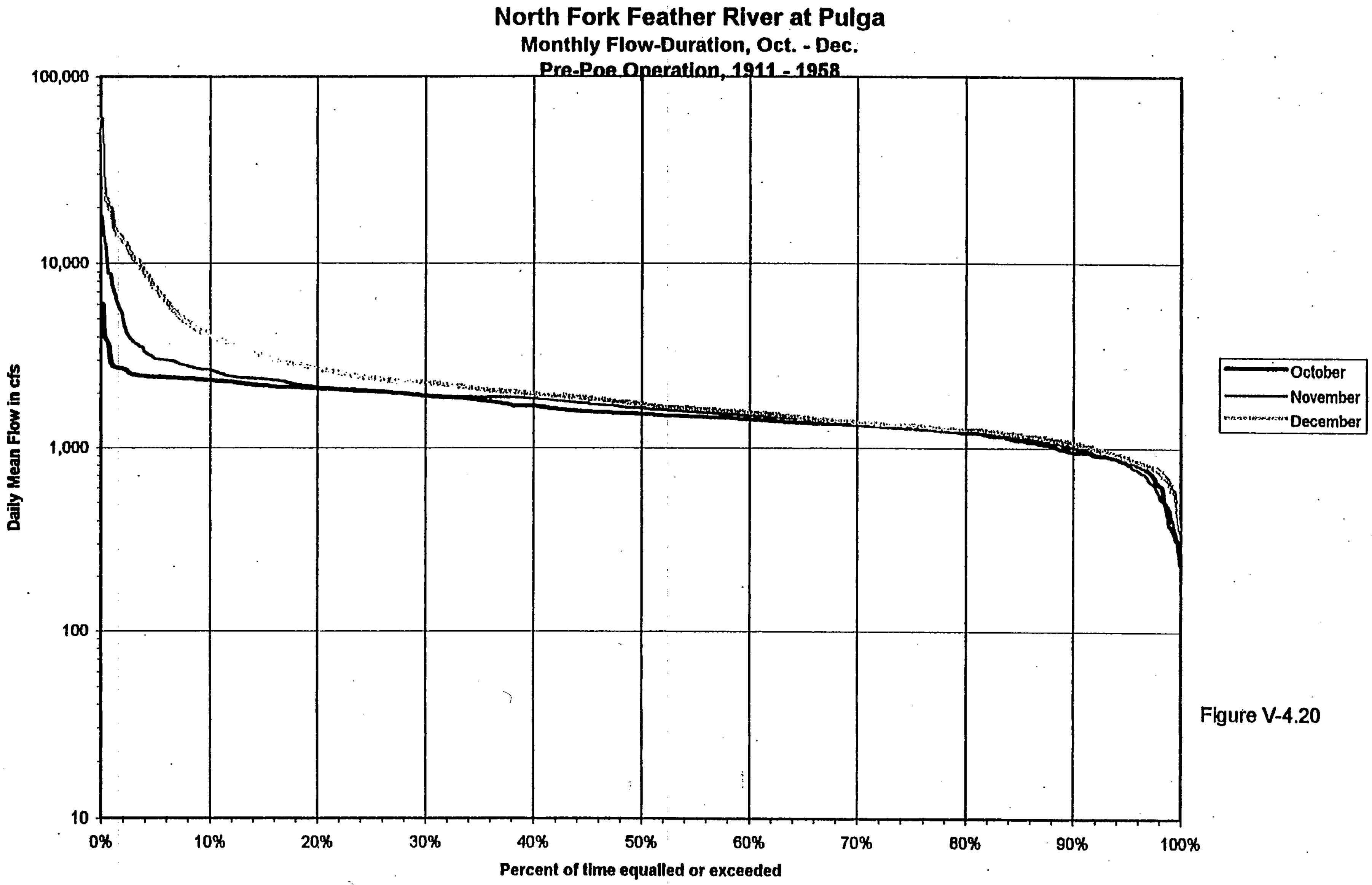

North Fork Feather River at Pulga
Monthly Flow-Duration, Oct. - Dec.
Pre-Poe Operation, 1911 - 1958
100,000
10,000
1,000
100
10
Daily Mean Flow in cfs
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of time equalled or exceeded
October
November
December

Figure V-4.20

POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX B-2

Indicators of Hydrologic Alteration Analysis

Indicators of Hydrologic Alteration

1.1 Introduction

In 1997, The Nature Conservancy developed and published a software package intended to allow the analysis of existing or proposed changes to riverine streamflow regimes (The Nature Conservancy, 1997, "Indicators of Hydrologic Alteration: User's Manual", developed with Smythe Scientific Software, Boulder, CO, pp 77). The Indicators of Hydrologic Alteration (IHA) software produces a standardized set of statistical metrics that contrast streamflow magnitudes, ranges, and timing of the pre- and post-Project streamflow records. These 32 metrics focus on descriptors of the streamflow regime that are thought to be important to the biological and physical aspects of a river. The IHA software requires mean daily streamflow records for the reach that is being analyzed, and a record of at least 25 years length is suggested.

In addition to producing mean or median monthly streamflows and other statistics, the IHA develops a prescriptive concept based on the natural variability of the metrics it calculates. For example, if the pre-Project median October streamflow is 2000 cfs, the 25% streamflow is 500 cfs, and the 75% streamflow is 4000 cfs, this span is termed the range of variability approach (RVA). If the post-Project median October streamflow is 100 cfs, the 25% streamflow is 10 cfs, and the 75% streamflow is 400 cfs, the RVA concept suggests that adverse biological and geomorphologic effects, if they occur, can be mitigated by changing the post-Project streamflow range until it overlaps, at least in part, the pre-Project RVA. This prescription is based on a "natural streamflow paradigm," which states that the full range of intra- and inter-annual streamflow variation is important for sustaining river ecosystem integrity.

The IHA method is new, and little evidence exists to document the successful implementation of the RVA precept. The range of the dispersion targets (+/- 25%, +/- 30%, or +/- 1 or 2 standard deviations) is user selected, and the User's Manual suggests that streamflow targets should be based on ecological information. The IHA developers believe that the RVA targets are means to achieving biological goals, and are not ends in themselves. Analysis of the pre- and post-Project RVA results may identify metrics that show a change. If this change (such as 3-day minimum streamflows) corresponds to a documented summer water temperature issue related to fisheries health, changes in summer streamflow schedules may be warranted. To this end, a water temperature monitoring program could be implemented that was designed to assess the ecological effects of changes in the monthly instream streamflow schedule. Monitoring results provide the basis for adapting the instream streamflow schedule as measures of key indicators and species are assessed over a number of years. The IHA developers suggest that a similar paradigm should be applied to any resource problem that is identified.

1.2 POE PROJECT UNIMPAIRED STREAMFLOW SYNTHESIS

Because the Project facilities have been in place since 1958, gage records of pre-Project daily mean streamflow have not been possible to collect for many years. Streamflow in the Poe Reach has been affected by other North Fork Feather River water resource developments since 1911. Because the streamflow has been modified for many years, an unimpaired streamflow record was synthesized for a 27-year period from 1974 through 2000. The daily streamflows were synthesized using a mass balance technique. The mass balance procedure takes into account daily streamflow through upstream powerhouses, reach instreamflow, daily changes in storage in upstream reservoirs, forebays, and afterbays, and other known instreamflows (springs and side-channel tributaries) and outstreamflows (sinks). The sum of these streamflows and storage changes for each day produces a streamflow record for a specified point on the river that approximates the streamflow that would occur at that point if no Project facilities were in place.

The mass balance procedure suffers from several error sources. Daily storage change estimates are based on changes in stage height of the reservoirs, and wind or inaccurate storage/stage height tables can result in errors in the daily record. This type of error is typically smoothed out by estimating long periods of time such as monthly unimpaired streamflow, but daily records require editing (smoothing) to compensate for these errors. Another source of error is associated with travel time through the river reaches, and additional error can intrude due to the inaccuracy of traditional stream gages at low or high streamflows.

A smoothing process was implemented to compensate for these errors. Each of the 27 years was plotted (streamflow in cfs versus day of the year), and precipitation magnitudes and durations were co-plotted. Spikes and dips were adjusted to a central tendency if no precipitation occurred, but streamflow increases and decreases associated with storms were retained. Cross-referencing to the observed streamflows at Licensee gage NF23 gage (USGS Station 11404500, North Fork Feather River at Pulga) was done to further determine the magnitude of storm responses versus streamflow variation due to input errors. All streamflow adjustments were made manually by a Certified Professional Hydrologist with extensive experience in hydrographic techniques. The completed 27-years of synthesized data were then combined with the record for Licensee gage NF23 to permit analysis by the IHA software.

1.3 POE PROJECT IHA

Based on the 27 years of unimpaired and regulated streamflow, a nonparametric IHA analysis of the Project reach was performed. To represent the pre- and post-Project format that is required by the IHA, the years for the unimpaired data were shifted by 30 years, and the 1974-2000 dates became 1944-1970. This date shift allows the IHA output to appear in chronological order and is a requirement of the program. The output of the IHA process is voluminous, and 32 plots are produced along with three tables. The analytical results can be clustered into five groups:

1. Magnitude of monthly water conditions
2. Magnitude and duration of annual extreme water conditions
3. Timing of annual extreme water conditions
4. Frequency and duration of high/low pulses
5. Rate/frequency of water condition changes

Group 1 parameters derive the median streamflow (across all the years) for each calendar month. Group 2 parameters derive annual maxima and minima streamflows for the 1-, 3-, 7-, 30-, and 90-day median streamflows, and a base streamflow. Group 3 parameters reflect timing by finding the Julian date of the maximum and minimum streamflow of each year and deriving the median value. Julian dating sets 1 January as Julian Day 1, and 31 December is Julian Day 365 in non-leap years. Group 4 parameters tabulate the number and duration of high and low pulses in each year, and calculate median values. Group 5 parameters derive the number of all positive and negative differences in daily streamflows to calculate median rise and fall rates as well as the number of reversals, or changes in direction.

A summary of the results as provided by the three tables for the Poe Reach is presented below as Tables 1 through 3

Table 1

Non-Parametric IHA Scorecard

			Poe IHA	1974-2000			bjmgurk 010604	
Pre-impact period	: 1944-1970	(27 years	)	Post-i	mpact peri	od: 1974-2000	(27 years)	
Watershed area		N/A				N/A		
Mean annual flow		3169.35				895.54		
Mean flow/area		3169.35				895.54		
Annual C. V.		0.71				0.06		
Flow predictability		0.52				0.45		
Constancy/predictabilit	y	0.66				0.78		
% of floods in 60d peri	od	0.44				0.44		
flood-free season		103				132		
	MEDIA	NS	COEFF.	of DISP.	DEVIATI	ON FACTOR	SIGNIFICANCE	COUNT
	Pre	Post	Pre	Post	Medians	C.V.	Medians	C.V.
Parameter	Group #1							
October	1143	67	0.39	0.97	0.94	1.49	0.26	0.51
November	1397	64	1.02	4.07	0.95	2.99	0.06	0.04
December	1868	92	0.95	7.74	0.95	7.16	0.02	0.01
January	3349	198	0.97	8.19	0.94	7.46	0.01	0
February	3820	354	1.08	9.08	0.91	7.40	0.09	0
March	5490	913	0.93	4.11	0.83	3.42	0.01	0
April	5135	353	0.77	7.76	0.93	9.10	0.03	0
May	4333	134	1.56	20.12	0.97	11.91	0.01	0.01
June	1825	65	1.49	2.32	0.96	0.55	0.08	0.39
July	994	62	0.80	0.22	0.94	0.73	0.26	0.78
August	802	59	0.66	0.18	0.93	0.73	0.33	0.92
September	887	62	0.46	0.29	0.93	0.38	0.33	0.97
Parameter	Group #2							
1-day minimum	634	51	0.38	0.24	0.92	0.38	0.33	1
3-day minimum	610	52	0.57	0.21	0.91	0.64	0.33	0.98
7-day minimum	624	53	0.59	0.17	0.92	0.72	0.28	0.81
30-day minimum	671	55	0.57	0.22	0.92	0.63	0.24	0.8
90-day minimum	831	57	0.63	0.16	0.93	0.74	0.33	0.89
1-day maximum	23182	17726	1.40	1.33	0.24	0.05	0.28	0.92
3-day maximum	15821	11781	1.61	1.71	0.26	0.07	0.29	0.86
7-day maximum	13035	6995	1.14	2.03	0.46	0.78	0.18	0.12
30-day maximum	8745	4143	1.06	1.54	0.53	0.45	0.06	0.28
90-day maximum	6751	2488	0.97	1.99	0.63	1.04	0.07	0.07
Number of zero days	0	0	0	0	999999	999999	0	0
Base flow	0	0	0.63	7.84	0.70	11.38	0.02	0
Parameter	Group #3							
Date of minimum	251	281	0.13	0.22	0.16	0.74	0.09	0.03
Date of maximum	65	45	0.10	0.15	0.11	0.45	0.06	0.48
Parameter	Group #4							
Low pulse count	4	6	0.75	1.17	0.50	0.56	0	0.17
Low pulse duration	16.6	26.9	0.92	3.09	0.62	2.36	0	0.04
High pulse count	6	3	0.67	2.00	0.50	2.00	0.02	0.01
High pulse duration	14.5	3	1.28	2.33	0.79	0.82	0.03	0.13
The low pulse threshol	d is	997						
The high pulse level is		3821						
Parameter	Group #5							
Rise rate	588.3	326.7	1.3	1.93	0.44	0.49	0.36	0.32
Fall rate	-378.1	-243.3	-1.29	-1.55	0.36	0.21	0.48	0.67
Number of reversals	124	152	0.21	0.27	0.23	0.29	0	0.36

Table 2

Non-Parametric IHA Percentile Data

					Poe IHA	1974-2000						
	Pre-	impact p	riod: 1944-	1970 (27	years)	Post-impa	ct period	: 1974	-2000 (2	years)	bjmgurk	010604
			Pre-Imp	act					Post-I	mpact		
	10%	25%	50%	75%	90%	(75-25)/50	10%	25%	50%	75%	90%	(75-25)/5
Parameter	Group #1											
October	690	901	1143	1344	1811	0.39	50	57	66	121	178	0.97
November	939	1108	1397	2532	6065	1.02	51	58	64	318	2056	4.07
December	1030	1276	1868	3048	9049	0.95	55	59	92	767	3522	7.74
January	1068	1490	3349	4732	9705	0.97	57	59	197	1676	5361	8.19
February	1343	2070	3820	6200	9152	1.08	58	111	354	3325	4864	9.08
March	2304	3334	5490	8428	11665	0.93	65	77	913	3826	6483	4.11
April	2275	3347	5135	7293	10055	0.77	59	72	353	2811	5928	7.76
May	1770	2380	4333	9133	11693	1.56	54	59	134	2761	4900	20.12
June	832	1141	1825	3866	8434	1.49	52	59	65	209	3541	2.32
July	572	679	994	1470	3078	0.8	49	56	62	69	122	0.22
August	493	568	802	1098	1491	0.66	47	53	59	64	105	0.18
September	566	671	887	1079	1246	0.46	48	53	61	71	147	0.29
Parameter	Group #2											
1-day minimum	449	505	634	747	987	0.38	20	46	51	58	85	0.24
3-day minimum	407	504	610	853	996	0.57	23	47	52	58	88	0.21
7-day minimum	412	505	624	874	1022	0.59	26	49	53	58	88	0.17
30-day minimum	428	523	670	908	1102	0.57	35	50	55	62	90	0.22
90-day minimum	528	566	830	1086	1294	0.63	47	53	57	62	104	0.16
1-day maximum	4768	7447	23182	39940	70735	1.4	208	2470	17726	26100	58797	1.33
3-day maximum	3936	6913	15821	32343	61040	1.61	158	1185	11781	21367	49082	1.71
7-day maximum	3412	6503	13035	21356	42026	1.14	115	575	6995	14779	33682	2.03
30-day maximum	2443	3666	8745	12975	18921	1.06	80	209	4143	6591	13877	1.54
90-day maximum	2222	3351	6751	9921	11737	0.97	71	160	2488	5099	6947	1.99
Number of zero day	0	0	0	0	0	0	0	0	0	0	0	0
Base flow	0.14	0.17	0.23	0.31	0.43	0.63	0.02	0.04	0.07	0.58	0.78	7.84
Parameter	Group #3											
Date of minimum	223	229	251	275	286	0	193	242	281	322	365	0
Date of maximum	0	45	65	83	136	0	355	15	45	70	92	0
Parameter	Group #4											
Low pulse count	1.8	3	4	6	8.2	0.75	2	2	6	9	10.4	1.17
Low pulse duration	1.9	5.6	16.6	20.8	36.9	0.9	19.8	24.1	26.9	107.0	123.9	3.1
High pulse count	2.6	4	6	8	9.4	0.67	0	0	3	6	10.2	2
High pulse duration	1.0	4.3	14.5	22.8	30.6	1.3	0.0	0.0	3.0	7.0	14.2	2.3
Parameter	Group #5											
Rise rate	136.0	216.2	588.3	978.5	1509.2	1.3	4.1	32.4	326.7	664.0	1149.3	1.9
Fall rate	-790.3	-631.5	-378.1	-145.5	-107.8	-1.3	-710.4	-401.2	-243.3	-23.3	-3.4	-1.6
Number of reversals	104	111	124	137	154.8	0.21	121	129	152	170	184.4	0.27

Table 3, Part 1

Non-Parametric IHA Summary Data

						Poe I	1974-2000, Part 1					bjmgurk 010604					
Year	Oct.	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	1-day min	3-day min	7-day min	30-day min	90-day min
1944	1394	7300	4795	10927	3820	10986	9719	9237	4739	1819	1181	1079	920	940	1033	1073	1167
1945	1325	1573	1614	1880	3793	5591	4957	11421	6821	1756	1100	1123	985	999	1019	1093	1282
1946	1936	1425	1304	1086	1394	2305	2241	1747	837	694	882	831	600	606	611	670	774
1947	782	854	809	996	1109	1110	1168	1226	749	475	383	583	368	371	374	383	459
1948	654	1061	2548	6942	4576	8428	6363	6998	3604	1289	753	842	575	587	591	640	830
1949	916	1144	1094	3329	4106	3577	4166	6151	1851	801	568	849	495	498	502	537	681
1950	1412	1431	1593	9400	8048	4315	5454	5412	2571	1105	806	918	658	709	731	805	882
1951	980	1113	2104	2128	3599	3334	3686	2465	1202	586	499	742	479	487	491	498	566
1952	1332	10237	9375	3918	9093	6059	11397	8620	3866	1746	960	1094	723	753	874	893	1087
1953	1836	2792	4319	4732	8322	13029	8684	12780	10566	3632	1682	1437	1178	1182	1187	1397	1615
1954	1805	5756	8967	4107	3697	5980	4514	4680	2396	1205	937	1042	846	853	860	908	1035
1955	1344	2681	1880	1541	2156	2707	5001	2473	1137	679	647	952	599	602	608	637	742
1956	1027	1134	1815	3807	20904	11324	5626	3956	1765	994	787	1181	691	696	703	745	927
1957	1135	1187	1276	1415	2629	4739	3034	1917	809	619	523	563	505	507	511	523	566
1958	699	968	2053	1670	1766	2300	2283	1943	1141	544	466	466	412	416	421	439	480
1959	629	1848	1129	1323	2070	11153	6218	2778	1531	778	708	770	544	556	557	627	736
1960	1290	1189	1068	1909	1441	3596	2870	2178	1663	580	511	582	459	465	478	501	554
1961	747	890	879	863	1135	3582	3464	2931	1518	959	723	671	643	647	654	668	739
1962	915	1100	1181	1138	2848	2646	3347	1776	1084	854	636	595	557	561	572	594	638
1963	901	952	1868	3983	4318	11059	9465	10442	5247	1470	802	691	596	610	624	681	871
1964	1123	1264	2348	1490	1697	2996	2791	2380	886	599	518	567	502	504	505	516	559
1965	799	1108	1351	8550	5319	17090	11792	14895	8126	3073	1488	1222	711	711	717	799	1086
1966	1209	1397	3048	3506	9385	6057	7533	9133	2603	1387	1099	1051	995	996	998	1043	1133
1967	1482	2532	9652	18656	5316	5771	5135	2884	1622	1016	888	887	747	763	774	878	919
1968	1143	1903	1868	6266	6484	7744	7293	10217	9669	3094	1503	1343	634	937	940	1138	1344
1969	1273	3181	3301	3984	6106	5490	5877	6359	3038	1327	1098	1011	771	871	903	977	1039
1970	1158	1672	1408	3349	6200	4822	6322	4333	1825	981	862	933	730	346	177	103	540
1974	73	2455	767	5308	334	5823	5616	2761	692	54	47	50	45	45	46	46	50
1975	55	58	59	56	523	934	1376	4225	1481	62	58	55	50	51	52	54	57
1976	58	60	58	58	72	68	63	54	50	50	51	53	48	49	49	50	50
1977	51	52	51	53	57	58	56	42	34	33	13	14	5	10	12	12	14
1978	16	26	179	2509	866	2504	573	134	55	47	47	54	14	15	15	16	47
1979	52	53	54	81	212	114	98	139	65	57	55	53	48	49	50	50	53
1980	149	59	81	4480	3627	603	130	73	61	55	48	42	37	37	38	40	45
1981	46	50	139	114	228	104	60	53	53	55	53	52	36	37	38	46	53
1982	122	4384	3362	693	4011	1420	7799	3560	75	58	52	52	46	47	50	51	52
1983	121	337	914	1469	4856	9126	4987	6442	3489	69	63	61	49	51	51	55	59
1984	56	1957	5269	1676	208	882	79	63	64	58	59	58	50	53	54	55	58
1985	59	101	64	59	111	68	147	59	59	62	62	61	54	55	56	58	60
1986	161	626	603	557	14317	4975	466	144	67	63	64	71	58	56	56	62	64
1987	75	64	69	79	354	457	78	55	55	57	55	66	48	52	53	55	56
1988	66	66	197	108	114	77	72	71	65	67	70	71	61	62	62	64	62
1989	69	318	55	58	60	3826	400	56	56	56	56	219	22	25	28	47	56
1990	162	62	57	77	56	66	55	64	62	59	59	59	51	52	53	54	57
1991	57	57	56	57	58	673	132	59	62	62	62	62	53	53	54	55	56
1992	59	55	62	57	207	74	66	61	61	62	59	56	51	52	53	55	57
1993	58	58	118	812	436	5297	2298	1221	150	59	60	61	51	51	52	58	60
1994	61	61	63	59	76	63	60	62	64	63	62	66	55	58	58	58	61
1995	63	64	67	5573	1323	11959	7176	9478	3747	149	58	63	54	56	56	58	61
1996	489	70	979	197	4894	2416	3756	3418	209	93	91	91	58	58	59	69	90
1997	90	206	4161	14121	3325	1032	519	176	115	115	113	124	84	87	88	90	114
1998	118	184	205	1799	3221	4665	3784	4515	5809	593	126	206	111	111	112	117	150
1999	121	914	1046	858	3390	3212	2811	2470	306	99	91	98	88	89	90	91	94
2000	243	102	92	232	2243	913	353	152	109	107	104	133	84	86	86	88	102

Table 3, Part 2

Non-Parametric IHA Summary Data

				Poe IHA	1974-2000, Part 2					bjmgurk 010604						
Year	1-day max	3-day max	7-day max	30-day max	90-day max	Zero days	Base flow	Date min	Date max	Lo pulse	#Lo pulse	LHi pulse	#Hi pulse	LRise rate	Fall rate	Reversals
1944	46549	35690	29748	13161	10066	0	0.18	275	90	1	4	14	13	1426	-789	110
1945	14913	14500	14245	12172	8171	0	0.28	243	135	2	2	4	29	423	-307	129
1946	4575	3808	3058	2403	2208	0	0.44	192	61	9	13	1	1	136	-100	145
1947	1767	1726	1442	1240	1328	0	0.44	230	54	12	17	0	0	62	-49	153
1948	19278	16741	13035	8745	7326	0	0.16	285	65	6	15	9	16	657	-445	132
1949	7930	7601	7357	6372	4658	0	0.21	229	127	7	12	11	7	233	-165	123
1950	53648	42303	28210	9711	7292	0	0.21	284	13	6	13	7	14	851	-507	122
1951	10538	7490	6503	3988	6751	0	0.26	223	45	3	35	8	4	274	-200	143
1952	41768	32343	21150	12975	9842	0	0.16	278	47	5	9	6	30	1723	-798	104
1953	39940	30691	21356	15258	11521	0	0.19	291	73	0	0	7	27	1325	-705	109
1954	27683	24718	17973	9693	6383	0	0.23	229	360	2	17	8	19	821	-414	124
1955	7063	6913	6647	5001	3435	0	0.32	227	98	2	50	4	6	189	-123	129
1956	104880	88293	58034	25317	12599	0	0.16	251	49	4	19	5	23	1453	-746	127
1957	15630	12763	8617	4934	3630	0	0.31	222	73	3	43	3	6	290	-173	97
1958	6161	3969	3500	2453	2226	0	0.31	251	345	6	21	3	1	135	-110	128
1959	39628	37890	25023	11905	6985	0	0.22	277	69	5	19	4	16	532	-340	125
1960	6288	5217	4988	3656	2901	0	0.3	224	152	4	28	8	3	216	-146	111
1961	18133	13532	7993	3666	3351	0	0.43	268	64	7	26	4	3	241	-161	137
1962	7447	6074	4699	3381	3049	0	0.38	260	51	7	17	6	2	176	-110	118
1963	24990	22675	17896	13075	10778	0	0.15	275	77	4	20	6	22	677	-454	106
1964	4816	4567	3981	3040	2784	0	0.32	236	66	4	29	3	4	179	-115	116
1965	62198	54226	38024	18323	15042	0	0.11	293	70	8	6	4	43	1638	-968	121
1966	25713	22163	16698	9341	7836	0	0.25	250	138	2	2	6	23	847	-486	111
1967	113271	93866	61034	21314	11460	0	0.17	270	2	5	14	7	20	1477	-740	104
1968	28950	23262	17728	10765	9921	0	0.19	274	83	4	4	5	33	979	-631	145
1969	23182	14733	10000	7118	6054	0	0.26	274	40	4	3	6	24	762	-475	162
1970	24227	15821	10259	6712	5995	0	0.06	232	45	5	19	8	15	588	-378	191
1974	34900	25200	17997	8235	5118	0	0.02	216	90	9	22	11	6	854	-601	129
1975	8000	7347	6340	4744	2593	0	0.07	275	136	7	24	6	5	327	-243	122
1976	221	170	121	81	68	0	0.85	233	60	2	1	0	0	4	-3	129
1977	80	71	63	59	71	0	0.28	262	2	2	107	0	0	3	-2	98
1978	15100	13800	8653	2834	2071	0	0.03	280	15	10	25	3	5	498	-291	122
1979	2740	1185	575	226	160	0	0.58	298	45	2	114	0	0	42	-24	136
1980	37500	29900	18823	4642	2923	0	0.05	270	13	4	78	2	7	664	-351	117
1981	3380	1543	707	275	2488	0	0.45	281	45	4	74	0	0	66	-52	147
1982	26100	22267	16226	8939	5099	0	0.02	306	102	9	24	10	7	1178	-700	127
1983	27000	21367	14779	9435	6836	0	0.02	274	73	7	27	7	18	721	-542	147
1984	19900	17200	12323	6028	3044	0	0.06	313	360	8	32	6	5	485	-306	152
1985	1050	623	409	149	470	0	0.75	286	39	2	117	0	0	23	-18	184
1986	81000	66267	43200	16792	6452	0	0.03	200	49	10	26	4	7	928	-648	153
1987	5940	3203	1481	696	295	0	0.44	244	44	4	56	2	1	110	-72	148
1988	2360	942	467	202	153	0	0.71	167	337	2	152	0	0	32	-23	148
1989	20900	20133	12327	4143	1471	0	0.06	313	69	6	48	3	3	320	-218	164
1990	1270	555	299	166	95	0	0.76	126	297	2	171	0	0	20	-20	164
1991	10500	6020	2713	693	295	0	0.46	341	64	4	53	1	2	101	-85	189
1992	2470	1200	590	209	115	0	0.72	242	51	2	112	0	0	26	-18	162
1993	18300	15733	11374	6591	3055	0	0.06	349	78	9	25	5	5	494	-391	150
1994	154	110	87	78	67	0	0.92	335	38	2	107	0	0	4	-3	180
1995	53246	44786	31652	13684	9993	0	0.02	322	70	5	25	5	21	1270	-868	165
1996	18181	15338	11081	4753	3711	0	0.04	12	52	12	20	10	4	638	-401	170
1997	100876	74391	41801	14651	7392	0	0.04	288	1	12	18	3	13	1142	-752	177
1998	17957	14487	10548	5943	5120	0	0.05	363	84	6	22	10	9	450	-376	168
1999	19274	11781	6995	4687	3335	0	0.07	236	40	7	25	11	3	370	-332	174
2000	17726	11206	5457	2654	1169	0	0.22	5	45	9	25	2	3	241	-167	186

Table 3, Part 3

Non-Parametric IHA Summary Data

Variance Data, Part 3

	Oct.	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	1-day min	3-day min	7-day min	30-day min	90-day min
Pre-Impact Distribution																	
1-day mi	629	854	809	863	1109	1110	1168	1226	749	475	383	466	368	346	177	103	459
25 pctile	901	1108	1276	1490	2070	3334	3347	2380	1141	679	568	671	505	504	505	523	566
Median	1143	1397	1868	3349	3820	5490	5135	4333	1825	994	802	887	634	610	624	670	830
75 pctile	1344	2532	3048	4732	6200	8428	7293	9133	3866	1470	1098	1079	747	853	874	908	1086
1-day m	1936	10237	9652	18656	20904	17090	11792	14895	10566	3632	1682	1437	1178	1182	1187	1397	1615
Post-Impact Distribution																	
1-day mi	16	26	51	53	56	58	55	42	34	33	13	14	5	10	12	12	14
25 pctile	57	58	59	59	111	77	72	59	59	56	53	53	46	47	49	50	53
Median	66	64	92	197	354	913	353	134	65	62	59	61	51	52	53	55	57
75 pctile	121	318	767	1676	3325	3826	2811	2761	209	69	64	71	58	58	58	62	62
1-day m	489	4384	5269	14121	14317	11959	7799	9478	5809	593	126	219	111	111	112	117	150

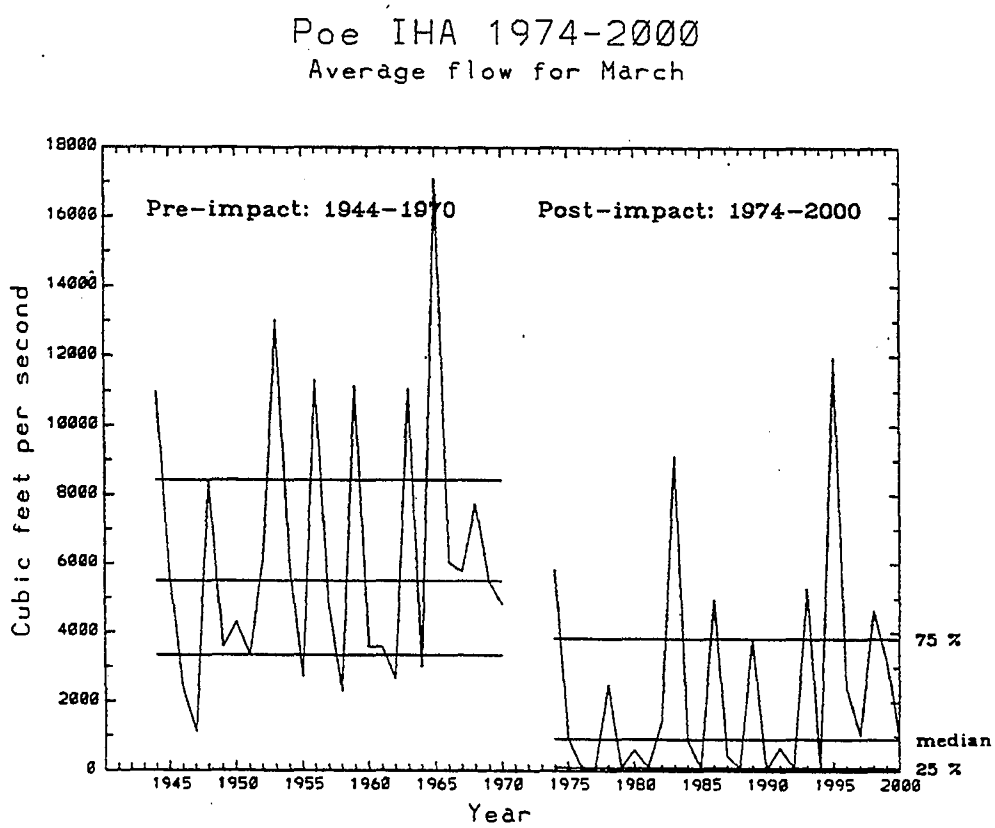
	1-day max	3-day max	7-day max	30-day max	90-day max	Zero days	Base flow	Date min	Date max	Lo pulse	#Lo pulse	LHi pulse	#Hi pulse	LRise rate	Fall rate	Reversals
Pre-Impact Distribution																
1-day mi	1767	1726	1442	1240	1328	0	0.06	192	2	0	0	0	0	62	-968	97
25 pctile	7447	6913	6503	3666	3351	0	0.17	229	45	3	6	4	4	216	-631	111
Median	23182	15821	13035	8745	6751	0	0.23	251	65	4	17	6	15	588	-378	124
75 pctile	39940	32343	21356	12975	9921	0	0.31	275	83	6	21	8	23	979	-146	137
1-day m	113271	93866	61034	25317	15042	0	0.44	293	360	12	50	14	43	1723	-49	191
Post-Impact Distribution																
1-day mi	80	71	63	59	67	0	0.02	5	1	2	1	0	0	3	-868	98
25 pctile	2470	1185	575	209	160	0	0.04	242	15	2	24	0	0	32	-401	129
Median	17726	11781	6995	4143	2488	0	0.07	281	45	6	27	3	3	327	-243	152
75 pctile	26100	21367	14779	6591	5099	0	0.58	322	70	9	107	6	7	664	-23	170
1-day m	100876	74391	43200	16792	9993	0	0.92	363	360	12	171	11	21	1270	-2	189

Significance

The 32 IHA plots provide a graphical illustration of the statistical change from pre- to post-Project, but they are available only as hardcopy due to DOS plotting limitations. As per the explanation of the 25% and 75% RVA plots above, the analysis below uses the extent of the overlap of the plots to conclude if the pre- and post-Project regimes are "significantly" different. In this discussion, if the median of either the pre- or post-Project plot of dispersion is within the 25%/75% range of the other plot, there is no "significant" difference. Alternately, if only the 25% or 75% extremes overlap, there is a "significant" difference between pre- and post-Project hydrologic regime. In Figure 1, the conclusion would be reached that the pre- and post-

Figure 1

IHA Results, Median Streamflows for March



Project March median streamflows are significantly different. This use of the term "significant" is not the same as the typical "statistically significant" term that results from testing hypothesis or doing F- or t-tests. The results from the 32 plots are summarized in Table 4.

Interpretation

Monthly Magnitude, Group 1

The Poe Reach is affected by the diversion to the powerhouse. The analysis detects the effect of the diversion and determines that all 12 monthly mean regulated streamflows are lower than

Table 4

"Indicators of Hydrologic Alteration" Results for Poe Reach

Group Name	Poe Reach
Monthly Magnitude	
	Oct-Sep: Pre>Post
Magnitude of Extremes	
	1,3,7,30,90-Day Min: Pre>Post 1,3,7,30-Day Max: Pre=Post 90-Day Max: Pre>Post Base Streamflow: Pre=Post*
Timing of Extremes	
Julian Date Min	Pre=251; Post=281:Insignificantly Different
Julian Date Max	Pre=65; Post=45:Insignificantly Different
Frequency and Duration	
	No. of Low Pulses: Pre=Post Length Low Pulses: Pre<Post No. of High Pulses: Pre=Post Length High Pulses: Pre>Post
Rates & Frequency Of Change	
	Rise Rate: Pre=Post Fall Rate: Pre=Post No. Of Reversals: Pre<Post No. of Hydrographic Falls: Pre<Post

*Base streamflow calculated by dividing 7-day minimum by annual mean, not meaningful in this case.

they were in the pre-Project (unimpaired streamflow) situation. Although the post-Project winter median streamflows for many of the years are in the same range as the pre-Project monthly medians, the IHA concludes that for period of record, the RVA limits do not overlap, and based on the definition above, the pre- and post-Project conditions are therefore significantly different.

Magnitude and Duration, Group 2

The post-Project 1-day, 3-day, 7-day, 30-day, and 90-day minimum streamflows are significantly less than the pre-Project minima, based on the definition above. This finding reflects the pre-hydro development summer base streamflows that occurred in the North Fork Feather River reaches due to streamflows from the large upstream area and the springs that originate from the volcanic material and come up under Lake Almanor. The post-Project 1-day, 3-day, 7-day, and 30-day maximum streamflows are the same as the pre-Project minima, based on the definition above, but the 90-day pre-Project maximum is greater than the post-Project maximum. There is considerable overlap between pre- and post-Project annual maxima in the maximum streamflow plots, however, reflecting the large inter-annual variation that continues to occur. The IHA concludes that pre-Project base streamflows are the same as the post-Project base streamflows. IHA base streamflows are calculated by dividing the 7-day minimum streamflow by the annual mean streamflow, a technique that is not a traditional estimate of base flow magnitude.

Timing of Extremes, Group 3

The overall median minimum streamflow is delayed by Project operations. In the Poe Reach, the median annual minimum was delayed from JD 251 to JD 281 (early-September to early-October), a 4-week change and one that the plots show is insignificant because of the large inter-annual variation. The overall median maximum streamflow for Poe is moved up from JD 65 to JD 45 (early March to mid-February), a 3-week change and one that the plot shows is not a significant difference.

Frequency and Duration, Group 4

For frequency and duration, the plots for the Poe Reach show that the number of low pulses (streamflows less that the 25% statistic, 997 cfs) is not significantly different for the pre- and post-Project condition. The number of pulses is four in the pre-Project condition and 6 in the post-Project condition. For the length of the low pulses, the pre-Project duration was 17 days, compared with 27 days, post-Project. Based on the criterion above, the change in pulse length was significant, and pulses are longer due to Project operations.

For high pulses (streamflows greater than the 75% statistic, 3821 cfs for the reach), the pre-Project number of pulses (six) was greater than the post-Project number (three). This change was not a significant difference based on the criterion above. For the length of the high pulses, the pre-Project durations was 14 days, compared with 3 days for post-Project in all reaches. Based on the criterion above, the change in pulse length was significant, and high pulses are shorter due to Project operations.

Rate & Frequency of Change, Group 5

For rates and frequency of change, the difference between the pre- and post-Project rise rate (588 cfs/day vs. 327 cfs/day) was not significant. The difference between pre- and post-Project fall rates -378 cfs/day vs. -243 cfs/day) was also not significant. This lack of significance suggests that operational change rates are similar to the natural daily changes in streamflow when the overall variation is taken into account. The number of pre-Project reversals was less than the post-Project reversals (124 vs. 152) for the Poe Reach, but this may be due to the smoothing of the "pre-Project" synthesized data. The post-Project record had no smoothing whatsoever, and the small changes that may occur in this record may have caused this result.

Conclusion

The results from the IHA analysis confirm many of the assumptions that existed for the Poe Reach. The Group 1 statistics illustrate the reduction of monthly streamflow magnitudes associated with the diversion for the Poe powerhouse. The Group 2 statistics illustrate that summer low streamflows are lower with the Project that they would be without the Project. Except for the longest-duration high streamflow, the high-streamflow durations are not changed by the Project. This finding confirms the assumption that peak winter streamflow magnitudes are so large that Project diversions are not significant.

Group 3 statistics confirm that the timing of the annual flood event has not changed due to the Project. The statistics show that the minimum streamflows have been insignificantly moved to an earlier time of the year by the Project's operations. Group 4 statistics show that the number of low pulses has not changed, but that the length of the post-Project low pulse is greater. This finding is not a surprise based on the steady summer minimum streamflow releases that are made to maintain the aquatic habitat and related, dependent species. Similar to the number of low pulses, the number of high pulses has not been affected by the Project. The duration of the high pulses has been decreased by the Project, which may be because the diversions reduce the time the streamflow is above the high-pulse threshold.

Group 5 statistics confirm that the Poe Reach streamflow rises and falls at the same rates pre- and post-Project. This finding is not a surprise because moderate and large winter storm events continue to flood the system regardless of the presence of the Project. The finding that streamflow reversals occur more frequently post-Project is unexpected, and may result from the fact that although the unimpaired hydrograph was extensively smoothed, the gage records were not smoothed in any way, and may contain more small daily streamflow reversals than the synthesized unimpaired records.

Poe Relicensing Project
FERC 2107

Spoil Pile Evaluation

July 2003

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Pacific Gas and Electric Company
Technical and Ecological Services

July 2003

Report No.: 026.11-03.12

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1.0 INTRODUCTION

As part of Pacific Gas and Electric Company's (the Licensee) ongoing relicensing of the Poe Hydroelectric Project (FERC 2107), soil and water samples were collected near two spoil piles associated with Poe Diversion Tunnel (Figure 1). This sampling effort was initiated following discussions with the State Water Resources Control Board (SWRCB), Regional Water Quality Control Board (RWQCB), and the Licensee on September 21, 2001.

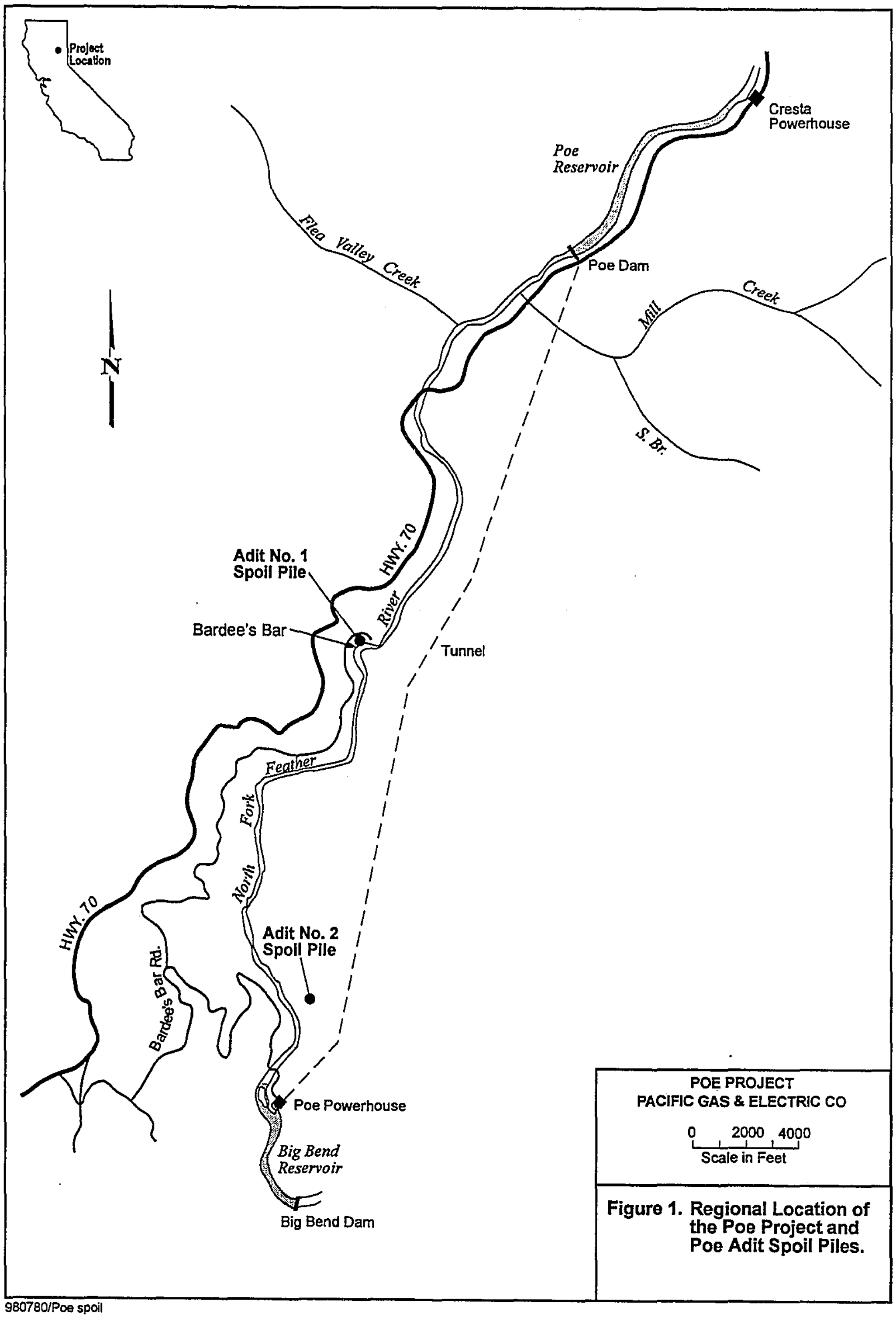
Water samples had been collected from the North Fork Feather River (NFFR) and drainage culvert associated with the Poe Adit No. 2 during the relicensing monitoring conducted 1999-2000. Data resulting from the initial monitoring effort was considered inadequate for determining the effect of the spoil piles on the water quality of the NFFR by the resource agencies. In addition, the RWQCB wanted information that would allow for the hazardous waste characterization of the material in each spoil pile.

2.0 STUDY AREA

The Adit No. 1 spoil pile is located adjacent to the NFFR at Bardees Bar (Figure 1). The tunnel length associated with Adit No. 1 is approximately 3.3 miles. The Adit No. 1 spoil pile has an estimated volume of approximately 13,500,000 to 16,200,000 cubic feet. The Adit No. 2 spoil pile is located approximately 0.75 miles upstream of Poe Powerhouse. The tunnel length associated with the No. 2 Adit is approximately 3.1 miles (distance from Adit No. 1 to Poe Powerhouse). The volume of the Adit No. 2 spoil pile appears to be similar to or slightly smaller than that of the Adit No. 1 spoil pile.

Both spoil piles are composed of natural bedrock material excavated during the construction of the diversion tunnel between Poe Reservoir and Poe Powerhouse. An evaluation of the surface geology of the Project area indicates that the Poe Diversion Tunnel passes through three major geologic substrates (California Division of Mines and Geology [CDMG] – Chico Gravity Map 1982). The primary rock type (63% of the tunnel area) is characterized by metavolcanic formations similar to the Lindgren, Turner, and Compton formations. These formations include associates of diabase, amphibolite, metabasalt, metarhyolite, metadacite, quartz porphyry, hornblende porphyry, and various schist compositions. The second major rock type associated with the Poe Diversion Tunnel (33% percent of the area) is characterized by ultrabasic intrusive rocks, that have been largely serpentized (CDMG 1982). The third major rock type (5% of the area) is composed of marine sedimentary and metasedimentary rocks, represented by gray quartzite, slaty sandstone, and limestone (CDMG 1982).

Figure 1. Regional Location of the Poe Project and the Poe Adit Spoil Piles.



Material was deposited at the Adit No. 1 and Adit No. 2 sites during construction operations. The site investigation indicates that both piles appear to be similarly constructed. Visual surveys indicated that the majority of each pile is composed of large angular material ranging in size from 1 to 6 ft in diameter. This size composition would be consistent with a drill and blast excavation method. Both piles have a relatively thin (less than 1 ft to 3 ft thick) layer of finer capping material that is likely the result of final tunnel cleanout and site stabilization efforts following completion of the tunnel.

The spoil pile associated with Adit No. 1 is located between the NFFR and the railroad grade (Figure 2). Because of this position, the NFFR contacts the lower portion of the spoil pile during high flow periods. During low flow periods, the water level is approximately 4 to 5 ft below the toe of the pile. Because of this contact, the lower portion of the Adit No.1 pile has been protected with a thin face of concrete. There is little or no surface leakage associated with Adit No. 1. The Adit No. 1 Spoil Pile is graded such that all runoff is directed into a main drainage depression that flows toward the northwest corner of the Spoil Pile. Some erosion and head cutting is evident on the face of the Adit No. 1 Pile where the main drainage exits over the face of the pile. Minor erosion channels are also present on the face of the spoil pile itself. These are primarily the result of precipitation falling directly on the exposed face as well as gravitational movement of the thin surface layer toward the bottom of the pile.

The spoil pile associated with Adit No. 2 is located above the railroad grade (Figure 3), and has no direct contact with the NFFR. There is only a small amount (less than 0.10 cfs) of surface leakage associated with Adit No. 2 tunnel. A culvert constructed with the Adit No. 2 access tunnel (~450 ft long) runs from the Adit under the spoil pile and exits on the riverside of the adjoining railroad grade. This culvert carries approximately 1 to 2 cfs of tunnel leakage from with the Adit No. 2 area. The Adit No. 2 spoil pile is graded such that all runoff is directed back toward the Adit entrance where a main drainage grate directs all runoff into the main culvert. Minor erosion channels are present on the face of the spoil pile itself. As with the Adit No. 1 spoil pile, these are primarily the result of precipitation falling directly on the face as well as gravitational movement of the thin surface layer toward the bottom of the pile.

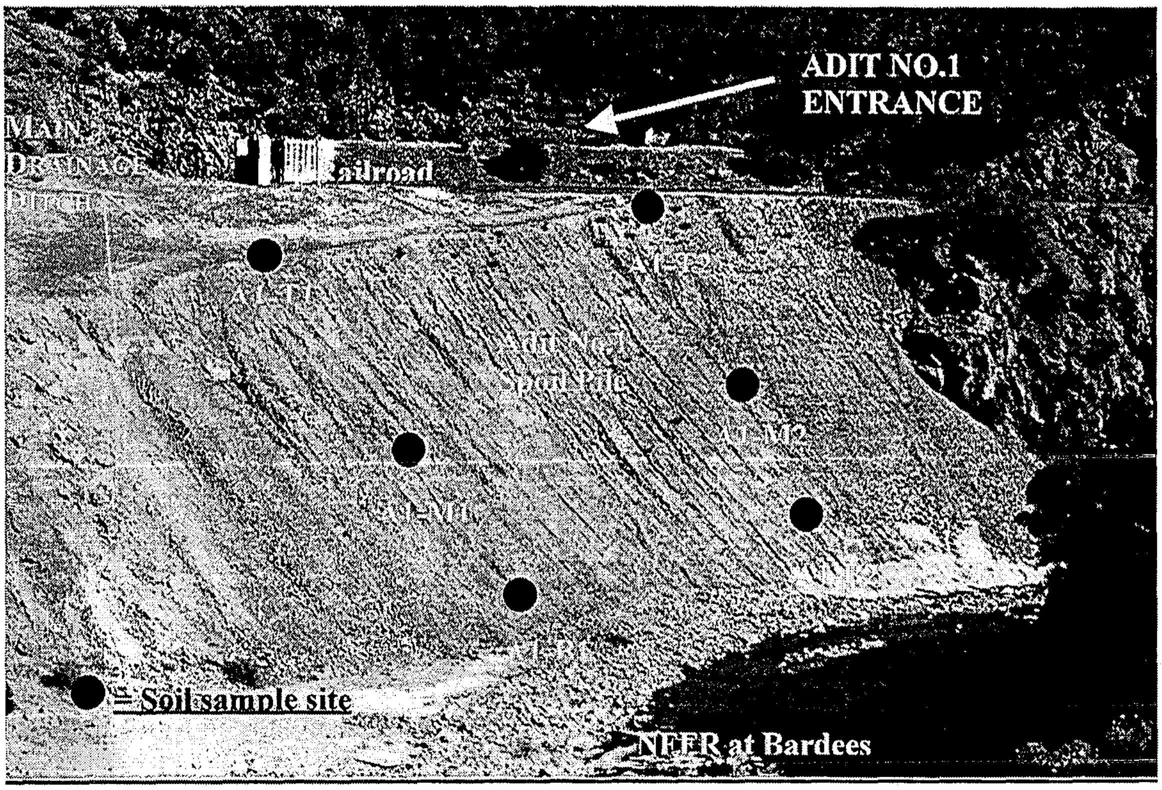


Figure 2. Photograph of Adit No. 1 Spoil Pile.

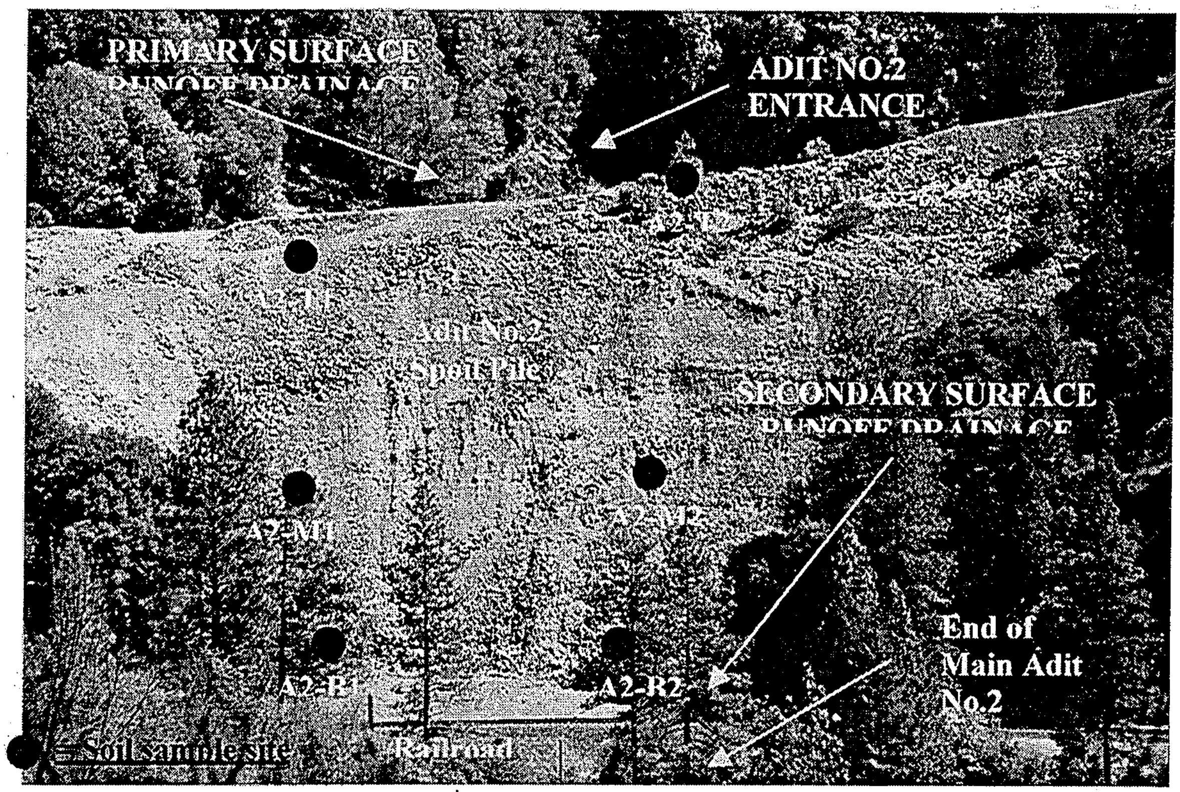


Figure 3. Photograph of Adit No. 2 Spoil Pile.

3.0 STUDY OBJECTIVE

The primary purpose of the Poe Project Spoil Pile evaluation was to determine the hazardous waste status of two spoil piles located within the Poe Project. In addition, the leachate quality of the spoil material was determined and the effect of runoff from the spoil sites on the water quality of the NFFR was evaluated. Monitoring was divided into soil and water sampling phases. Phase I consisted on characterizing the spoil material contained in the spoil piles located adjacent to Adit No. 1 and Adit No. 2. The spoil material was evaluated for 17 (CAM-17) trace metals using Total Threshold Limit Concentration (TTLC) and Soluble Threshold Limit Concentration (STLC) methodology. Phase II involved the evaluating the effect of spoil pile runoff on the NFFR in the immediate vicinity of the two spoil piles. Two surface water-sampling efforts were conducted as part of the Phase II investigation. The first sampling effort was conducted during dry conditions (base flow, low runoff) and another effort was conducted during wet conditions (elevated flows, higher runoff). The Phase II sampling results were used to characterize trace metal concentrations, as well as selected general chemistry constituents and *in situ* parameters associated with the NFFR and runoff from the spoil piles under different conditions.

The resultant data from both phases of the evaluation were to be used by the RWQCB to define the hazardous waste status of the spoil piles and evaluate the impact of runoff from Project-related spoil piles on trace metal concentrations in the NFFR.

4.0 STUDY METHODS

4.1 Phase I (Soil Characterization)

Soil samples were collected from the spoil piles located at Adit No. 1 and Adit No. 2 of the Poe Diversion Tunnel. A sample of undisturbed native material from a location adjacent to each of the spoil piles was also collected as an indicator of background conditions.

Soil was collected from six pits distributed uniformly on each spoil pile. Specifically, the six pits were distributed along two vertical transect lines (three locations on each transect) such that the top, middle, and bottom of each pile was represented by samples from each transect (Figures 2 and 3).

At each sampling pit, the top layer of soil was removed to a depth of at least 2 feet below ground surface. Sub-surface soil samples (sediment less than pea gravel size) were collected from the bottom of each pit. Soil from each pit was collected as a discrete sample (six samples per spoil pile, 12 samples total). Each sample was placed in a glass container and shipped to a California State certified analytical laboratory.

Background soil samples were collected from an undisturbed area adjacent to each pile. The location of each background sample was selected to assure that there was no contamination from spoil material or from side-cast associated with the railroad grade. Soil was collected from approximately the same depth (below surface) as the spoil pile samples.

All soil samples were analyzed using U. S. Environmental Protection Agency (USEPA) Method 6010/7471-7470 for the determination of TTLC and STLC. For the STLC portion of the analysis, two extraction methods were utilized. The first method used the STLC Waste Extraction Test (WET) in order to aid classifying the piles as to their hazardous waste status. The STLC-WET method uses buffered citric acid (pH = 5.0) as the extracting agent. A second extraction test was done using de-ionized water as the extracting agent. This simulated the effect of rainwater as the leaching agent. Data from this test was used to estimate leachate conditions from the spoil pile sites. Soil samples were evaluated for the 17 trace metals (CAM-17) and iron.

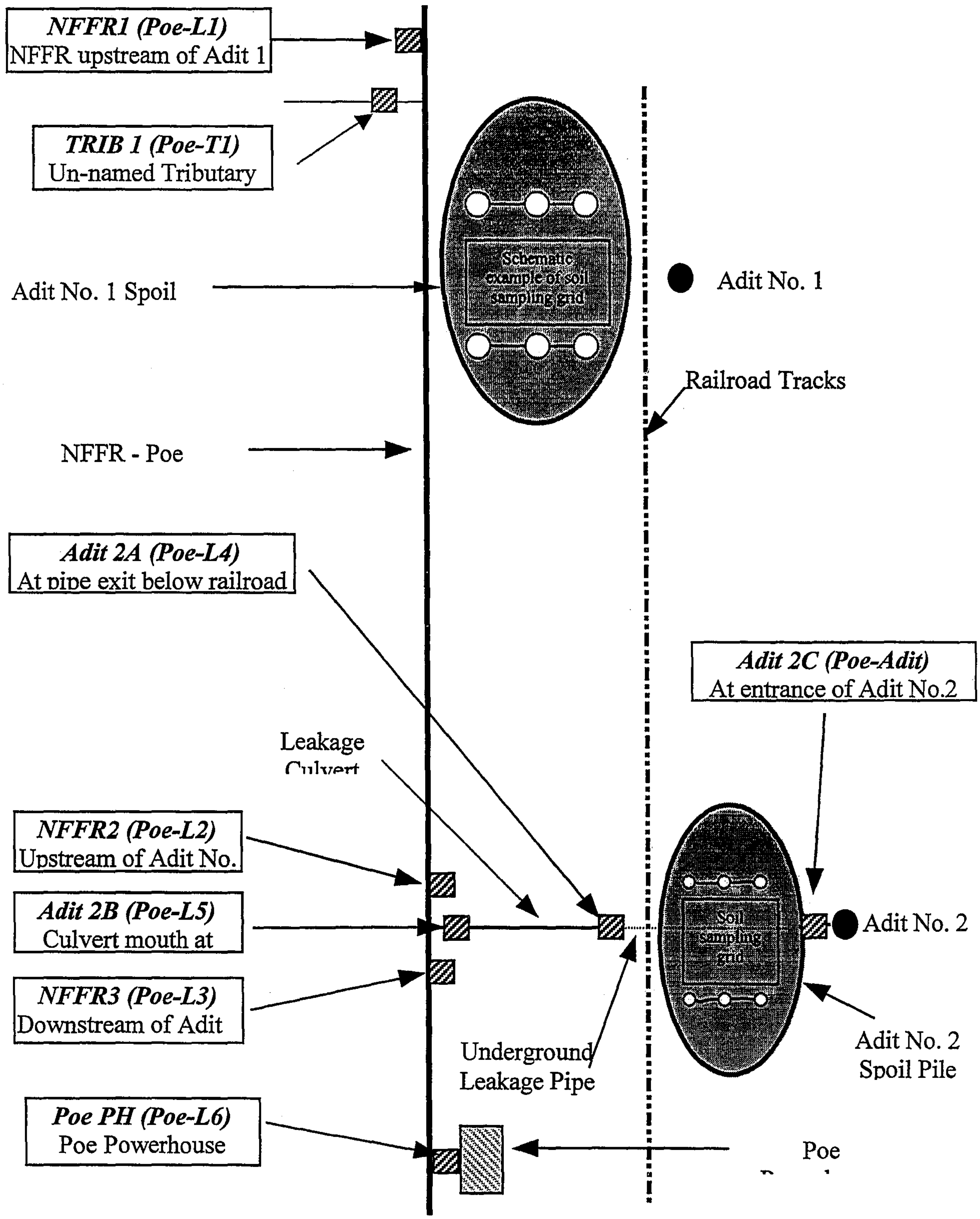
4.2 Phase II (Water Characterization)

Water sampling was conducted at three river and two culvert stations near the two spoil piles. The general location of water sampling stations is presented in Figure 4. The three river stations were located in the NFFR. These stations were located immediately upstream of the Adit No. 1 pile, immediately upstream of the culvert inflow from Adit No. 2, and immediately downstream of the culvert inflow from Adit No. 2 (Figure 4). In addition to the river samples, water was collected from two locations in the leakage culvert associated with Adit No. 2. The first culvert station was located at the exit of the underground culvert below the railroad grade (Adit 2A). This site was chosen following a site visit that indicated that the culvert started inside the Adit tunnel near the diversion tunnel and ran unexposed under the entire spoil pile. Two drainage grates were constructed that captured run-off from the No. 2 Pile. All of these drainage grates empty into the main culvert and occur upstream of the exit point below the railroad grade. The second culvert station (Adit 2B) was located immediately above the point of entry into the NFFR (Figure 4). This station defined the final quality of water entering the NFFR from the spoil pile culvert. A water sample was also collected from Poe Powerhouse Tailrace (Poe PH). This sample represented conditions in the tunnel and is essentially a background control for the culvert samples. Samples were collected from two additional locations during the wet sampling event to help define runoff conditions (from an unnamed tributary to the NFFR [TRIB1] and from the entrance of Adit No. 2 [Adit 2C]).

Water from each location was collected and prepared to characterize the total and dissolved fraction of each metal. The total metal fraction was collected in a plastic container and preserved without filtration. The dissolved fraction was field filtered (0.45 micron filter) and then preserved for analysis.

Water samples were evaluated for the thirteen trace metals. In addition to the trace metal analysis, selected general chemistry constituents and *in situ* parameters were also evaluated.

Figure 4. Schematic Diagram of Water Sampling Stations Associated with the Poe Spoil Piles.



Poe Project, FERC No. 2107

All samples (soil and water) were shipped under Chain-Of-Custody to a state certified laboratory. Laboratory selection was consistent with that used during previous monitoring efforts. All appropriate preservation and handling methods were utilized during sample collection. The laboratory was instructed to report all concentrations down to their method detection limit (MDL), which is more sensitive than the standard reporting limit (RL). These estimated concentrations or J-values represent the concentration of the analytes detected above the MDL, but below the RL. The MDL is a theoretical detection limit that is calculated by the laboratory by using a statistical formula to evaluate the results of a series of replicates that are run by the instrument at a low detection limit. The statistical formula looks at the standard deviation of the results rather than the accuracy of the results. The MDL is the industry standard for what the instrument can reliably see and quantify that isn't subject to a lot of errors. The laboratory typically sets the RL to two to five times the MDL.

5.0 RESULTS

5.1 Phase I – Soil Sampling

Results of the Phase I soil sampling effort are presented in Tables 1, 2 and 3. In all three tables, the results for each of the six discrete samples along with the associated background sample are reported for each spoil pile. An average value was compiled from the six discrete samples as representative of the spoil pile.

Table 1 presents the results of the TTLC analysis. As indicated by the data, none of the discrete samples exceeded the total threshold criteria. Levels of the CAM-17 metals from the spoil pile samples were typically similar to levels found in background samples. Geologic data indicated that both tunnel sections were composed on similar geologic materials. Based on this information it was assumed that both piles would contain similar materials. The TTLC data from both piles exhibited similar concentrations, which supports this assumption. Data from both piles indicated that chromium, cobalt, and nickel were significantly higher in the background samples than the spoil pile samples. Barium and copper were found in slightly higher concentrations in the spoil pile samples. However, as previously discussed all levels were well below the threshold concentrations used to define hazardous waste.

Table 2 presents the results of the STLC-WET analysis. As indicated by the data, none of the discrete samples exceeded the soluble threshold criteria. Levels of the CAM-17 metals from the spoil pile samples were typically similar to levels found in background samples. Only barium, copper, and nickel were found in detectable concentrations in the spoil pile samples.

Table 3 presents the results of the STLC-DI analysis. The data were collected as an indicator of possible leachate concentrations; there are no applicable threshold criteria established for the deionized extraction method. Levels of the CAM-17 metals from the spoil pile samples were typically similar to levels found in background samples. Only barium was found in detectable concentrations in the spoil pile samples using the DI extraction method.

Table 1
Summary of Total Threshold Limit Concentration Analysis (TTLC)

				Adit No. 1							
		Report		Adit 1	Transect 1			Transect 2			Background
Constituent	Units	Limit	Criteria	Average	A1_T1	A1_M1	A1_B1	A1_T2	A1_M2	A1_B2	B1_1
Antimony	mg/L	2.0	500	< 2.0	ND	ND	ND	ND	ND	ND	ND
Arsenic	mg/L	1.0	500	1.9	2.0	1.9	1.5	1.9	2.4	1.8	5.5
Barium	mg/L	1.0	10,000	69.3	120.0	13.0	49.0	120.0	53.0	61.0	11.0
Beryllium	mg/L	0.5	75	< 0.5	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/L	0.5	100	1.8	1.5	2.8	1.7	1.7	1.7	1.1	4.1
Chromium	mg/L	1.0	2,500	70.8	37.0	180.0	81.0	37.0	56.0	34.0	150.0
Cobalt	mg/L	1.0	8,000	13.1	7.4	29.0	15.0	7.7	12.0	7.2	41.0
Copper	mg/L	1.0	2,500	47.7	51.0	38.0	40.0	48.0	65.0	44.0	24.0
Lead	mg/L	1.0	1,000	1.9	1.2	1.5	ND	1.3	4.8	2.1	1.3
Mercury	mg/L	0.05	20	< 0.05	ND	ND	ND	ND	ND	ND	ND
Molybdenum	mg/L	1.0	3,500	< 1.0	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/L	1.0	2,000	158.3	36.0	510.0	220.0	32.0	99.0	53.0	1200.0
Selenium	mg/L	2.0	100	< 2.0	ND	ND	ND	ND	ND	ND	ND
Silver	mg/L	1.0	500	< 1.0	ND	ND	ND	ND	ND	ND	ND
Thallium	mg/L	1.0	700	< 1.0	ND	ND	ND	ND	ND	ND	ND
Vanadium	mg/L	1.0	2,400	20.7	27.0	11.0	15.0	31.0	23.0	17.0	27.0
Zinc	mg/L	1.0	5,000	16.7	19.0	11.0	13.0	22.0	21.0	14.0	14.0
Iron	mg/L	10	—	10,267	8,700	17,000	10,000	9,800	9,700	6,400	25000

				Adit No. 2							
				Adit 2	Transect 1			Transect 2			Background
Constituent	Units	Rep. Limit	Criteria	Average	A2_T1	A2_M1	A2_B1	A2_T2	A2_M2	A2_B2	B2_1
Antimony	mg/L	2.0	500	< 2.0	ND	ND	ND	ND	ND	ND	ND
Arsenic	mg/L	1.0	500	2.9	1.8	5.9	4.1	1.9	2.0	1.9	9.2
Barium	mg/L	1.0	10,000	43.0	24.0	180.0	17.0	14.0	12.0	11.0	8.2
Beryllium	mg/L	0.5	75	< 0.5	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/L	0.5	100	1.8	1.4	3.5	2.1	1.5	1.3	1.2	2.9
Chromium	mg/L	1.0	2,500	49.7	34.0	28.0	42.0	54.0	110.0	30.0	160.0
Cobalt	mg/L	1.0	8,000	11.8	7.8	13.0	12.0	11.0	18.0	8.8	83.0
Copper	mg/L	1.0	2,500	53.7	45.0	54.0	76.0	39.0	57.0	51.0	41.0
Lead	mg/L	1.0	1,000	2.4	1.1	2.3	4.1	1.8	2.1	2.8	1.1
Mercury	mg/L	0.05	20	< 0.05	ND	ND	ND	ND	ND	ND	ND
Molybdenum	mg/L	1.0	3,500	< 1.0	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/L	1.0	2,000	62.3	39.0	34.0	37.0	76.0	140.0	48.0	990.0
Selenium	mg/L	2.0	100	< 2.0	ND	ND	ND	ND	ND	ND	ND
Silver	mg/L	1.0	500	< 1.0	ND	ND	ND	ND	ND	ND	ND
Thallium	mg/L	1.0	700	< 1.0	ND	ND	ND	ND	ND	ND	ND
Vanadium	mg/L	1.0	2,400	22.5	18.0	45.0	25.0	19.0	15.0	13.0	28.0
Zinc	mg/L	1.0	5,000	16.9	12.0	37.0	19.0	13.0	9.2	11.0	8.9
Iron	mg/L	10	—	10,500	8,200	19,000	12,000	8,700	8,200	6,900	18,000

Table 2
Summary of Soluble Threshold Limit Concentration (STLC)-WET Extraction Analysis

				Adit No. 1							
				Adit 1	Transect 1			Transect 2			Background
Constituent	Units	Rep. Limit	Criteria	Average	A1_T1	A1_M1	A1_B1	A1_T2	A1_M2	A1_B2	B1_1
Antimony	mg/L	0.50	15	< 0.50	ND	ND	ND	ND	ND	ND	ND
Arsenic	mg/L	0.50	5	< 0.50	ND	ND	ND	ND	ND	ND	ND
Barium	mg/L	0.10	100	2.65	3.90	1.20	1.80	3.50	2.70	2.80	0.90
Beryllium	mg/L	0.10	0.75	< 0.10	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/L	0.10	1	< 0.10	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/L	0.50	5	< 0.50	ND	ND	ND	ND	ND	ND	ND
Cobalt	mg/L	0.50	80	< 0.50	ND	ND	ND	ND	ND	ND	2.20
Copper	mg/L	0.50	25	0.95	ND	2.30	0.77	ND	1.50	0.62	ND
Lead	mg/L	0.50	5	< 0.50	ND	ND	ND	ND	ND	ND	ND
Mercury	mg/L	0.02	0.2	< 0.02	ND	ND	ND	ND	ND	ND	ND
Molybdenum	mg/L	0.50	350	< 0.50	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/L	0.50	20	1.95	ND	6.60	2.70	ND	1.30	0.60	21.00
Selenium	mg/L	0.20	1	< 0.20	ND	ND	ND	ND	ND	ND	ND
Silver	mg/L	0.50	5	< 0.50	ND	ND	ND	ND	ND	ND	ND
Thallium	mg/L	0.50	7	< 0.50	ND	ND	ND	ND	ND	ND	ND
Vanadium	mg/L	0.50	24	< 0.50	ND	ND	ND	ND	ND	ND	ND
Zinc	mg/L	0.50	250	< 0.50	ND	ND	ND	ND	0.50	ND	ND
Iron	mg/L	1.0	----	34.6	14.0	120.0	4.8	11.0	38.0	20.0	63.0

				Adit No. 2							
				Adit 2	Transect 1			Transect 2			Background
Constituent	Units	Rep. Limit	Criteria	Average	A2_T1	A2_M1	A2_B1	A2_T2	A2_M2	A2_B2	B2_1
Antimony	mg/L	0.50	15	< 0.50	ND	ND	ND	ND	ND	ND	ND
Arsenic	mg/L	0.50	5	< 0.50	ND	ND	ND	ND	ND	ND	ND
Barium	mg/L	0.10	100	2.26	6.20	3.00	1.00	1.50	0.98	0.89	0.78
Beryllium	mg/L	0.10	0.75	< 0.10	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/L	0.10	1	< 0.10	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/L	0.50	5	< 0.50	ND	ND	ND	ND	ND	ND	0.70
Cobalt	mg/L	0.50	80	< 0.50	0.51	ND	ND	ND	ND	ND	6.20
Copper	mg/L	0.50	25	1.93	ND	1.00	0.75	1.10	0.80	7.70	ND
Lead	mg/L	0.50	5	< 0.50	ND	ND	ND	ND	ND	ND	ND
Mercury	mg/L	0.02	0.2	< 0.02	ND	ND	ND	ND	ND	ND	ND
Molybdenum	mg/L	0.50	350	< 0.50	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/L	0.50	20	0.91	1.10	0.75	ND	1.60	1.20	0.54	19.00
Selenium	mg/L	0.20	1	< 0.20	ND	ND	ND	ND	ND	ND	ND
Silver	mg/L	0.50	5	< 0.50	ND	ND	ND	ND	ND	ND	ND
Thallium	mg/L	0.50	7	< 0.50	ND	ND	ND	ND	ND	ND	ND
Vanadium	mg/L	0.50	24	< 0.50	ND	ND	ND	ND	ND	ND	ND
Zinc	mg/L	0.50	250	< 0.50	0.73	0.59	ND	ND	ND	ND	ND
Iron	mg/L	1.0	----	36.0	58.0	38.0	36.0	43.0	17.0	24.0	200.0

Table 3
Summary of Soluble Threshold Limit Concentration (STLC)-DI Extraction Analysis

Constituent	Units	Rep. Limit	Criteria	Adit No. 1: Adit 1 Average	Transect 1: A1_T1	Transect 1: A1_M1	Transect 1: A1_B1	Transect 2: A1_T2	Transect 2: A1_M2	Transect 2: A1_B2	Background B1_1
Antimony	mg/L	0.01	----	0.11	0.025	0.027	ND	0.30	0.075	0.20	ND
Arsenic	mg/L	0.06	----	< 0.06	ND	ND	ND	ND	ND	ND	ND
Barium	mg/L	0.02	----	0.12	0.084	0.11	0.13	0.085	0.32	ND	0.15
Beryllium	mg/L	0.02	----	< 0.02	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/L	0.02	----	< 0.02	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/L	0.02	----	< 0.02	ND	ND	ND	ND	ND	ND	0.10
Cobalt	mg/L	0.02	----	< 0.02	ND	ND	ND	ND	ND	ND	0.017
Copper	mg/L	0.02	----	< 0.02	0.027	ND	ND	0.019	ND	ND	ND
Lead	mg/L	0.02	----	< 0.02	ND	ND	ND	ND	ND	ND	ND
Mercury	mg/L	0.00028	----	< 0.00	ND	ND	ND	ND	ND	ND	ND
Molybdenur	mg/L	0.01	----	< 0.01	0.026	0.022	ND	ND	ND	ND	ND
Nickel	mg/L	0.02	----	< 0.02	ND	ND	ND	ND	ND	ND	0.83
Selenium	mg/L	0.05	----	< 0.05	ND	ND	ND	ND	ND	ND	ND
Silver	mg/L	0.01	----	< 0.01	ND	ND	ND	ND	ND	ND	ND
Thallium	mg/L	0.04	----	< 0.04	ND	0.044	0.043	ND	ND	ND	ND
Vanadium	mg/L	0.02	----	< 0.02	ND	ND	ND	ND	ND	ND	ND
Zinc	mg/L	0.05	----	< 0.05	ND	ND	ND	ND	ND	ND	ND
Iron	mg/L	0.27	----	0.87	1.4	ND	0.28	2.2	1.1	ND	20.0

Constituent	Units	Rep. Limit	Criteria	Adit No. 2: Adit 2 Average	Transect 1: A2_T1	Transect 1: A2_M1	Transect 1: A2_B1	Transect 2: A2_T2	Transect 2: A2_M2	Transect 2: A2_B2	Background B2_1
Antimony	mg/L	0.01	----	0.01	0.036	0.015	ND	ND	ND	ND	ND
Arsenic	mg/L	0.062	----	< 0.06	ND	ND	ND	ND	ND	ND	ND
Barium	mg/L	0.016	----	0.13	0.15	0.10	0.11	0.18	0.15	0.087	0.057
Beryllium	mg/L	0.019	----	< 0.02	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/L	0.019	----	< 0.02	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/L	0.018	----	< 0.02	ND	ND	ND	ND	ND	ND	0.056
Cobalt	mg/L	0.017	----	< 0.02	ND	ND	ND	ND	ND	ND	ND
Copper	mg/L	0.019	----	< 0.02	ND	ND	ND	ND	0.019	ND	0.026
Lead	mg/L	0.022	----	< 0.02	ND	ND	ND	ND	ND	ND	ND
Mercury	mg/L	0.00028	----	< 0.00	ND	ND	ND	ND	ND	ND	ND
Molybdenur	mg/L	0.014	----	< 0.01	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/L	0.021	----	< 0.02	ND	ND	ND	ND	0.034	ND	0.40
Selenium	mg/L	0.054	----	< 0.05	ND	ND	ND	ND	ND	ND	ND
Silver	mg/L	0.007	----	< 0.007	ND	ND	ND	ND	ND	ND	ND
Thallium	mg/L	0.042	----	< 0.04	ND	ND	ND	ND	ND	ND	ND
Vanadium	mg/L	0.020	----	< 0.02	ND	ND	ND	0.02	ND	ND	ND
Zinc	mg/L	0.054	----	< 0.05	ND	ND	ND	ND	ND	ND	ND
Iron	mg/L	0.266	----	0.59	0.43	ND	0.52	0.49	1.4	0.57	5.7

5.2 Phase II-Water Quality Sampling

Results of the dry (base flow) period sampling are presented in Table 4. The data were collected on November 26, 2001 when flow in the Poe Reach of the NFFR was 131 cfs. Precipitation for the 30-days prior to the sampling period was 7.2 inches as measured at the DWR station at Lake Oroville Dam. As indicated by the *in situ* data, water temperature, conductivity, pH, and turbidity were similar at all six stations. Of the thirteen trace metal constituents only barium, chromium, copper, iron, manganese, nickel, and zinc were measured in detectable concentrations. Due to the low suspended sediment concentration, filtration had little effect on the concentration of the detected constituents, with the exception of copper, manganese and iron. These constituents exhibited significant reductions in concentration after filtration. This indicates that these constituents existed in the water column primarily as suspended matter and not as a dissolved species. In general, there was little or no difference in water quality between the control and test stations. This was especially evident when comparing dissolved concentrations.

Table 4 also compares the applicable regulatory criteria with trace metal constituents found in detectable concentrations during the dry period sampling effort. As indicated by this comparison, none of the dissolved metal concentrations exceeds any of the listed criteria. Where applicable, hardness based criteria were calculated based on measured hardness.

Results of the wet period sampling are presented in Table 5. The data were collected on January 3, 2002 when flow in the Poe Reach of the NFFR was 4,560 cfs. Precipitation for the 30-days prior to the sampling period was 9.6 inches as measured at the DWR station at Lake Oroville Dam. As indicated by the *in situ* data, water temperature, conductivity, pH, and turbidity was similar at all three river stations and the powerhouse tailrace. The three stations associated with the leakage from Adit No.2 exhibited the influence from surface and ephemeral tributary/spring flow contributions. However, as was observed during the dry period sampling, of the thirteen trace metal constituents only barium, copper, iron, manganese, nickel, and zinc were measured in detectable concentrations. In addition, silver was also measured in detectable concentrations. The suspended sediment concentrations in the river were 2.0 to 8.5 times the levels measured during the dry period. As a result, filtration significantly reduced the concentration of copper, iron, manganese, and nickel. In general, there was little or no difference in trace metal concentrations between the control and test stations. This was especially evident when comparing dissolved concentrations.

Table 5 also compares the applicable regulatory criteria with trace metal constituents found in detectable concentrations during the wet period sampling effort. As indicated by this comparison, none of the dissolved metal concentrations exceeds any of the listed criteria. Where applicable, hardness based criteria were calculated based on measured hardness.

Table 4
Results of NFFR Water Quality Sampling near Poe Project Spoil Piles - Dry Condition

Parameter	Limits RL	Limits MDL	Phase		Sampling Stations [1] NFFR1 Poe-L1	NFFR2 Poe-L2	NFFR3 Poe-L3	Adit 2A Poe-L4	Adit 2B Poe-L5	Poe PH Poe-L6
				Date	11/26/01	11/26/01	11/26/01	11/26/01	11/26/01	11/26/01
				Time	1425	1215	1150	1130	1230	1315
Arsenic	**0.005 mg/l**	**0.003 mg/l**	**Total**		**<0.003**	**<0.003**	**<0.003**	**<0.003**	**<0.003**	**<0.003**
			Dissolved		**<0.003**	**<0.003**	**<0.003**	**<0.003**	**<0.003**	**<0.003**
				CTR- CMC	*0.34*	*0.34*	*0.34*	*0.34*	*0.34*	*0.34*
				CTR - CCC	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*
				USEPA - CMC	*0.34*	*0.34*	*0.34*	*0.34*	*0.34*	*0.34*
				USEPA - CCC	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*
				Basin Plan	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
				DHS- Primary MCL	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Barium	**0.005 mg/l**	**0.0003 mg/l**	**Total**		**0.013**	**0.013**	**0.013**	**0.015**	**0.014**	**0.016**
			Dissolved		**0.040**	**0.042**	**0.041**	**0.043**	**0.042**	**0.042**
				CTR- CMC	----	----	----	----	----	----
				CTR - CCC	----	----	----	----	----	----
				USEPA - CMC	----	----	----	----	----	----
				USEPA - CCC	----	----	----	----	----	----
				Basin Plan	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*
				DHS- Primary MCL	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Cadmium [3]	**0.001 mg/l**	**0.000074 mg/l**	**Total**		**<0.000074**	**<0.000074**	**<0.000074**	**<0.000074**	**<0.000074**	**<0.000074**
			Dissolved		**<0.000074**	**<0.000074**	**<0.000074**	**<0.000074**	**<0.000074**	**<0.000074**
				CTR- CMC	*0.00188*	*0.00188*	*0.00188*	*0.00184*	*0.00201*	*0.00188*
				CTR - CCC	*0.00128*	*0.00128*	*0.00128*	*0.00126*	*0.00134*	*0.00128*
				USEPA - CMC	*0.00097*	*0.00097*	*0.00097*	*0.00095*	*0.00103*	*0.00097*
				USEPA - CCC	*0.00013*	*0.00013*	*0.00013*	*0.00013*	*0.00014*	*0.00013*
				Basin Plan	*0.00019*	*0.00019*	*0.00019*	*0.00019*	*0.00019*	*0.00019*
				DHS- Primary MCL	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Chromium [2,3]	**0.005 mg/l**	**0.0002 mg/l**	**Total**		**0.00060 [J]**	**0.00043 [J]**	**0.00060 [J]**	**0.00055 [J]**	**0.00055 [J]**	**0.00055 [J]**
			Dissolved		**0.00042 [J]**	**0.00052 [J]**	**0.00040 [J]**	**0.00041 [J]**	**0.00048 [J]**	**0.00022 [J]**
				CTR- CMC	*0.296*	*0.296*	*0.296*	*0.291*	*0.311*	*0.296*
				CTR - CCC	*0.096*	*0.096*	*0.096*	*0.094*	*0.101*	*0.096*
				USEPA - CMC	*0.307*	*0.307*	*0.307*	*0.302*	*0.323*	*0.307*
				USEPA - CCC	*0.040*	*0.040*	*0.040*	*0.039*	*0.042*	*0.040*
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*

Table 4
Results of NFFR Water Quality Sampling near Poe Project Spoil Piles - Dry Condition

Parameter	Limits: RL	Limits: MDL	Phase		Sampling Stations[1]: NFFR1 Poe-L1	NFFR2 Poe-L2	NFFR3 Poe-L3	Adit 2A Poe-L4	Adit 2B Poe-L5	Poe PH Poe-L6
				Date	11/26/01	11/26/01	11/26/01	11/26/01	11/26/01	11/26/01
				Time	1425	1215	1150	1130	1230	1315
Copper[3]	**0.005 mg/l**	**0.0003 mg/l**	**Total**		**0.0012 [J]**	**0.0011 [J]**	**0.0015 [J]**	**0.0020 [J]**	**0.0017 [J]**	**0.0016 [J]**
			Dissolved		**<0.0003**	**0.00052 [J]**	**0.00035 [J]**	**<0.0003**	**<0.0003**	**<0.0003**
				CTR- CMC	*0.007*	*0.007*	*0.007*	*0.007*	*0.007*	*0.007*
				CTR - CCC	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
				USEPA - CMC	*0.007*	*0.007*	*0.007*	*0.007*	*0.007*	*0.007*
				USEPA - CCC	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
				Basin Plan	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
				DHS- Primary MCL	*1.3*	*1.3*	*1.3*	*1.3*	*1.3*	*1.3*
				DHS- Secondary MCL	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
Iron	**0.2 mg/l**	**0.0151 mg/l**	**Total**		**0.094 [J]**	**0.095 [J]**	**0.085 [J]**	**0.14 [J]**	**0.16 [J]**	**0.17 [J]**
			Dissolved		**0.096 [J]**	**0.046 [J]**	**0.031 [J]**	**0.055 [J]**	**0.056 [J]**	**0.048 [J]**
				CTR- CMC	---	---	---	---	---	---
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	---	---	---	---	---	---
				USEPA - CCC	---	---	---	---	---	---
				Basin Plan	*0.30*	*0.30*	*0.30*	*0.30*	*0.30*	*0.30*
				DHS- Secondary MCL	*0.30*	*0.30*	*0.30*	*0.30*	*0.30*	*0.30*
Lead[3]	**0.001 mg/l**	**0.000066 mg/l**	**Total**		**<0.000066**	**<0.000066**	**<0.000066**	**<0.000066**	**<0.000066**	**<0.000066**
			Dissolved		**<0.000066**	**<0.000066**	**<0.000066**	**<0.000066**	**<0.000066**	**<0.000066**
				CTR- CMC	*0.028*	*0.028*	*0.028*	*0.027*	*0.030*	*0.028*
				CTR - CCC	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*
				USEPA - CMC	*0.028*	*0.028*	*0.028*	*0.027*	*0.030*	*0.028*
				USEPA - CCC	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	*0.015*	*0.015*	*0.015*	*0.015*	*0.015*	*0.015*
Manganese	**0.005 mg/l**	**0.0009 mg/l**	**Total**		**0.0079**	**0.0079**	**0.0089**	**0.019**	**0.016**	**0.026**
			Dissolved		**0.0074**	**0.0048 [J]**	**0.0019 [J]**	**0.0021 [J]**	**0.0028 [J]**	**0.0023 [J]**
				CTR- CMC	---	---	---	---	---	---
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	---	---	---	---	---	---
				USEPA - CCC	---	---	---	---	---	---
				Basin Plan	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
				DHS- Secondary MCL	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*

Table 4
Results of NFFR Water Quality Sampling near Poe Project Spoil Piles - Dry Condition

Parameter	Limits RL	Limits MDL	Phase		Sampling Stations[1] *NFFR1*	*NFFR2*	*NFFR3*	*Adit 2A*	*Adit 2B*	*Poe PH*
					Poe-L1	*Poe-L2*	*Poe-L3*	*Poe-L4*	*Poe-L5*	*Poe-L6*
				Date	*11/26/01*	*11/26/01*	*11/26/01*	*11/26/01*	*11/26/01*	*11/26/01*
				Time	*1425*	*1215*	*1150*	*1130*	*1230*	*1315*
Mercury	0.0002 mg/l	0.00004 mg/l	**Total**		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
			Dissolved		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
				CTR- CMC	---	---	---	---	---	---
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	*0.0014*	*0.0014*	*0.0014*	*0.0014*	*0.0014*	*0.0014*
				USEPA - CCC	*0.00077*	*0.00077*	*0.00077*	*0.00077*	*0.00077*	*0.00077*
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
				USEPA- HHWP-drinking water sources[4]	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*
				USEPA- HHWP-other waters[4]	*0.000051*	*0.000051*	*0.000051*	*0.000051*	*0.000051*	*0.000051*
Nickel[3]	0.005 mg/l	0.0019 mg/l	**Total**		0.0023 [J]	0.0022 [J]	0.0023 [J]	0.0023 [J]	0.0020 [J]	0.0022 [J]
			Dissolved		0.0022 [J]	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019
				CTR- CMC	*0.247*	*0.247*	*0.247*	*0.243*	*0.261*	*0.247*
				CTR - CCC	*0.003*	*0.003*	*0.003*	*0.003*	*0.003*	*0.003*
				USEPA - CMC	*0.247*	*0.247*	*0.247*	*0.243*	*0.261*	*0.247*
				USEPA - CCC	*0.028*	*0.028*	*0.028*	*0.027*	*0.029*	*0.028*
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*
Selenium	0.005 mg/l	0.0042 mg/l	**Total**		<0.0042	<0.0042	<0.0042	<0.0042	<0.0042	<0.0042
			Dissolved		<0.0042	<0.0042	<0.0042	<0.0042	<0.0042	<0.0042
				CTR- CMC[4]	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*
				CTR - CCC[4]	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
				USEPA - CMC	---	---	---	---	---	---
				USEPA - CCC[4,5]	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Silver[3]	0.005 mg/l	0.0003 mg/l	**Total**		<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
			Dissolved		<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
				CTR- CMC	*0.00094*	*0.00094*	*0.00094*	*0.00091*	*0.00105*	*0.00094*
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	*0.00094*	*0.00094*	*0.00094*	*0.00091*	*0.00105*	*0.00094*
				USEPA - CCC	---	---	---	---	---	---
				Basin Plan	*0.010*	*0.010*	*0.010*	*0.010*	*0.010*	*0.010*
				DHS- Secondary MCL	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*

Table 4

Results of NFFR Water Quality Sampling near Poe Project Spoil Piles - Dry Condition

	Limits				Sampling Stations[1]					
					NFFR1	*NFFR2*	*NFFR3*	*Adit 2A*	*Adit 2B*	*Poe PH*
					Poe-L1	*Poe-L2*	*Poe-L3*	*Poe-L4*	*Poe-L5*	*Poe-L6*
				Date	*11/26/01*	*11/26/01*	*11/26/01*	*11/26/01*	*11/26/01*	*11/26/01*
Parameter	**RL**	**MDL**	**Phase**	Time	*1425*	*1215*	*1150*	*1130*	*1230*	*1315*
Zinc[3]	**0.01 mg/l**	**0.0032 mg/l**	**Total**		**<0.0032**	**<0.0032**	**<0.0032**	**<0.0032**	**0.0041 [J]**	**<0.0032**
			Dissolved		**<0.0032**	**0.0053 [J]**	**0.0050 [J]**	**0.0058 [J]**	**0.0061 [J]**	**0.0065 [J]**
				CTR- CMC	*0.0618*	*0.0618*	*0.0618*	*0.0607*	*0.0651*	*0.0618*
				CTR - CCC	*0.0623*	*0.0623*	*0.0623*	*0.0612*	*0.0657*	*0.0623*
				USEPA - CMC	*0.0618*	*0.0618*	*0.0618*	*0.0607*	*0.0651*	*0.0618*
				USEPA - CCC	*0.0623*	*0.0623*	*0.0623*	*0.0612*	*0.0657*	*0.0623*
				Basin Plan	*0.0143*	*0.0143*	*0.0143*	*0.0143*	*0.0143*	*0.0143*
				DHS- Primary MCL	*5.0*	*5.0*	*5.0*	*5.0*	*5.0*	*5.0*
Calcium	**0.2 mg/l**	**0.0152 mg/l**	**Total**		**8.8**	**8.7**	**8.8**	**11.0**	**11.0**	**11.0**
			Dissolved		**9.1**	**8.7**	**8.7**	**11.0**	**11.0**	**10.0**
				CTR- CMC	---	---	---	---	---	---
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	---	---	---	---	---	---
				USEPA - CCC	---	---	---	---	---	---
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	---	---	---	---	---	---
Magnesium	**0.2 mg/l**	**0.0255 mg/l**	**Total**		**6.0**	**6.2**	**6.2**	**4.8**	**5.3**	**4.8**
			Dissolved		**6.2**	**6.2**	**6.1**	**4.8**	**5.4**	**4.7**
				CTR- CMC	---	---	---	---	---	---
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	---	---	---	---	---	---
				USEPA - CCC	---	---	---	---	---	---
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	---	---	---	---	---	---
Sodium	**4.8 mg/l**	**0.062 mg/l**	**Total**		**3.7**	**3.5**	**3.4**	**4.3**	**4.3**	**4.7**
			Dissolved		**5.1**	**4.2**	**3.9**	**4.8**	**4.8**	**4.8**
				CTR- CMC	---	---	---	---	---	---
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	---	---	---	---	---	---
				USEPA - CCC	---	---	---	---	---	---
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	---	---	---	---	---	---

Table 4
Results of NFFR Water Quality Sampling near Poe Project Spoil Piles - Dry Condition

	Limits				Sampling Stations [1]					
					NFFR1	*NFFR2*	*NFFR3*	*Adit 2A*	*Adit 2B*	*Poe PH*
					Poe-L1	*Poe-L2*	*Poe-L3*	*Poe-L4*	*Poe-L5*	*Poe-L6*
				Date	*11/26/01*	*11/26/01*	*11/26/01*	*11/26/01*	*11/26/01*	*11/26/01*
Parameter	**RL**	**MDL**	**Phase**	Time	*1425*	*1215*	*1150*	*1130*	*1230*	*1315*
Potassium	**1.0 mg/l**	**0.050 mg/l**	**Total**		**0.98 [J]**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**
			Dissolved		**1.1**	**1.1**	**1.0**	**1.1**	**1.1**	**1.0**
				CTR- CMC	---	---	---	---	---	---
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	---	---	---	---	---	---
				USEPA - CCC	---	---	---	---	---	---
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	---	---	---	---	---	---
TDS	**1 mg/l**	----	**Total**		**52**	**53**	**63**	**60**	**82**	**59**
				DHS - Secondary MCL	*500*	*500*	*500*	*500*	*500*	*500*
Hardness	**10 mg/l**	----	**Total**		**47**	**47**	**47**	**46**	**50**	**47**
Chloride	**0.2 mg/l**	----	**Total**		**2.9**	**3.0**	**2.9**	**3.2**	**3.2**	**3.2**
				USEPA - CMC	*860*	*860*	*860*	*860*	*860*	*860*
				USEPA - CCC	*230*	*230*	*230*	*230*	*230*	*230*
				DHS - Secondary MCL	*250*	*250*	*250*	*250*	*250*	*250*
Sulfate	**0.2 mg/l**	----	**Total**		**3.9**	**3.6**	**3.6**	**5.2**	**6.2**	**4.6**
				DHS - Secondary MCL	*250*	*250*	*250*	*250*	*250*	*250*
Temperature	**0.1 °C**				**7.2**	**8.4**	**8.4**	**7.4**	**7.6**	**7.1**
Specific Conductivity	**1.0 µmohs/cm @ 25°C**				**108**	**105**	**106**	**112**	**117**	**108**
				Basin Plan	*150*	*150*	*150*	*150*	*150*	*150*
				DHS - Secondary MCL	*900*	*900*	*900*	*900*	*900*	*900*
pH	**0.1 units**				**7.7**	**7.7**	**7.7**	**7.6**	**7.6**	**7.6**
				USEPA Instananeous Max.	*6.5-9.0*	*6.5-9.0*	*6.5-9.0*	*6.5-9.0*	*6.5-9.0*	*6.5-9.0*
				Basin Plan	*6.5-8.5*	*6.5-8.5*	*6.5-8.5*	*6.5-8.5*	*6.5-8.5*	*6.5-8.5*
Turbidity	**0.1 NTU**				**2.1**	**2.5**	**2.5**	**3.2**	**2.8**	**4.2**

Table 4
Results of NFFR Water Quality Sampling near Poe Project Spoil Piles - Dry Condition

	Limits				Sampling Stations [1]					
					NFFR1	*NFFR2*	*NFFR3*	*Adit 2A*	*Adit 2B*	*Poe PH*
					Poe-L1	*Poe-L2*	*Poe-L3*	*Poe-L4*	*Poe-L5*	*Poe-L6*
				Date	*11/26/01*	*11/26/01*	*11/26/01*	*11/26/01*	*11/26/01*	*11/26/01*
Parameter	RL	MDL	Phase	Time	*1425*	*1215*	*1150*	*1130*	*1230*	*1315*

[1] Station Locations
- ***Poe-L1*** NFFR upstream of Adit No.1, background condition.
- ***Poe-L2*** NFFR upstream of Adit No.2, test condition.
- ***Poe-L3*** NFFR downstream of Adit No.2, test condition.
- ***Poe-L4*** Adit No.2 leakage culvert below railroad grade, test condition.
- ***Poe-L5*** Adit No.2 leakage culvert at inflow to NFFR, test condition.
- ***Poe-L6*** Poe Powerhouse tailrace, background condition.

[2] = Criteria shown for Chromium represent Chromium (III), except for DHS-Primary MCL which represents total chromium

[3] = Criteria for CTR and USEPA are based on a calculation that uses the sample's date/time specific hardness

[4] = Criteria expressed as total recoverable

[5] = Selenium criteria for USEPA -CCC can be converted to a value expressed as dissolved by multiplying by 0.922 (i.e., 0.005*0.922 = 0.00461)

RL = Laboratory reporting limit
MDL = Method detection limit (a limit that is based on statistical analysis of a series of sample runs for a particular analysis)
[J] = J-value is an estimated concentration that is below the laboratory's reporting limit (RL) but above the method detection limit (MDL)
CTR-CMC = California Toxics Rule Criteria for Freshwater Aquatic Life Protection, Criteria Maximum Concentration (1-hour average)
CTR-CCC = California Toxics Rule Criteria for Freshwater Aquatic Life Protection, Criteria Continuous Concentration (4-day average)
USEPA-CMC = USEPA National Recommended Ambient Water Quality Criteria for Freshwater Aquatic Life Protection, Criteria Maximum Concentration (1-hour average)
USEPA-CCC = USEPA National Recommended Ambient Water Quality Criteria for Freshwater Aquatic Life Protection, Criteria Continuous Concentration (4-day average)
Basin Plan = Regional Water Quality Control Board (RWQCB) Basin Plan Criteria, 1998 RWQCB Basin Plan
DHS-Primary MCL = California Department of Health Services, Primary Maximum Contaminant Level
DHS-Secondary MCL = California Department of Health Services, Secondary Maximum Contaminant Level
USEPA- HHWP-drinking water sources = USEPA National Recommended Ambient Water Quality Criteria, Human Health and Welfare Protection, Non-Cancer Health Effects, Sources of drinking water (water and organisms)
USEPA- HHWP-other waters = USEPA National Recommended Ambient Water Quality Criteria, Human Health and Welfare Protection, Non-Cancer Health Effects, Other waters (aquatic organism consumption only)

Table 5
Results of NFFR Water Quality Sampling near Poe Project Spoil Piles - Wet Condition

Parameter	Limits RL	Limits MDL	Phase		Sampling Stations [1] NFFR1 Poe-L1	TRIB1 Poe-T1	NFFR2 Poe-L2	NFFR3 Poe-L3	Adit 2C Poe-Adit	Adit 2A Poe-L4
				Date	01/03/02	01/03/02	01/03/02	01/03/02	01/03/02	01/03/02
				Time	930	920	1215	1100	1145	1200
Arsenic	0.005 mg/l	0.003 mg/l	Total		<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
			Dissolved		<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
				CTR- CMC	*0.34*	*0.34*	*0.34*	*0.34*	*0.34*	*0.34*
				CTR - CCC	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*
				USEPA - CMC	*0.34*	*0.34*	*0.34*	*0.34*	*0.34*	*0.34*
				USEPA - CCC	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*
				Basin Plan	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
				DHS- Primary MCL	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Barium	0.005 mg/l	0.0003 mg/l	Total		0.019	0.015	0.018	0.015	0.0092	0.016
			Dissolved		0.040	0.043	0.040	0.041	0.039	0.036
				CTR- CMC	----	----	----	----	----	----
				CTR - CCC	----	----	----	----	----	----
				USEPA - CMC	----	----	----	----	----	----
				USEPA - CCC	----	----	----	----	----	----
				Basin Plan	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*
				DHS- Primary MCL	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Cadmium [3]	0.001 mg/l	0.000074 mg/l	Total		<0.000074	<0.000074	<0.000074	<0.000074	<0.000074	<0.000074
			Dissolved		<0.000074	<0.000074	<0.000074	<0.000074	<0.000074	<0.000074
				CTR- CMC	*0.00145*	*0.00367*	*0.00149*	*0.00149*	*0.00227*	*0.00223*
				CTR - CCC	*0.00107*	*0.00202*	*0.00109*	*0.00109*	*0.00146*	*0.00144*
				USEPA - CMC	*0.00077*	*0.00176*	*0.00079*	*0.00079*	*0.00115*	*0.00113*
				USEPA - CCC	*0.00011*	*0.00020*	*0.00011*	*0.00011*	*0.00015*	*0.00015*
				Basin Plan	*0.00019*	*0.00019*	*0.00019*	*0.00019*	*0.00019*	*0.00019*
				DHS- Primary MCL	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
Chromium [2,3]	0.005 mg/l	0.0002 mg/l	Total		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
			Dissolved		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
				CTR- CMC	*0.243*	*0.490*	*0.248*	*0.248*	*0.341*	*0.336*
				CTR - CCC	*0.079*	*0.159*	*0.081*	*0.081*	*0.111*	*0.109*
				USEPA - CMC	*0.252*	*0.508*	*0.258*	*0.258*	*0.354*	*0.349*
				USEPA - CCC	*0.033*	*0.066*	*0.034*	*0.034*	*0.046*	*0.045*
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*

Table 5
Results of NFFR Water Quality Sampling near Poe Project Spoil Piles - Wet Condition

Parameter	Limits RL	Limits MDL	Phase	Sampling Stations[1] NFFR1 Poe-L1	TRIB1 Poe-T1	NFFR2 Poe-L2	NFFR3 Poe-L3	Adit 2C Poe-Adit	Adit 2A Poe-L4
			Date	01/03/02	01/03/02	01/03/02	01/03/02	01/03/02	01/03/02
			Time	930	920	1215	1100	1145	1200
Copper[3]	0.005 mg/l	0.0003 mg/l	Total	0.0084	<0.0003	0.0054	0.0052	<0.0003	<0.0003
			Dissolved	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
			CTR- CMC	*0.005*	*0.012*	*0.005*	*0.005*	*0.008*	*0.008*
			CTR - CCC	*0.004*	*0.008*	*0.004*	*0.004*	*0.006*	*0.005*
			USEPA - CMC	*0.005*	*0.012*	*0.005*	*0.005*	*0.008*	*0.008*
			USEPA - CCC	*0.004*	*0.008*	*0.004*	*0.004*	*0.006*	*0.005*
			Basin Plan	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
			DHS- Primary MCL	*1.3*	*1.3*	*1.3*	*1.3*	*1.3*	*1.3*
			DHS- Secondary MCL	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
Iron	0.2 mg/l	0.0151 mg/l	Total	0.820	0.250	0.860	0.270	<0.0151	0.43
			Dissolved	0.060 [J]	<0.0151	0.024 [J]	0.030 [J]	<0.0151	<0.0151
			CTR- CMC	---	---	---	---	---	---
			CTR - CCC	---	---	---	---	---	---
			USEPA - CMC	---	---	---	---	---	---
			USEPA - CCC	---	---	---	---	---	---
			Basin Plan	*0.30*	*0.30*	*0.30*	*0.30*	*0.30*	*0.30*
			DHS- Secondary MCL	*0.30*	*0.30*	*0.30*	*0.30*	*0.30*	*0.30*
Lead[3]	0.001 mg/l	0.000066 mg/l	Total	0.00027 [J]	<0.000066	0.00025 [J]	0.00026 [J]	<0.000066	0.00010 [J]
			Dissolved	<0.000066	<0.000066	<0.000066	<0.000066	<0.000066	<0.000066
			CTR- CMC	*0.022*	*0.055*	*0.022*	*0.022*	*0.034*	*0.033*
			CTR - CCC	*0.001*	*0.002*	*0.001*	*0.001*	*0.001*	*0.001*
			USEPA - CMC	*0.022*	*0.055*	*0.022*	*0.022*	*0.034*	*0.033*
			USEPA - CCC	*0.001*	*0.002*	*0.001*	*0.001*	*0.001*	*0.001*
			Basin Plan	---	---	---	---	---	---
			DHS- Primary MCL	*0.015*	*0.015*	*0.015*	*0.015*	*0.015*	*0.015*
Manganese	0.005 mg/l	0.0009 mg/l	Total	0.0550	0.0053	0.0550	0.0480	<0.0009	0.028
			Dissolved	0.0250	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009
			CTR- CMC	---	---	---	---	---	---
			CTR - CCC	---	---	---	---	---	---
			USEPA - CMC	---	---	---	---	---	---
			USEPA - CCC	---	---	---	---	---	---
			Basin Plan	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
			DHS- Secondary MCL	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*

Table 5
Results of NFFR Water Quality Sampling near Poe Project Spoil Piles - Wet Condition

Parameter	Limits RL	Limits MDL	Phase		Sampling Stations [1] *NFFR1*	*TRIB1*	*NFFR2*	*NFFR3*	*Adit 2C*	*Adit 2A*
					Poe-L1	*Poe-T1*	*Poe-L2*	*Poe-L3*	*Poe-Adit*	*Poe-L4*
				Date	*01/03/02*	*01/03/02*	*01/03/02*	*01/03/02*	*01/03/02*	*01/03/02*
				Time	*930*	*920*	*1215*	*1100*	*1145*	*1200*
Mercury	**0.0002 mg/l**	**0.00004 mg/l**	**Total**		**<0.00004**	**<0.00004**	**<0.00004**	**<0.00004**	**<0.00004**	**<0.00004**
			Dissolved		**<0.00004**	**<0.00004**	**<0.00004**	**<0.00004**	**<0.00004**	**<0.00004**
				CTR- CMC	---	---	---	---	---	---
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	*0.0014*	*0.0014*	*0.0014*	*0.0014*	*0.0014*	*0.0014*
				USEPA - CCC	*0.00077*	*0.00077*	*0.00077*	*0.00077*	*0.00077*	*0.00077*
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
				USEPA- HHWP-drinking water sources [4]	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*	*0.00005*
				USEPA- HHWP-other waters [4]	*0.000051*	*0.000051*	*0.000051*	*0.000051*	*0.000051*	*0.000051*
Nickel [3]	**0.005 mg/l**	**0.0019 mg/l**	**Total**		**0.0069**	**0.019**	**0.007**	**0.005**	**<0.0019**	**<0.0019**
			Dissolved		**<0.0019**	**0.013**	**<0.0019**	**<0.0019**	**<0.0019**	**<0.0019**
				CTR- CMC	*0.202*	*0.416*	*0.207*	*0.207*	*0.287*	*0.282*
				CTR - CCC	*0.022*	*0.046*	*0.023*	*0.023*	*0.032*	*0.031*
				USEPA - CMC	*0.202*	*0.416*	*0.207*	*0.207*	*0.287*	*0.282*
				USEPA - CCC	*0.022*	*0.046*	*0.023*	*0.023*	*0.032*	*0.031*
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*
Selenium	**0.005 mg/l**	**0.0042 mg/l**	**Total**		**<0.0042**	**<0.0042**	**<0.0042**	**<0.0042**	**<0.0042**	**<0.0042**
			Dissolved		**<0.0042**	**<0.0042**	**<0.0042**	**<0.0042**	**<0.0042**	**<0.0042**
				CTR- CMC [4]	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*
				CTR - CCC [4]	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
				USEPA - CMC	---	---	---	---	---	---
				USEPA - CCC [4, 5]	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Silver [3]	**0.005 mg/l**	**0.0003 mg/l**	**Total**		**0.0003 [J]**	**0.00033 [J]**	**<0.0003**	**0.00033 [J]**	**0.00038[J]**	**<0.0003**
			Dissolved		**0.00038[J]**	**0.00031 [J]**	**<0.0003**	**0.00031 [J]**	**<0.0003**	**<0.0003**
				CTR- CMC	*0.00062*	*0.00272*	*0.00065*	*0.00065*	*0.00127*	*0.00123*
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	*0.00062*	*0.00272*	*0.00065*	*0.00065*	*0.00127*	*0.00123*
				USEPA - CCC	---	---	---	---	---	---
				Basin Plan	*0.010*	*0.010*	*0.010*	*0.010*	*0.010*	*0.010*
				DHS- Secondary MCL	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*

Table 5
Results of NFFR Water Quality Sampling near Poe Project Spoil Piles - Wet Condition

	Limits				Sampling Stations[1]					
					NFFR1	*TRIB1*	*NFFR2*	*NFFR3*	*Adit 2C*	*Adit 2A*
					Poe-L1	*Poe-T1*	*Poe-L2*	*Poe-L3*	*Poe-Adit*	*Poe-L4*
				Date	*01/03/02*	*01/03/02*	*01/03/02*	*01/03/02*	*01/03/02*	*01/03/02*
Parameter	**RL**	**MDL**	**Phase**	Time	*930*	*920*	*1215*	*1100*	*1145*	*1200*
Zinc[3]	**0.01 mg/l**	**0.0032 mg/l**	**Total**		**0.02**	**0.0034 [J]**	**0.0081 [J]**	**0.017**	**<0.0032**	**0.0078 [J]**
			Dissolved		**0.013**	**0.0065 [J]**	**0.0078 [J]**	**0.0079[J]**	**0.0071 [J]**	**0.0073 [J]**
				CTR- CMC	*0.0505*	*0.1041*	*0.0516*	*0.0516*	*0.0717*	*0.0706*
				CTR - CCC	*0.0509*	*0.1050*	*0.0520*	*0.0520*	*0.0723*	*0.0712*
				USEPA - CMC	*0.0505*	*0.1041*	*0.0516*	*0.0516*	*0.0717*	*0.0706*
				USEPA - CCC	*0.0509*	*0.1050*	*0.0520*	*0.0520*	*0.0723*	*0.0712*
				Basin Plan	*0.0143*	*0.0143*	*0.0143*	*0.0143*	*0.0143*	*0.0143*
				DHS- Primary MCL	*5.0*	*5.0*	*5.0*	*5.0*	*5.0*	*5.0*
Calcium	**0.2 mg/l**	**0.0152 mg/l**	**Total**		**7.5**	**4.4**	**7.9**	**7.8**	**15.0**	**13.0**
			Dissolved		**6.7**	**4.2**	**6.7**	**6.9**	**15.0**	**12.0**
				CTR- CMC	---	---	---	---	---	---
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	---	---	---	---	---	---
				USEPA - CCC	---	---	---	---	---	---
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	---	---	---	---	---	---
Magnesium	**0.2 mg/l**	**0.0255 mg/l**	**Total**		**4.3**	**19.0**	**4.5**	**4.6**	**4.3**	**5.8**
			Dissolved		**4.0**	**18.0**	**3.9**	**4.3**	**4.4**	**5.6**
				CTR- CMC	---		---	---		---
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	---	---	---	---	---	---
				USEPA - CCC	---	---	---	---	---	---
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	---	---	---	---	---	---
Sodium	**1.0 mg/l**	**0.062 mg/l**	**Total**		**7.2**	**0.85 [J]**	**7.6**	**7.3**	**2.6**	**7.1**
			Dissolved		**2.6**	**1.0**	**2.6**	**2.6**	**2.8**	**2.5**
				CTR- CMC	---	---	---	---	---	---
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	---	---	---	---	---	---
				USEPA - CCC	---	---	---	---	---	---
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	---	---	---	---	---	---

Table 5
Results of NFFR Water Quality Sampling near Poe Project Spoil Piles - Wet Condition

	Limits				Sampling Stations [1]					
					NFFR1	*TRIB1*	*NFFR2*	*NFFR3*	*Adit 2C*	*Adit 2A*
					Poe-L1	*Poe-T1*	*Poe-L2*	*Poe-L3*	*Poe-Adit*	*Poe-L4*
				Date	*01/03/02*	*01/03/02*	*01/03/02*	*01/03/02*	*01/03/02*	*01/03/02*
Parameter	**RL**	**MDL**	**Phase**	Time	*930*	*920*	*1215*	*1100*	*1145*	*1200*
Potassium	**1.0 mg/l**	**0.050 mg/l**	**Total**		**0.87 [J]**	**0.50 [J]**	**0.89 [J]**	**0.75 [J]**	**0.96 [J]**	**1.10**
			Dissolved		**0.72 [J]**	**0.47 [J]**	**0.68 [J]**	**0.69 [J]**	**0.97 [J]**	**0.96 [J]**
				CTR- CMC	---	---	---	---	---	---
				CTR - CCC	---	---	---	---	---	---
				USEPA - CMC	---	---	---	---	---	---
				USEPA - CCC	---	---	---	---	---	---
				Basin Plan	---	---	---	---	---	---
				DHS- Primary MCL	---	---	---	---	---	---
TDS	**1 mg/l**	----	**Total**		**85**	**130**	**97**	**120**	**140**	**170**
				DHS - Secondary MCL	*500*		*500*	*500*		*500*
Hardness	**10 mg/l**	----	**Total**		**37**	**87**	**38**	**38**	**56**	**55**
Chloride	**0.2 mg/l**	----	**Total**		**2.5**	**3.7**	**2.7**	**2.6**	**2.7**	**2.5**
				USEPA - CMC	*860*	*860*	*860*	*860*	*860*	*860*
				USEPA - CCC	*230*	*230*	*230*	*230*	*230*	*230*
				DHS - Secondary MCL	*250*	*250*	*250*	*250*	*250*	*250*
Sulfate	**0.2 mg/l**	----	**Total**		**2.7**	**2.0**	**2.7**	**2.8**	**3.2**	**6.3**
				DHS - Secondary MCL	*250*	*250*	*250*	*250*	*250*	*250*
Temperature	**0.1 °C**				**6.5**	**10.3**	**6.7**	**6.8**	**12.1**	**9.5**
Specific Conductivity	**1.0 µmohs/cm @ 25°C**				**74**	**154**	**73**	**76**	**118**	**112**
				Basin Plan	*150*	*150*	*150*	*150*	*150*	*150*
				DHS - Secondary MCL	*900*	*900*	*900*	*900*	*900*	*900*
pH	**0.1 units**				**7.6**	**7.3**	**7.5**	**7.5**	**7.4**	**7.6**
				USEPA InstananeousMax.	*6.5-9.0*	*6.5-9.0*	*6.5-9.0*	*6.5-9.0*	*6.5-9.0*	*6.5-9.0*
				Basin Plan	*6.5-8.5*	*6.5-8.5*	*6.5-8.5*	*6.5-8.5*	*6.5-8.5*	*6.5-8.5*
Turbidity	**0.1 NTU**				**17.4**	**3.3**	**17.6**	**17.6**	**0.8**	**9.2**

Table 5
Results of NFFR Water Quality Sampling near Poe Project Spoil Piles - Wet Condition

Parameter	Limits RL	Limits MDL	Phase		Sampling Stations[1] NFFR1 Poe-L1	TRIB1 Poe-T1	NFFR2 Poe-L2	NFFR3 Poe-L3	Adit 2C Poe-Adit	Adit 2A Poe-L4
				Date	*01/03/02*	*01/03/02*	*01/03/02*	*01/03/02*	*01/03/02*	*01/03/02*
				Time	*930*	*920*	*1215*	*1100*	*1145*	*1200*

[1] Station Locations
- ***Poe-L1*** NFFR upstream of Adit No.1, background condition.
- ***Poe-L2*** NFFR upstream of Adit No.2, test condition.
- ***Poe-L3*** NFFR downstream of Adit No.2, test condition.
- ***Poe-L4*** Adit No.2 leakage culvert below railroad grade, test condition.
- ***Poe-L5*** Adit No.2 leakage culvert at inflow to NFFR, test condition.
- ***Poe-L6*** Poe Powerhouse tailrace, background condition.

[2] = Criteria shown for Chromium represent Chromium (III), except for DHS-Primary MCL which represents total chromium

[3] = Criteria for CTR and USEPA are based on a calculation that uses the sample's hardness

[4] = Criteria expressed as total recoverable

[5] = Selenium criteria for USEPA -CCC can be converted to a value expressed as dissolved by multiplying by 0.922 (i.e., 0.005*0.922 = 0.00461)

RL = Laboratory reporting limit
MDL = Method detection limit (a limit that is based on statistical analysis of a series of sample runs for a particular analysis)
[J] = J-value is an estimated concentration that is below the laboratory's reporting limit (RL) but above the method detection limit (MDL)
CTR-CMC = California Toxics Rule Criteria for Freshwater Aquatic Life Protection, Criteria Maximum Concentration (1-hour average)
CTR-CCC = California Toxics Rule Criteria for Freshwater Aquatic Life Protection, Criteria Continuous Concentration (4-day average)
USEPA-CMC = USEPA National Recommended Ambient Water Quality Criteria for Freshwater Aquatic Life Protection, Criteria Maximum Concentration (1-hour average)
USEPA-CCC = USEPA National Recommended Ambient Water Quality Criteria for Freshwater Aquatic Life Protection, Criteria Continuous Concentration (4-day average)
Basin Plan = Regional Water Quality Control Board (RWQCB) Basin Plan Criteria, 1998 RWQCB Basin Plan
DHS-Primary MCL = California Department of Health Services, Primary Maximum Contaminant Level
DHS-Secondary MCL = California Department of Health Services, Secondary Maximum Contaminant Level
USEPA- HHWP-drinking water sources = USEPA National Recommended Ambient Water Quality Criteria, Human Health and Welfare Protection, Non-Cancer Health Effects, Sources of drinking water (water and organisms)
USEPA- HHWP-other waters = USEPA National Recommended Ambient Water Quality Criteria, Human Health and Welfare Protection, Non-Cancer Health Effects, Other waters (aquatic organism consumption only)

6.0 CONCLUSION

Based on the data collected as part of the Poe Relicensing effort, the spoil piles associated with the Poe Diversion Tunnel do not appear to contribute elevated levels of trace metals to the NFFR. TTLC and STLC analysis indicates that concentrations of the CAM-17 metals were well below the associated threshold criteria. Water sampling indicated that there is no difference in trace metals concentrations in the NFFR downstream of either the Adit No.1 or Adit No.2 piles.

7.0 REFERENCES

California Division of Mines and Geology 1982. Chico Gravity Map

POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX E2-2

Sediment Incipient Motion Analysis

Sediment Incipient Motion Analysis

Poe Reach of the
Lower North Fork Feather River

Prepared for

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March 2003

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EXECUTIVE SUMMARY

In the last couple of decades, Pacific Gas and Electric Company (PG&E) has sponsored a variety of studies to address the environmental issues on the North Fork Feather River (NFFR) related to the dams built on the NFFR for water-supply management and the generation of hydroelectric power. One of the key issues is the downstream effect of increasing the minimum release flow from Poe Reservoir. The increased release of water could have potential benefit to the fishery habitats downstream of the dam. These increased flow releases must be managed properly, so that higher flows will not disrupt the downstream sediment structure. Therefore, PG&E has authorized this incipient motion study of the Lower NFFR, which will provide important information for the various resource agencies to determine the optimal water releases.

This study covers one river reach along the Lower NFFR, the Poe Reach. PG&E supplied a total of 31 surveyed river cross-section (transect) data from the Lower NFFR. The Poe Reach of the NFFR extends from south of the Poe Dam to just north of the Poe Powerhouse and is divided into three sub-reaches. The Pulga Sub-Reach of the NFFR extends from south of the Poe Dam, where Mill Creek intersects the NFFR, downstream past the Pulga town-site to the Highway 70 Bridge. The second sub-reach encompasses the Bardee's Bar area, which is located at an anomalous U-shaped bend in the river. The third sub-reach, Poe Powerhouse, is located just upstream of the Poe Powerhouse Bridge. The following table summarizes the number of transects analyzed and their characteristic river type.

Table E1 Summary of Transects in Three Studied Sub-Reaches

	Pulga Sub-Reach	Bardee's Bar Sub-Reach	Poe Powerhouse Sub-Reach	Total
Pocket Water	1	4	0	5
Run	4	2	2	8
Low Gradient Riffle	1	0	1	2
High Gradient Riffle	0	1	0	1
Pool	6	7	2	15
Total	12	14	5	31

The first step in the incipient motion analysis is the hydraulic analysis to establish the flow characteristics at each study location. PG&E conducted four test flow releases and measured the corresponding flow velocities, water surface elevations and slopes for each transect. The hydraulic flow characteristics, such as channel velocities and Manning's n values, were calibrated using these field data. Once the stage-flow values were developed, the mathematical relationship for each transect was extrapolated to determine a wider range of flows for use in the incipient motion analysis.

The incipient motion analysis determines the flow threshold of sediment motion, which is the minimum flow needed to mobilize a specific size of sediment. The predominant factors in the calculation of sediment incipient motion are: channel velocity, energy slope at the cross section, and characteristic roughness height of the bed. Movement of sediment (bed material) is defined by the dimensionless grain shear stress (τ^*). The τ^* value is the ratio of the grain shear stress

(τ') to the critical shear stress (τ_c). When $\tau^* < 1$, there is insufficient shear stress to mobilize the bed material; when $\tau^* > 1$, particle mobilization occurs. The median (D_{50}) size of the bed material is typically used to evaluate incipient motion conditions because, in cobble and gravel bed streams, the full range of particle sizes in the bed are mobilized over a very narrow range of shear stresses. At discharges less than the critical discharge for the median size, the bed is essentially immobile. At higher discharges, virtually the entire bed material matrix is in motion.

Analysis of the variation in dimensionless grain shear stress (τ^*) with discharge at key locations provides a good representation of the dynamics of the study reach. Five gravel grain sizes, ranging from very fine to very coarse gravels, were included for incipient motion analysis. At each transect and a given sediment size, a shear stress and flow relationship was developed. The threshold flow at which the sediment incipient motion is expected for the given size is determined. Five threshold flows were used to construct the curve showing required minimum flow to mobilize the given sediment size. Each river section typically contained five to six riverine categories, varying from low gradient riffles to runs. No pools were included in the analysis. These threshold flows versus grain-size curves are then plotted together to determine an optimal range of discharges to mobilize various gravel sizes for each specific river section. The three sections of the Poe Reach, therefore, yielded three "optimal discharge versus grain-size" relationships (**Exhibit 1**). From these three relationships, a composite, best-fit relationship is then inferred to typify the entire Poe Reach.

On the Poe Reach, the three dashed lines represent the trends for each specific river sub-reach. The solid, bold line falls within the upper and lower limits of these three lines and represents the composite Poe relationship. This line signifies the incipient motion boundary for which any grain-size versus discharge point above this boundary will not be in motion while any point below will be in motion.

The following Table summarizes the results of sediment incipient motion analysis for Poe Reaches:

Table E2 Summary Results from Incipient Motion Analysis – Poe Reach

Gravel Size	Threshold Flow (cfs)		
	Lower Threshold	Average Threshold	Upper Threshold
Very Fine Gravel (3 mm)	12	14	20
Fine Gravel (6 mm)	62	68	76
Median Gravel (12 mm)	275	334	437
Coarse Gravel (24 mm)	1,010	1,630	2,500
Very Coarse Gravel (48 mm)	3,680	7,940	14,290

Based on the composite curve for the Poe Reach (Figure 15), the current instream flow release of 100 cfs at Poe Dam will put sediments less than 7 mm (fine gravel) in motion.

1. INTRODUCTION

In the last couple of decades, PG&E has sponsored a variety of studies to address the environmental issues on the North Fork Feather River (NFFR) related to the dams built on the NFFR for water-supply management and generation of hydroelectric power. One of the key issues is the feasibility of increasing flow release from Poe Reservoir. The increased release of water could have potential benefit to the fishery habitats downstream of the dams. It is important that any increased flow releases be managed properly so that the higher flows will not disrupt the downstream sediment structure. Therefore, the Pacific Gas and Electric (PG&E) has authorized this incipient motion study of the Lower NFFR, which will provide important information for PG&E management to determine the optimal dam releases.

The main objective of this study is to estimate the sediment incipient motion in the Lower NFFR associated with different flow releases from Poe Dam (Poe Reservoir). Surveyed river cross sections, measured flow characteristics and sediment samples were analyzed to evaluate the critical shear stress and corresponding threshold flow at which incipient motion of sediments will occur. The primary product resulting from this study is a table of threshold flows at which sediment motion is expected to commence in the Poe Reach of the Lower NFFR. This information will assist in the optimization of flow releases from the Poe Dam for achieving a balance between desired resource conditions (e.g., stream temperature, fishery physical habitat and recreational needs) and sediment dynamics in the Lower NFFR. **Figure 1** shows the regional location of the studied areas.

2. PHYSICAL SETTING

The North Fork Feather River (NFFR) is a relatively steep gradient, canyon bound river that drains from the west slope of the Sierra Nevada Mountains. Channel form and sediment distribution within steep mountain channels are most influenced by infrequent hydrologic events. The transport of bed material is an episodic phenomenon requiring large magnitude flows to entrain the more coarse-grained sediments and finer sediments trapped in pools (Harvey, Mussetter and Wick, 1993).

This sediment incipient motion study covers one river reach along the Lower NFFR, the Poe Reach. **Figure 2** shows the location of limits of the three studied sub-reaches within the Poe Reach. PG&E supplied a total of 31 surveyed river cross-section (transect) data along the NFFR. These transects were selected for the PG&E study of the fishery habitats using the In-stream Flow Incremental Methodology (IFIM). The Poe Reach of the NFFR is divided into three sections, and extends from south of the Poe Dam to just north of the Poe Powerhouse. The Pulga Sub-Reach of the NFFR extends from south of the Poe Dam, where Mill Creek intersects the NFFR, downstream past the Pulga town-site to the Highway 70 Bridge. The second sub-reach encompasses the Bardee's Bar area, which is located at an anomalous U-shaped bend in the river. The third sub-reach, Poe Powerhouse, is located just upstream of the Poe Powerhouse Bridge.

The characteristics of 31 cross sections can be grouped into different riverine categories, Pools, Low Gradient Riffles (LGR), High Gradient Riffles (HGR), Runs (Run) and Pocket Water (POW). The following definitions of the various habitats type are from the California Department of Fish and Game (Flosi, G. and F.L. Reynolds):

- Low Gradient Riffle – "LGR"
  Shallow reaches with swiftly flowing turbulent water with some partially exposed substrate; gradient < 4%, substrate is usually cobble dominated.

- High Gradient Riffle – "HGR"
  Steep reaches of moderately deep, swift, and very turbulent water, amount of exposed substrate is relatively high; gradient > 4%, and substrate is boulder dominated.

- Run – "RUN"
  Swiftly flowing reaches with little surface agitation and no major flow obstructions; often appears as flooded riffles; typical substrate consists of gravel, cobble, and boulders.

- Pocket Water – "POW"
  A section of swift flowing stream containing numerous boulders or other large obstructions, which create eddies or scour holes (pockets) behind the obstructions.

- Pool – "STP"
  A series of pools separated by short riffles or cascades; generally found in high gradient, confined mountain streams dominated by boulder substrate.

Pictures 1 to 5 (see **Figure 3**) show representative cross sections for a pool, a low gradient riffle, a high gradient riffle, a run and a pocket water. The detailed definitions and graphical exhibits of different habitats are shown in **Appendix A**.

3. FIELD DATA

To study the sediment incipient motion, it is necessary to fully understand the sediment and flow characteristics for the studied reaches. PG&E and their consultants performed field studies to survey river cross-sections and to collect sediment, as well as flow data. The data were used to evaluate the critical shear stress and corresponding threshold flow at which the incipient motion of sediments will occur.

Surveyed river cross sections (transects) were provided by PG&E from their IFIM studies on the defined reaches. The following table, **Table 1**, summarizes the number of transects analyzed and their characteristic river type.

Table 1 Summary of Transects in Three Studied Sub-Reaches

	Pulga Sub-Reach	Bardee's Bar Sub-Reach	Poe Powerhouse Sub-Reach	Total
POW	1	4	0	5
RUN	4	2	2	8
LGR	1	0	1	2
HGR	0	1	0	1
POOL	6	7	2	15
Total	12	14	5	31

All transects except those categorized as pools and the high gradient riffle reach were analyzed for the incipient motion analysis. The number of transects studied is 15, out of the total 31 transects surveyed.

At each transect, velocities and water surface energy slopes were measured and analyzed for a range of stream flow conditions. PG&E conducted various flow releases from Poe Dam so that flow characteristics could be measured in the downstream reaches. The following table, **Table 2**, summarizes the approximate flow releases from Poe Reservoir:

Table 2 Summary of Flow Releases for Field Study

Flow Release No.	Flow from Poe Dam (cfs)
1	~ 500
2	~ 265
3	~ 100

Wolman sediment counts were collected from the surface of the streambed at three different locations (RCE,1992): one just upstream of Poe Powerhouse, one at the gravel bar at Bardee's Bar, and one at the gravel bar just downstream of Poe Dam. **Figure 4** shows the locations where the sediment counts were taken. The following table, **Table 3**, summarizes the grain size distributions for the 3 sediment Wolman Counts collected. The sediment particle size gradation curves are shown in **Appendix B**.

Table 3 Summary of Wolman Count Grain Sizes

Sample No.	Sample Location	Median Grain Size (mm)	D_{84} Grain Size (mm)	Classification
1	Below Poe Dam	64.0	163	Very Coarse Gravel
2	At Bardee's Bar	26.0	48.5	Coarse Gravel
3	Above Poe Powerhouse	18.1	46.7	Coarse Gravel

4. HYDRAULIC ANALYSIS

Before performing the incipient motion analysis, it is necessary to first complete the hydraulic analysis to establish the flow characteristics at each studied transect. PG&E provided three measured flow discharges and the corresponding water surface elevations at each transect for the purpose of calibrating the hydraulic models. River flow characteristics, such as channel velocities and Manning's n values, were calibrated using these, discharge versus measured water surface elevation, values.

The surveyed river transects provided a core around which to build the hydraulic models. The analysis was performed using the one-dimensional U.S. Army Corps of Engineers HEC-RAS computer program. Three sets of flow characteristics were calculated for each transect based on the surveyed field hydraulic data. The main goal is to establish the velocity versus discharge relationship for each transect. Once the velocity versus discharge values are established, the mathematical relationship for each transect was extrapolated to determine a wider range of velocities for use in the incipient motion calculations. Hydraulic conditions within the study reach were evaluated for discharges ranging from 35 cfs to 10,000 cfs. Results were then used to establish hydraulic parameters and estimate incipient motion conditions for the range of discharges at specific transects within the reach.

Although the hydraulic analysis is based on a one-dimensional solution to a multi-dimensional hydraulic problem, the present assessment is adequate to provide a guideline and trend analysis for a sediment management plan. The present analysis clearly defines the variations in hydraulic energy that occur over a wide range of discharges at various transects.

5. INCIPIENT MOTION - THEORY

At low flows, movement of sediment only occurs for fine material. As shown in a typical movable bed physical model study, the flow may be laminar initially, which is an orderly flow that is constant with time. Typically, as flow volume and velocity increase, the turbulent threshold is reached and flow becomes less orderly, varying with time. At some point in the increase of flow volume and velocity, sediment begins to move. This initiation of movement is termed incipient motion. The start of sediment motion occurs sporadically. The particles more prone to move are the ones that have higher drag and less weight. Then as flow increases, the particles more resistant to movement begin to move (Shvidchenko, A.B., P. Gareth and T.B. Hoey, 2000).

Previous studies have indicated that the relative amounts of sand and gravel on the stream bottom affect the magnitude of the water flow that can move them. Sand sizes were all entrained over a narrow range of bed shear stress while entrainment of gravel sizes was still a function of grain size.

Given a flow, the incipient motion analysis determines the critical particle size (D_c); the riverbed grain size that is on the verge of motion for a specific transect under study. The critical particle size for the range of discharges modeled was estimated using the Shields (1936) relation:

$$\tau_c = \tau_{*c}(\gamma_s - \gamma)D \qquad (1)$$

where: τ_c is the critical shear stress,
τ_{*c} is the dimensionless critical shear stress,
γ_s is the unit weight of sediment (~165 lb/ft^3, γ_s is the unit weight of water (62.4 lb/ft^3), and
D is the particle size.

D_c is obtained by substituting the grain shear stress (τ') for τ_c, and D_c for D in Equation (1), and rearranging into the following form:

$$D_c = \frac{\tau'}{\tau_{*c}(\gamma_s - \gamma)} \qquad (2)$$

Reported values for τ_{*c} for the median particle size of the surface bed material range are from 0.03 (Meyer-Peter, Muller, 1948; Neill, 1968) to 0.06 (Shields, 1936).

Figure 5 is a graph of the data used by Shields to determine the Equation (1). The data delineating the curve were obtained by Shields and several other researchers from experiments in flumes with fully-developed turbulent flows and artificially flattened beds of non-cohesive sediments. In this graph, the quantity d_s is taken as the mean size of the sediment. The curve reaches a minimum of τ_{*c} (dimensionless critical shear stress) of 0.033 at R^*_c (critical boundary Reynolds number) near 10. For higher R^* the curve reaches the constant value of τ_{*c} = 0.06.

Shields' results shown in Figure 5 have been widely accepted, although some researchers have reported somewhat different values for the parameters. A value of 0.047 is commonly used in engineering practice based on the Meyer-Peter, Muller bed-load transport equation (Meyer-Peter, Muller, 1948). More recent studies indicate that a value of 0.03 may be more reasonable for gravel and cobble bed streams (Parker et al., 1982; Andrews, 1983). Neill (1968) concluded that 0.03 maybe a good indicator of the incipient motion where the bed material is just at the verge of motion while 0.047 is indicative of a "low, but measurable transport rate." The value of 0.06 represents the condition when the bed is having a very active sediment transport.

For purposes of this analysis, incipient conditions were computed using τ_{*c} values of 0.03, 0.047, and 0.06 to address the range of conditions associated with uncertainty in selection of a single appropriate value. The bed shear stress due to grain resistance (τ') is a better descriptor of near-bed hydraulic energy in gravel-cobble bed streams than the more commonly used total shear stress because it eliminates the effects of flow resistance due to irregularities in the channel boundary, non-linearity of the channel, variations in channel width, and other factors that contribute to the total flow depth, but not the energy available to move individual particles on the channel bed (Einstein, 1950). The grain shear stress (τ') is computed from the following relation:

$$\tau' = \gamma Y' S \qquad (3)$$

where: Y' is the portion of the total hydraulic depth associated with grain resistance (Einstein, 1950) and S is the energy slope at the cross section. The value of Y' is computed by iteratively solving the semi-logarithmic velocity profile equation:

$$\frac{V}{V_*'} = 5.75 + 6.25\log\left(\frac{Y'}{K_s}\right) \tag{4}$$

where: V is the mean velocity at the cross section,
K_s is the characteristic roughness height of the bed, and
V_*' is the shear velocity due to grain resistance given by:

$$V_*' = \sqrt{gY'S} \tag{5}$$

The characteristic roughness height of the bed (K_s) was assumed to be 3.5 D_{84}, (Hey, 1979).

The dimensionless grain shear stress (τ^*), is the ratio of the grain shear stress (τ') to the critical shear stress (τ_c) or:

$$\tau'_* = \frac{\tau'}{\tau_c} = \frac{\gamma Y'S}{\tau_{*c}(\gamma_s - \gamma)D_{50}} \tag{6}$$

When $\tau^* < 1$, there is insufficient shear stress to mobilize the bed material; when $\tau^* > 1$, particle mobilization is indicated.

The median (D_{50}) size of the bed material was used to evaluate incipient motion conditions because, in cobble and gravel bed streams, the full range of particle sizes in the bed are mobilized over a very narrow range of shear stresses (Parker et al., 1982). At discharges less than the critical discharge for the median size, the bed is essentially immobile. At higher discharges, virtually the entire bed material matrix is in motion. Analysis of the variation in dimensionless grain shear stress (τ^*) with discharge at key locations provides a good picture of the dynamics of the study reach.

6. INCIPIENT MOTION - DATA ANALYSIS

For each transect in the study, discharge versus τ^* plots were generated for five median grain sizes: very fine, fine, medium, coarse and very coarse gravel; and for three values of dimensionless critical shear stress (τ_{*c}): 0.03, 0.047, and 0.06. The following table, Table 4, summarizes the diameters for various gravel sizes used for the present analysis.

Table 4 Typical Gravel Sizes

Class Name	Size Range (mm)	Size Used in Analysis (mm)
Very Coarse Gravel	64-32	48
Coarse Gravel	32-16	24
Medium Gravel	16-8	12
Fine Gravel	8-4	6
Very Fine Gravel	4-2	3

From these discharge versus τ^* plots, the corresponding points of intersection with the line $\tau^*=1$ are inferred to equal the discharge for that specific grain-size and location at which incipient motion will be initiated. For the purpose of this analysis, the τ_{*c} value of 0.047 is considered the ideal value, while the τ_{*c} values of 0.03 and 0.06 were analyzed as upper and lower boundaries to establish a range of incipient motion conditions.

The graphical results for the three typical transects within Lower NFFR, Poe Reach, Pulga Sub-Reach, (as shown in **Figure 3** pictures) are shown in **Figures 6 to 8**. Results are provided only for Transect 3 (RUN), Transect 5 (POW), and Transect 8 (LGR) because Transects 1, 2, 4, 7, 9, 11, and 12 are pools. Incipient motion conditions were not analyzed for the pool transects in this study.

Figure 6 details dimensionless grain shear stress versus discharge for one specific grain size, medium gravel (12 mm), over the range of three dimensionless critical shear stresses: 0.03, 0.047, and 0.06. In the same figure, a dashed line (dimensionless grain shear stress = 1) is drawn to show the threshold value above which the medium gravel size (12 mm) would be mobilized. For instance, taking critical shear stress of 0.047 as the criterion, the interception point with the dashed line at flow of 400 cfs would mobilize the 12 mm gravel. The lower and upper boundaries of the incipient motion flow can be considered as 100 cfs (dimensionless critical shear stress = 0.03) and 1000 cfs (dimensionless critical shear stress = 0.06). For the same gravel size, the sediment incipient motion characteristics for the other five transects are shown in **Figures 7 and 8**. Similar analyses were done for other gravel sizes.

Figure 9 consolidates the dimensionless grain shear stress versus discharge for one specific dimensionless critical shear stress, 0.047, over the range of median gravel grain sizes: very fine, fine, medium, coarse, very coarse. The graphs can provide information on whether each specific gravel size would move under certain flow conditions. **Figures 9 to 11** shows the results for the same Transects 3, 4 and 5 of Pulga Sub-Reach, respectively. Take **Figure 9** as an example, it will take 60, 400 and 10,000 cfs, respectively, to mobilize fine gravel, median gravel, and coarse gravel in Transect 3 (RUN) of Pulga Sub-Reach. Similar information can be obtained from **Figures 10 and 11**.

From **Figures 9 to 11**, the interception points with the threshold dashed line for each sediment sizes are determined as the minimum flow requirement for sediment initiation. The sediment sizes and the required initiation flows were then used to construct the incipient motion relationship for the given transect as shown in **Figure 12**. Three dimensionless critical shears stresses of 0.03, 0.047 and 0.06 are included in the figure to provide the range of potential values for incipient motion. For each grain size diameter there are a range of discharges, which can mobilize the sediment. For example, the flows to mobilize median gravel (12 mm) are 400 cfs (average), 100 cfs (lower limit) and 1,000 cfs (upper limit), respectively. Or, for 1,000 cfs, it is possible to mobilize gravel between 12 mm (median gravel) and 24 mm (coarse gravel). **Figures 13 to 14** shows the results for Transects 5 and 8 (Pulga Sub-Reach).

The relationship of discharge versus grain-size incipient motion for each riverine category (runs, riffles, pocket waters, etc.) are then plotted together (**Figure 15**) to determine an optimal range of discharges, which would mobilize various gravel sizes for each specific river section. The three sections of the Poe Reach yielded three "optimal discharge versus grain-size" relationships. From these three relationships, a composite, best-fit relationship is then inferred to typify the entire Poe Reach. The incipient motion summary charts for Poe Reach is shown in **Figure 15**.

7. RESULTS AND DISCUSSIONS

On the Poe Reach incipient motion summary chart (**Figure 15**), the three dashed lines represent the trends for each specific river section in the Poe Reach. The solid, bold line falls within the upper and lower limits of these three lines and represents the composite Poe relationship. This line signifies the overall incipient motion boundary, above which the given grain-size sediment will not be entrained, while below which will be in motion.

Table 5 summarizes the results of sediment incipient motion analysis for Poe Reach.

Table 5 Summary Results from Incipient Motion Analysis – Poe Reach

Gravel Size	Threshold Flow (cfs)		
	Lower Threshold	Average Threshold	Upper Threshold
Very Fine Gravel (3 mm)	12	14	20
Fine Gravel (6 mm)	62	68	76
Median Gravel (12 mm)	275	334	437
Coarse Gravel (24 mm)	1,010	1,630	2,500
Very Coarse Gravel (48 mm)	3,680	7,940	14,290

Based on the composite curve for the Poe Reach (**Figure 15**), the current instream flow release of 100 cfs at Poe Dam will put sediments less than 7 mm (fine gravel) in motion and not median gravel or larger material. From sediment gradation data collected by RCE, sediments of less than 8 to 10 mm are generally less than 10% of the total fraction. This is in agreement with the results of this study.

The incipient motion analysis results for the Poe Reach also agree with the results of RCE's Bar Dynamics Assessment, RM 17.7 – RM 18.2, North Fork Feather River, prepared for PG&E in April 1994. The study reach of the RCE assessment lies upstream of Poe Dam, which is located at river mile 15.5. The grain size distribution for RM 17.7 to RM 18.2 is larger than for the Poe Reach, with an average D_{84} of about 264 mm and an average D_{50} of about 150 mm (RCE, 1994). The RCE assessment analyzed the incipient motion conditions of the primary and secondary bars, and their adjacent pools, of the Cresta Reach, upstream of the Cresta Powerhouse. Since the current study did not include pool or split-flow bar sections, the most comparable transect from the RCE analysis is Transect 2207.5 (Riffle), which was the only riffle section RCE analyzed within the Cresta Reach. At this riffle section, critical conditions are exceeded at discharges greater than about 900 cfs, which is similar to the threshold flows determined for the Poe Reach. The incipient motion results for Transect 2207.5 are summarized in **Figure 16**.

It should be noted that this study was performed to provide a general guidance in optimizing a suitable regulated flow release to minimize sediment impact. This study does not address, nor is intended to, describe geomorphic process during high flows (in the range of thousands of cfs). This study does not address the sediment recruitment and/or sediment routing in the river system.

This study also only addresses a sediment setting with uniform size sediment. Previous studies reveal that critical bed shear stress for incipient motion of uniform sediment depends not only on the grain size, but also on the bed slope. This is explained by the effect of relative roughness on overall flow resistance. It is also known that the value of critical dimensionless bed shear stress is not constant for rough turbulent flow, as is usually assumed, but gradually reduces for coarser gravel.

The incipient motion of individual size fractions within a mixture appears to be controlled by their relative size (d_{50} /d_{84}), median size (d_{50}), and sediment sorting. The experiments with graded sediment demonstrate that shear stress at incipient motion of median-sized particles (d_{50}) in mixtures with geometric standard deviation is the same as for uniform sediment of the same size. For mixtures with a wider grading, the critical shear stress of the d_{50} particles is higher compared to uniform sediment. This is explained by the silting effect reducing the overall mobility of the bed material.

The Gravel Grain-Size versus Discharge (Incipient Motion) plots were extended to 10,000 cfs primarily for presentation purposes. The Manning coefficients best-fitted to the field velocity data can be extrapolated to values greater than the calibrated range. However, the extrapolation range is valid as long as the hydraulic characteristics, such as the channel geometry and hydraulic control, do not change significantly from the calibration condition. Given the fact that the In-stream Flow Incremental Methodology (IFIM) procedures allow for the extrapolation of discharges up to 2.5 times greater than the highest calibration discharge, the Licensee believes that the same assumption is applicable to the sediment incipient motion study results.

Using this assumption, the upper extrapolation limit would correspond to a discharge of roughly 1,250 cfs for the Poe Reach. Since the objective of the study is to determine and optimize the incipient motion of various gravel sizes in various reaches in the NFFR, the Licensee believes the resource management should focus on gravels suitable for trout with size less than the coarse gravel (24 mm). To manage the recruitment of coarse gravels (24 mm), the analytical result of the incipient threshold discharge ranges from 1,000 to 2,500 cfs in the Poe Reach. These threshold discharges are within a reasonable range of the upper extrapolation limit considering the relatively uniform channel section of the Lower North Fork Feather River; and therefore, validate the use of the study results for sediment recruitment management. The results for larger size material (such as in the cobble or boulder range) incipient motion should be applied with caution to ensure that the basic hydraulic assumptions are not violated. The study of the large size material is beyond the scope of this incipient motion study.

8. REFERENCES

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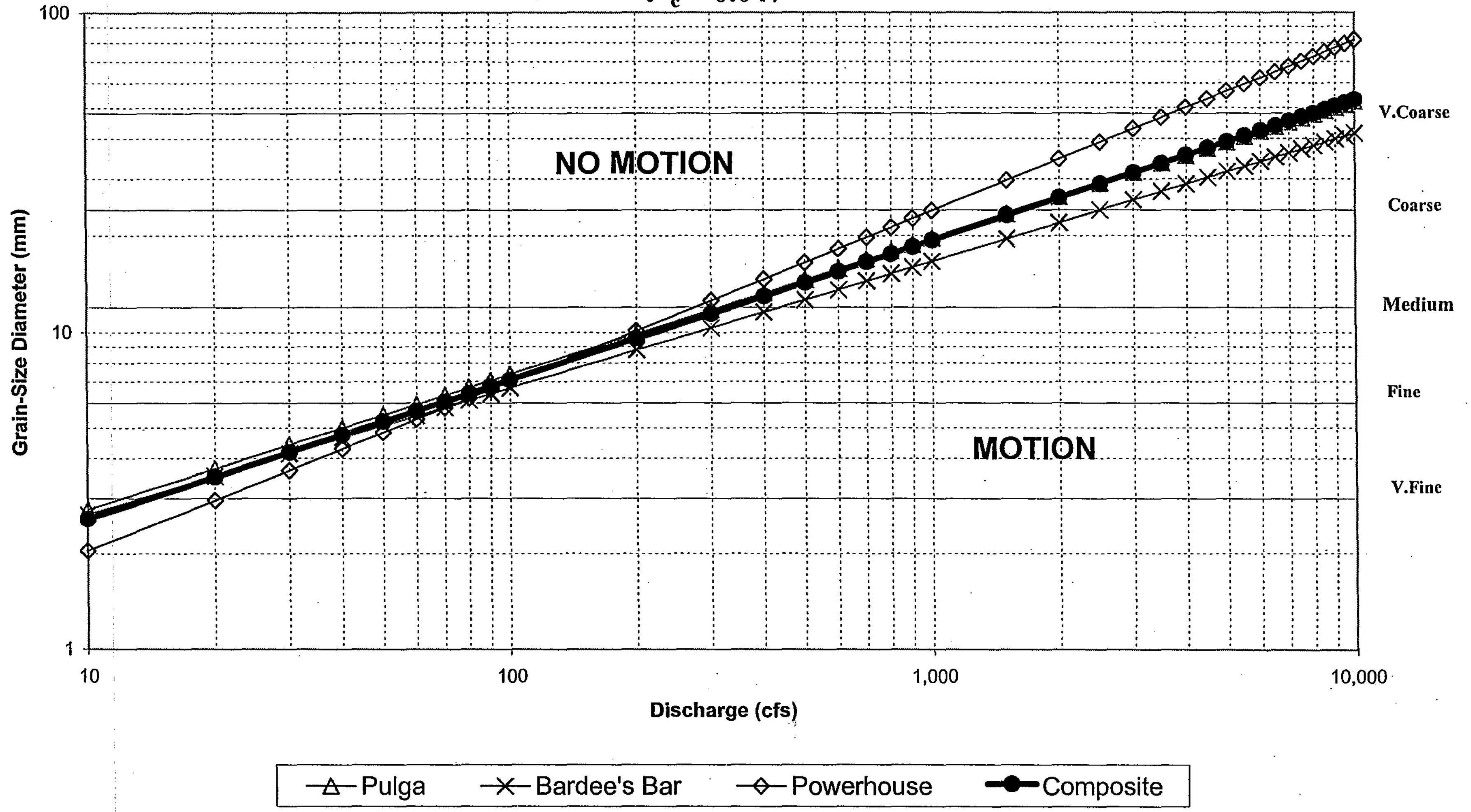
9. ACKNOWLEDGEMENT

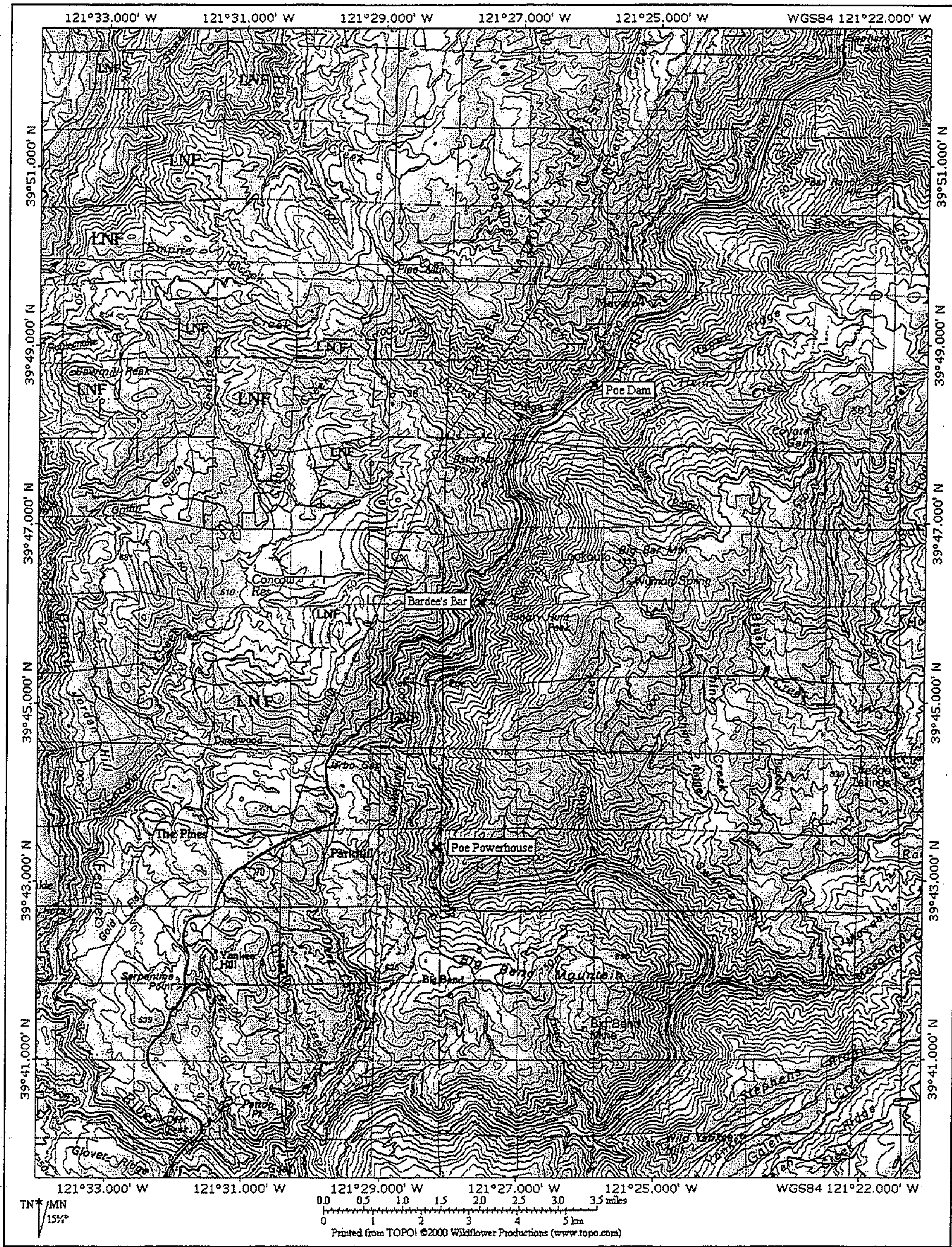
Dr. Scott Tu and Ms. Elizabeth Frantz of PG&E Technical and Ecological Services provided basic data, background information and some of the concepts presented herein.

EXHIBITS

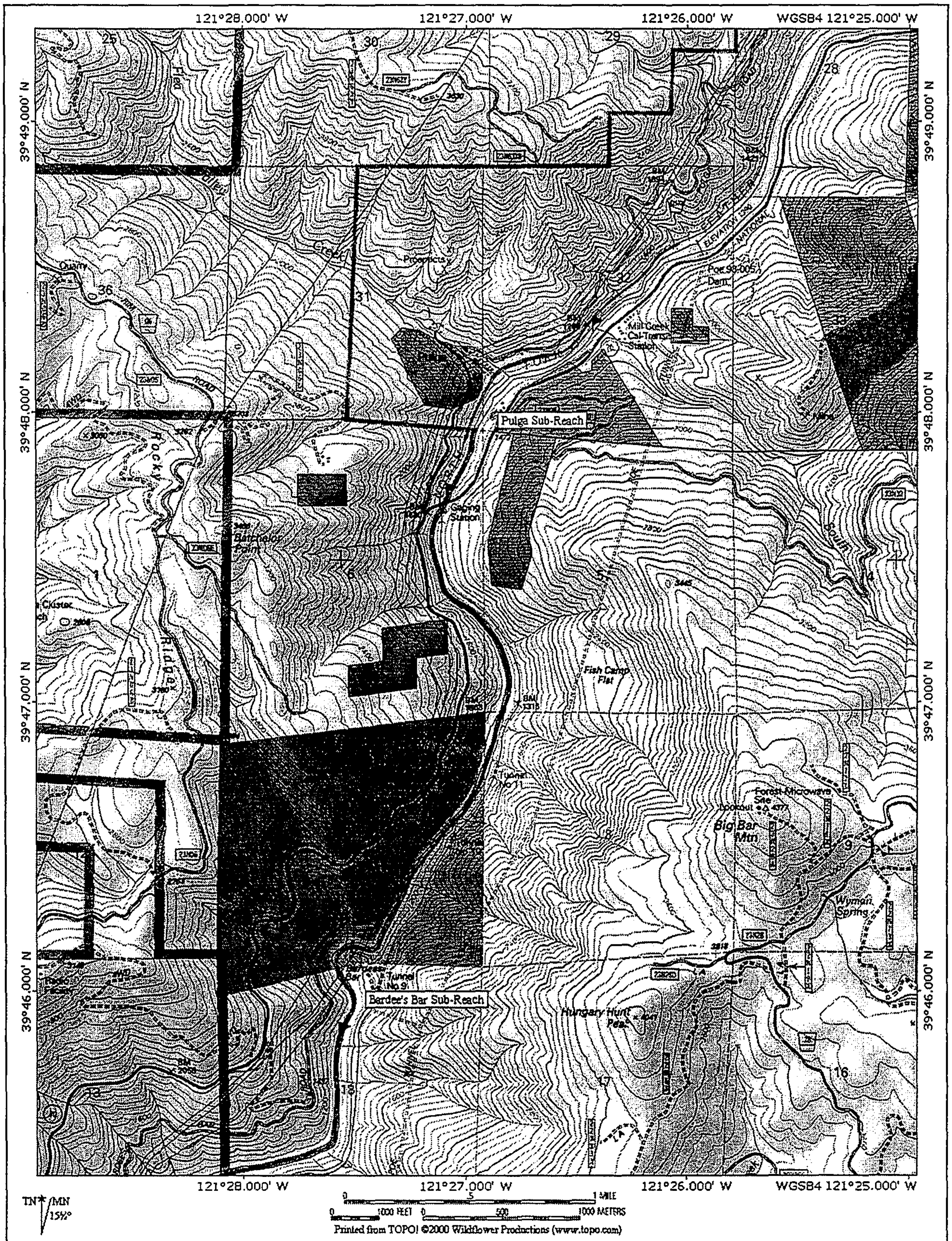
EXHIBIT 1
Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR- Poe Reach
$\tau^*_c = 0.047$



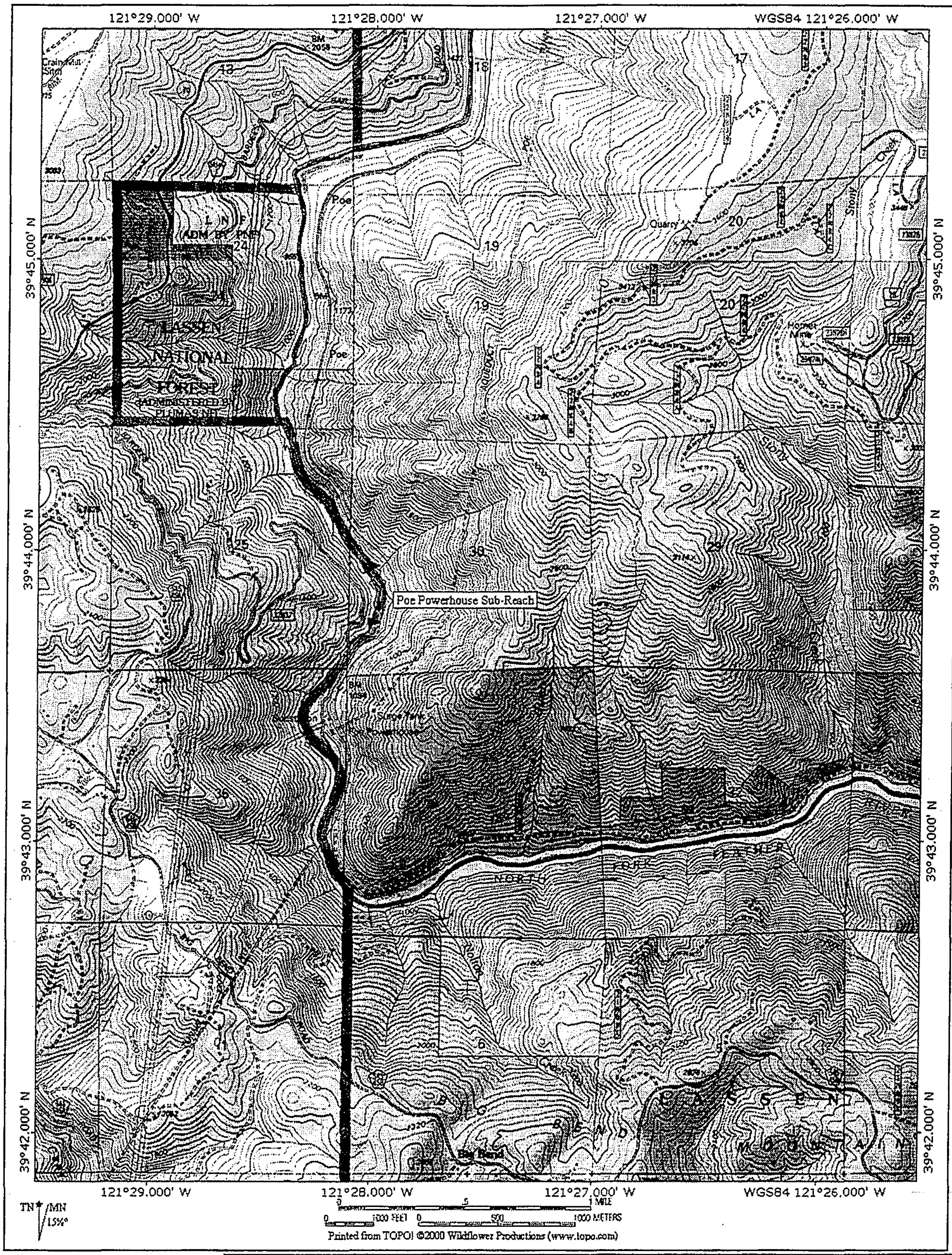
FIGURES



North Fork Feather River Regional Map	FIGURE 1
Lower NFFR Incipient Motion Study	March 2003



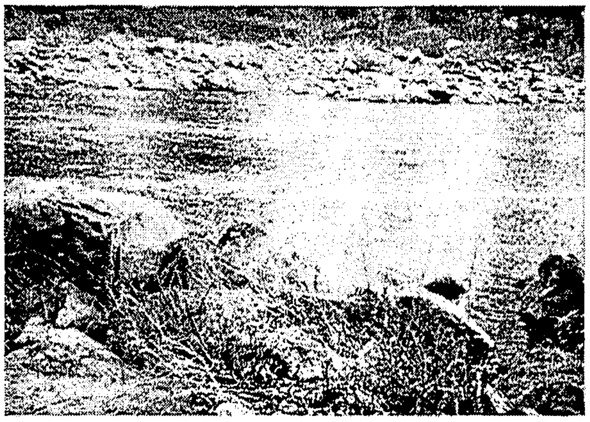
North Fork Feather River Regional Map Pulga and Bardee's Bar Sub-Reaches	FIGURE 2A
Lower NFFR Incipient Motion Study	March 2003



North Fork Feather River Regional Map Poe Powerhouse Sub-Reach	FIGURE 2B
Lower NFFR Incipient Motion Study	March 2003

Picture 1

NFFR – Poe Reach
Pulga Sub-Reach, Transect 3
Habitat Type - **Run**

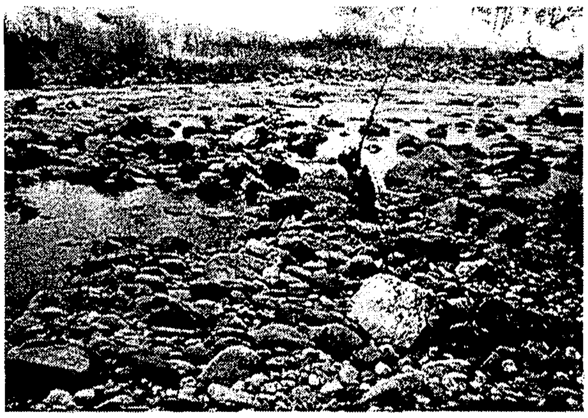


Picture 2

NFFR – Poe Reach
Pulga Sub-Reach, Transect 4
Habitat Type – **Pool**

Picture 3

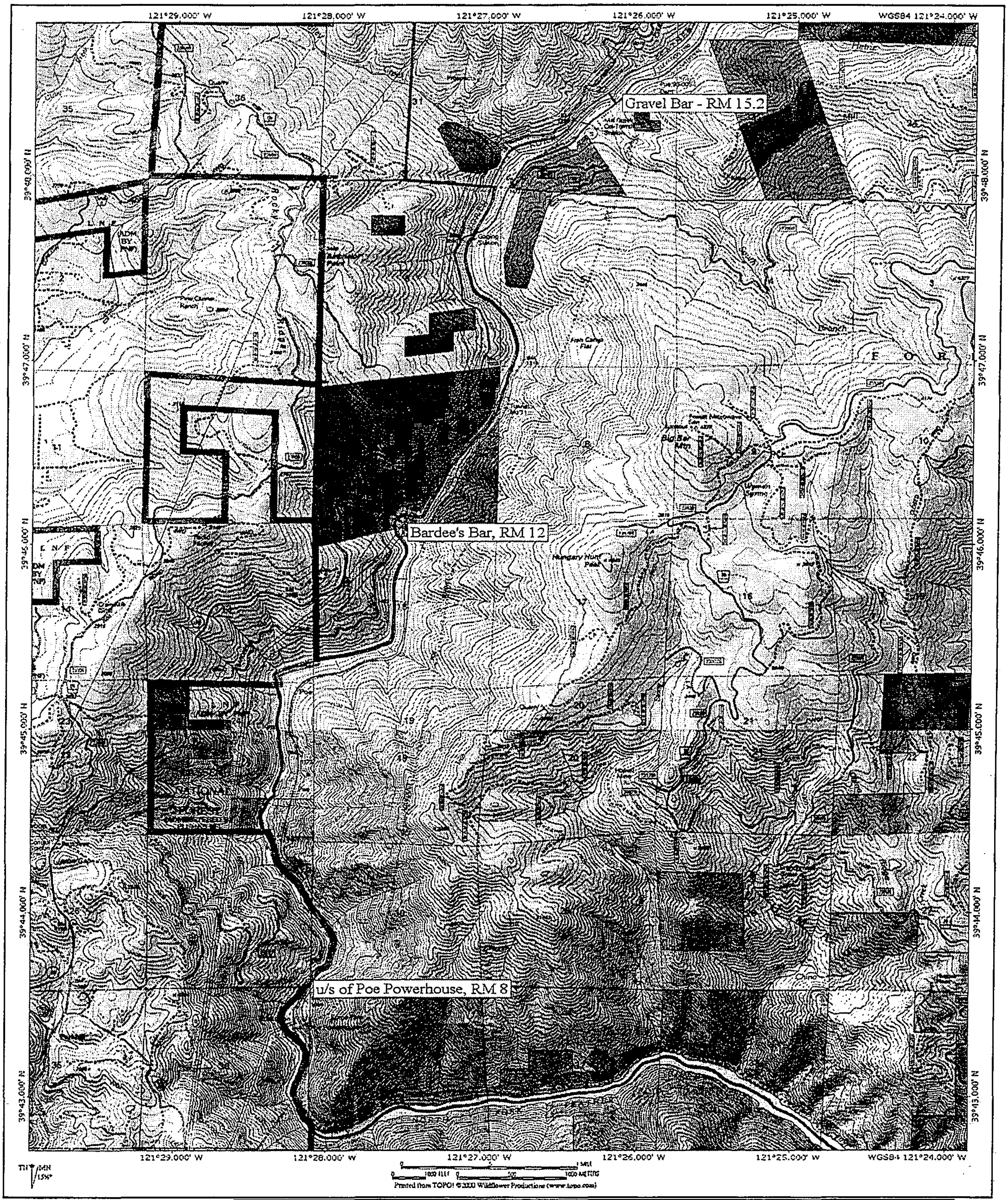
NFFR – Poe Reach
Pulga Sub-Reach, Transect 5
Habitat Type – **Pocket Water**



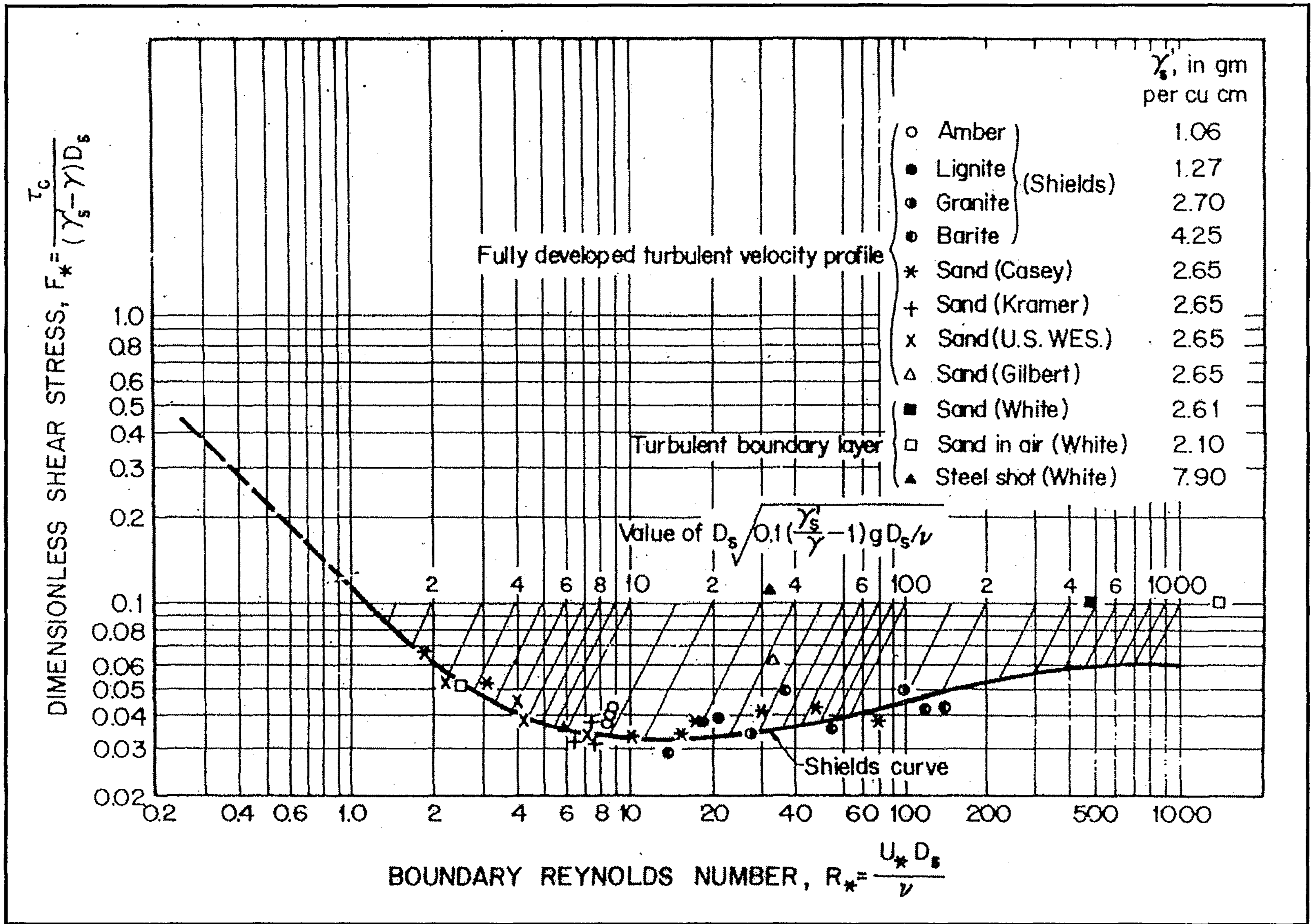
Picture 4

NFFR – Poe Reach
Pulga Sub-Reach, Transect 8
Habitat Type – **Low Gradient Riffle**

FIGURE 3 Photos for Four Habitat Types



Sediment Sampling Sites For Incipient Motion Analysis	FIGURE 4
Lower NFFR Incipient Motion Study	March 2003



Shields Diagram: Dimensionless Critical Shear Stress	FIGURE 5
Lower NFFR Incipient Motion Study	March 2003

FIGURE 6

Dimensionless Grain Shear Stress Versus Discharge

NFFR- Poe Reach 1 - Transect 3 RUN

Medium Gravel (12mm) Incipient Motion Analysis

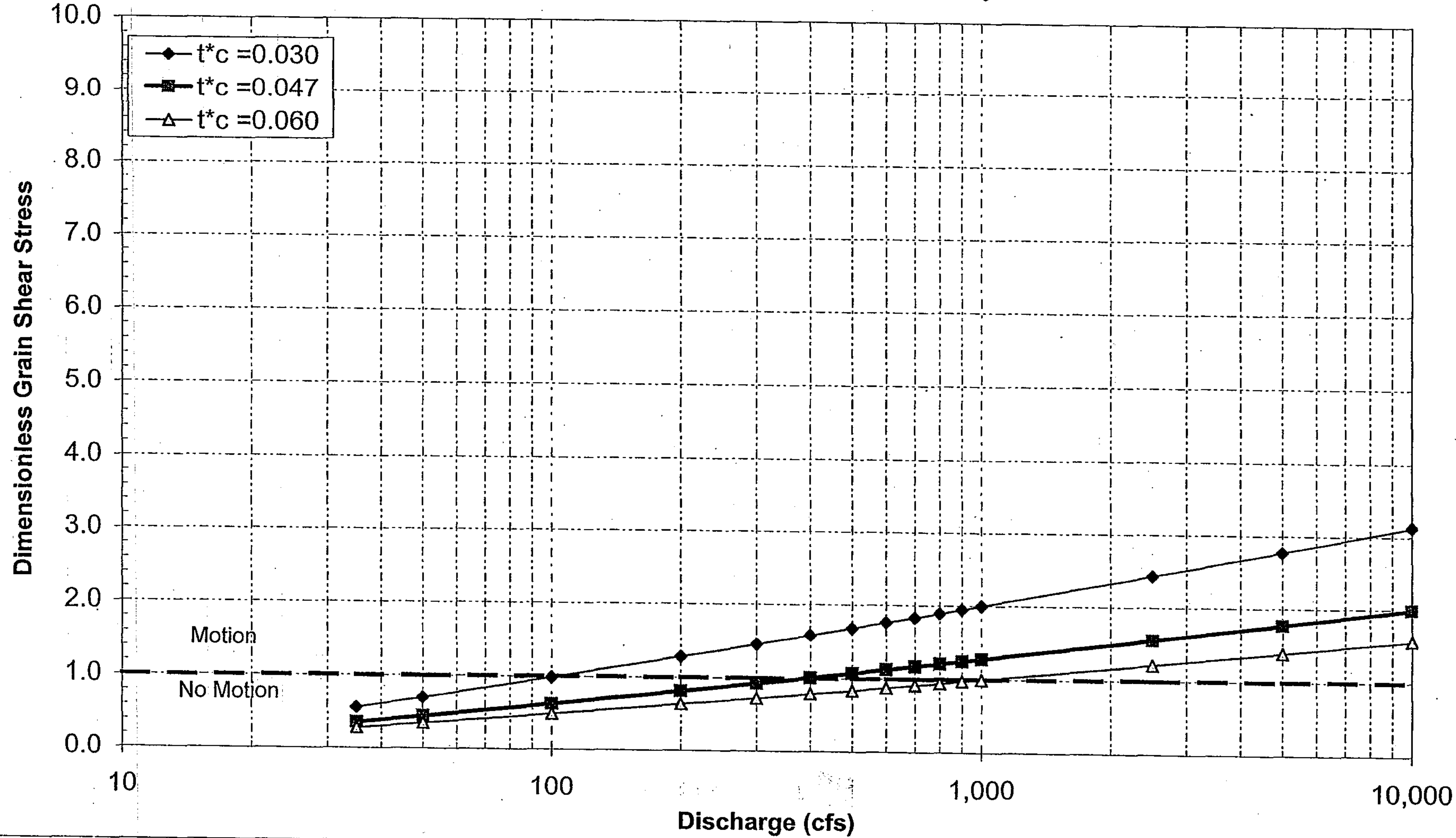


FIGURE 7
Dimensionless Grain Shear Stress Versus Discharge
NFFR- Poe Reach 1 - Transect 5 POW
Medium Gravel (12mm) Incipient Motion Analysis

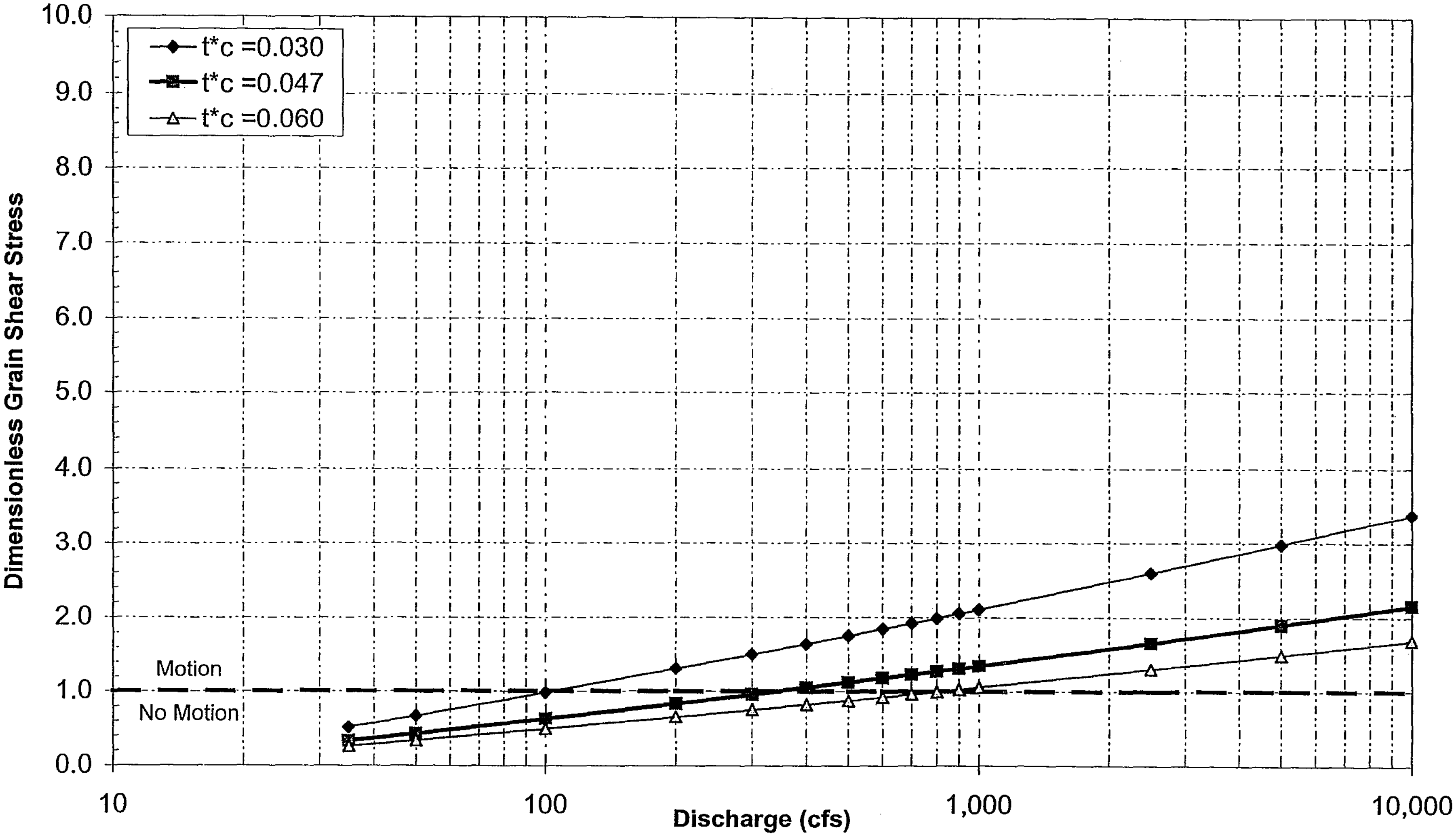
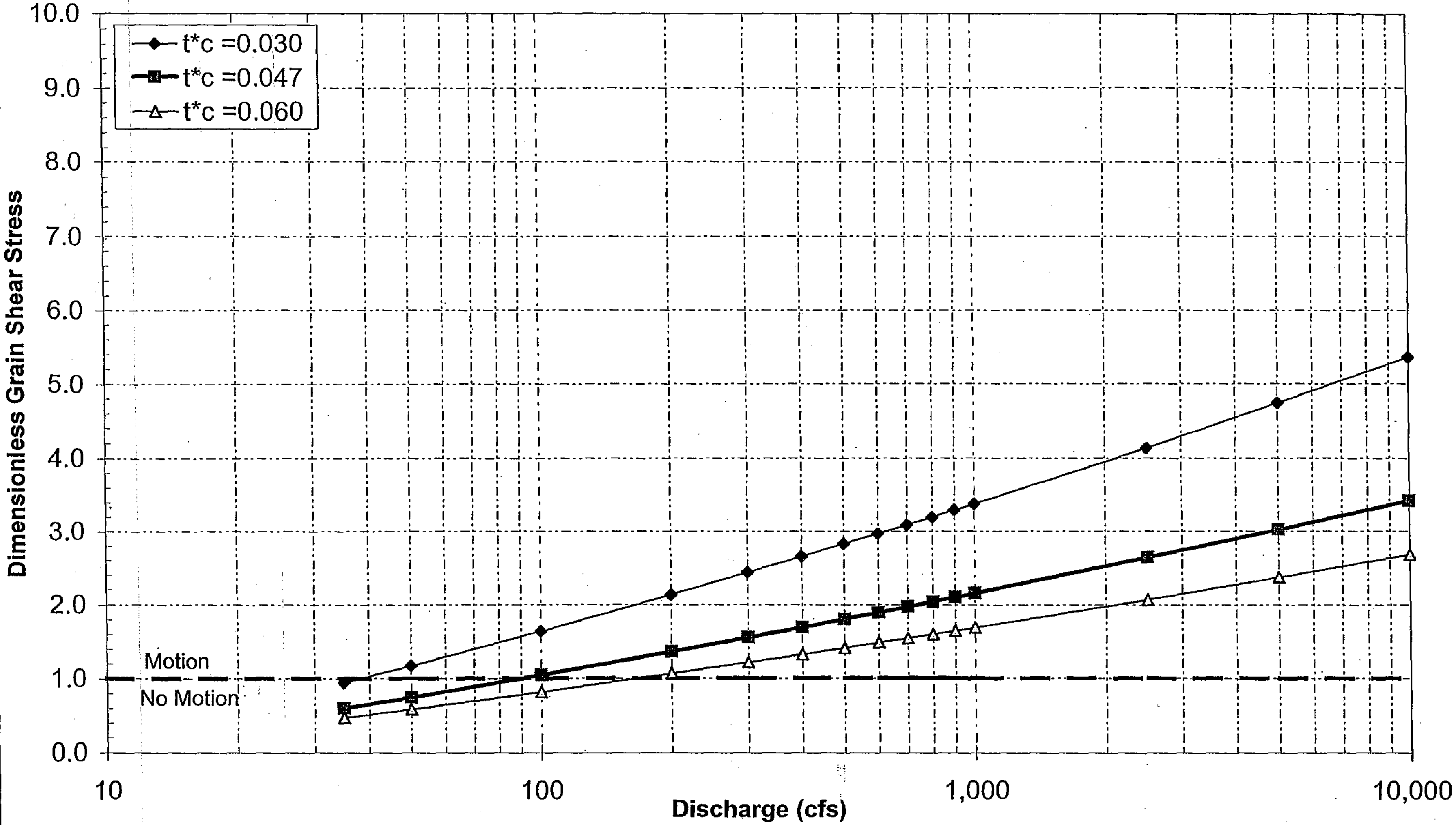


FIGURE 8

Dimensionless Grain Shear Stress Versus Discharge

NFFR- Poe Sub-Reach 1 - Transect 8 LGR

Medium Gravel (12mm) Incipient Motion Analysis



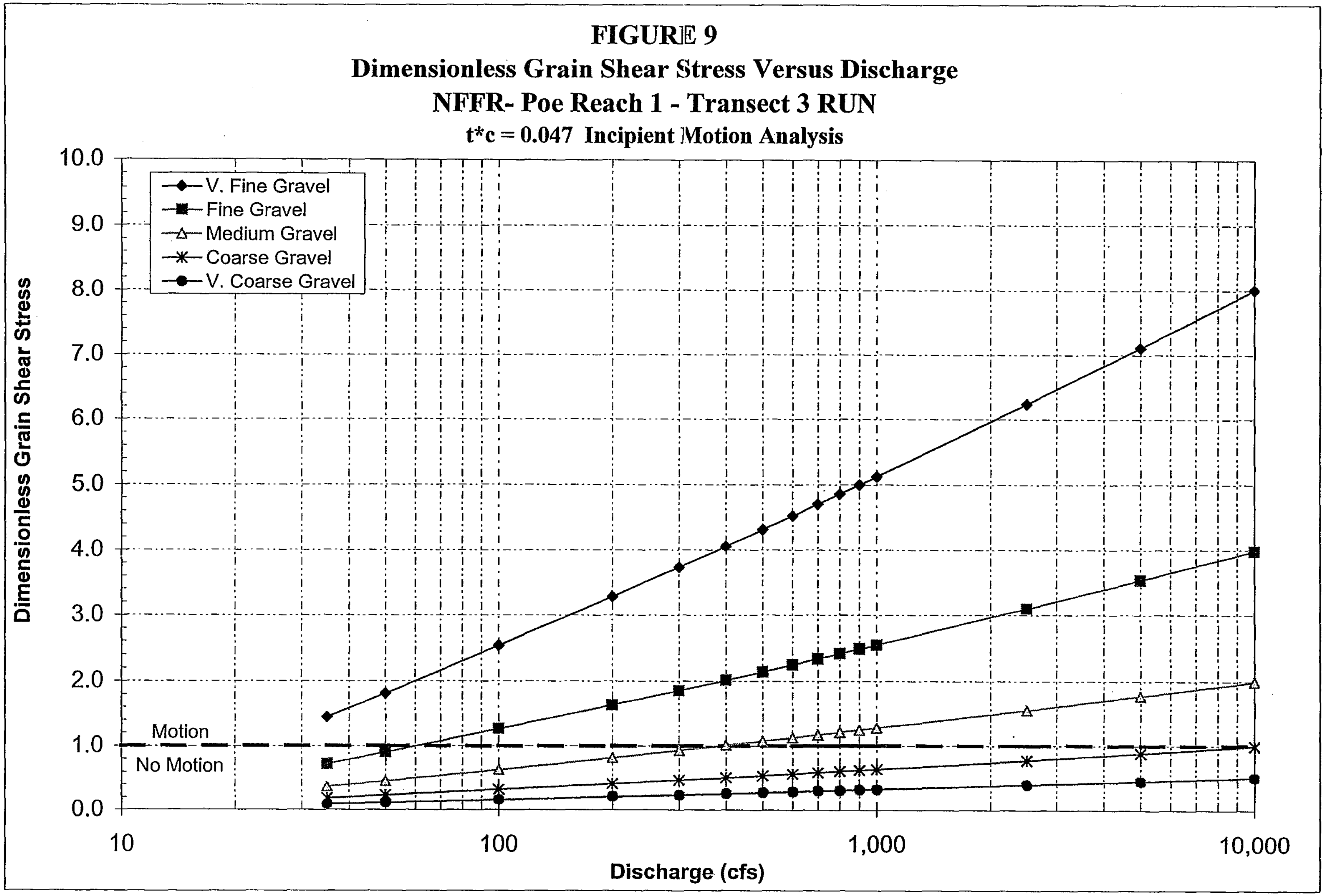


FIGURE 9
Dimensionless Grain Shear Stress Versus Discharge
NFFR- Poe Reach 1 - Transect 3 RUN
t*c = 0.047 Incipient Motion Analysis
V. Fine Gravel
Fine Gravel
Medium Gravel
Coarse Gravel
V. Coarse Gravel
Motion
No Motion
Dimensionless Grain Shear Stress
Discharge (cfs)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
10
100
1,000
10,000

FIGURE 10
Dimensionless Grain Shear Stress Versus Discharge
NFFR- Poe Reach 1 - Transect 5 POW
t*c = 0.047 Incipient Motion Analysis

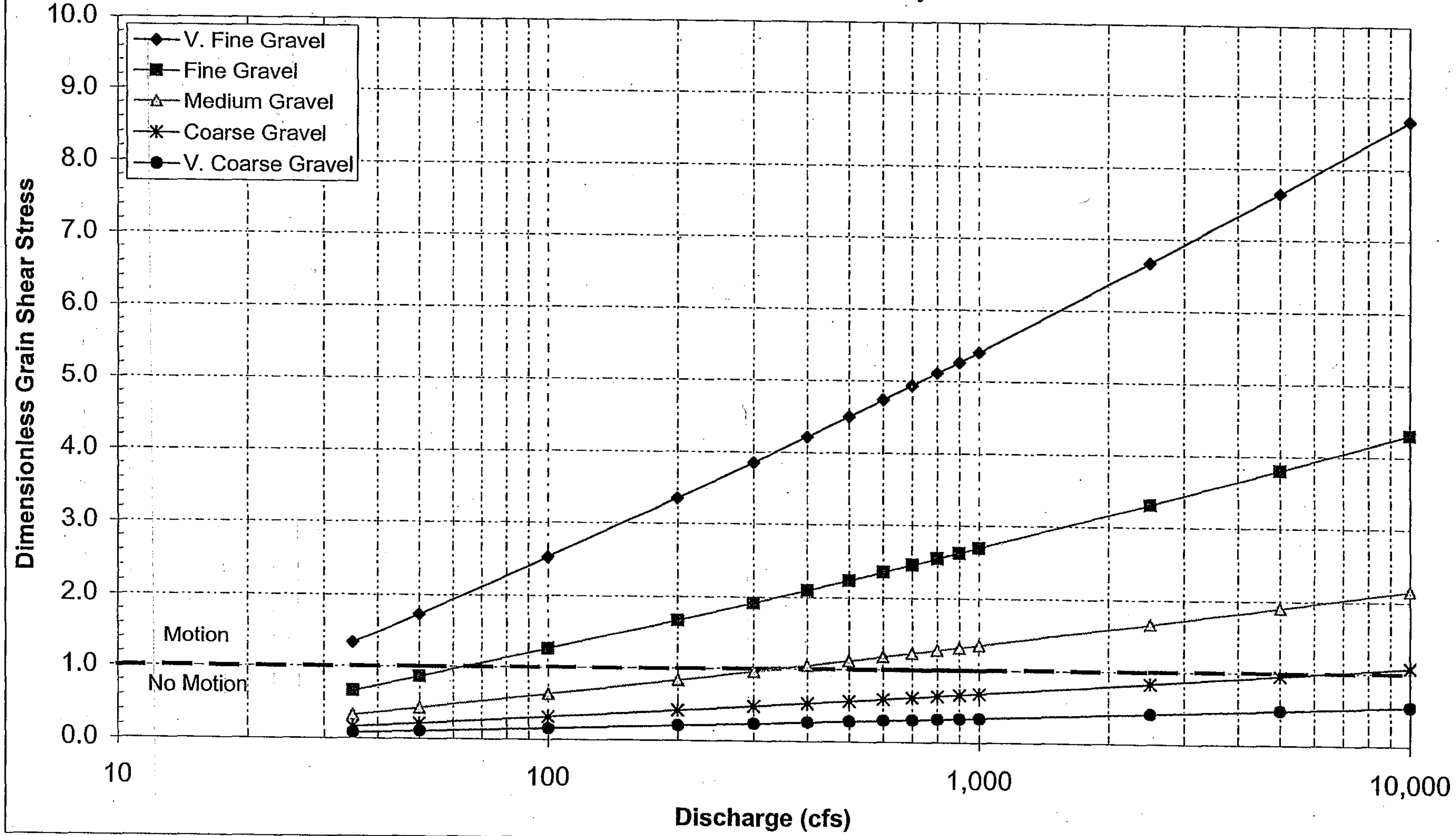


FIGURE 11
Dimensionless Grain Shear Stress Versus Discharge
NFFR- Poe Sub-Reach 1 - Transect 8 LGR
t*c = 0.047 Incipient Motion Analysis

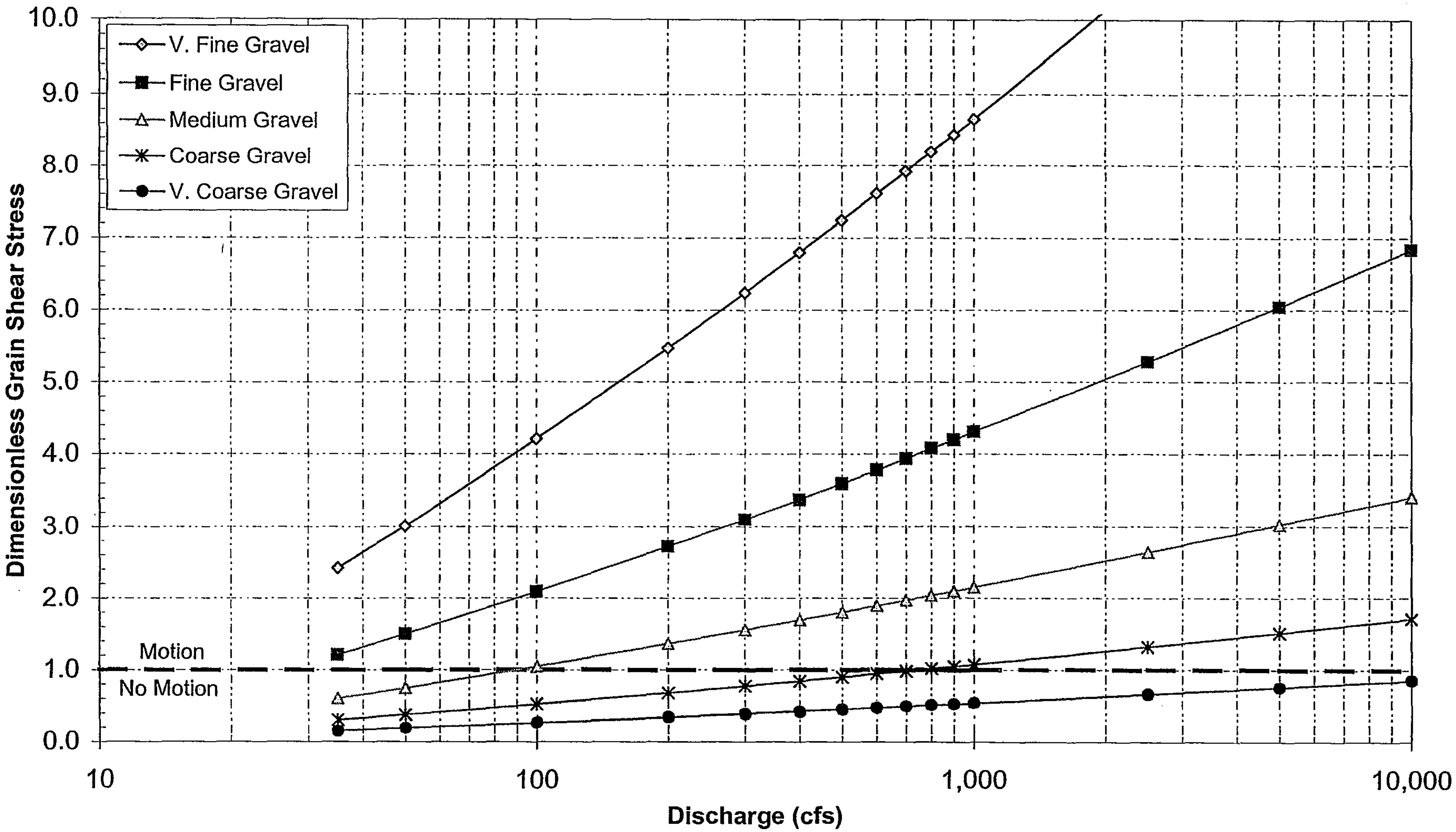


FIGURE 12
Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR- Poe Sub-Reach 1 - Transect 3 RUN

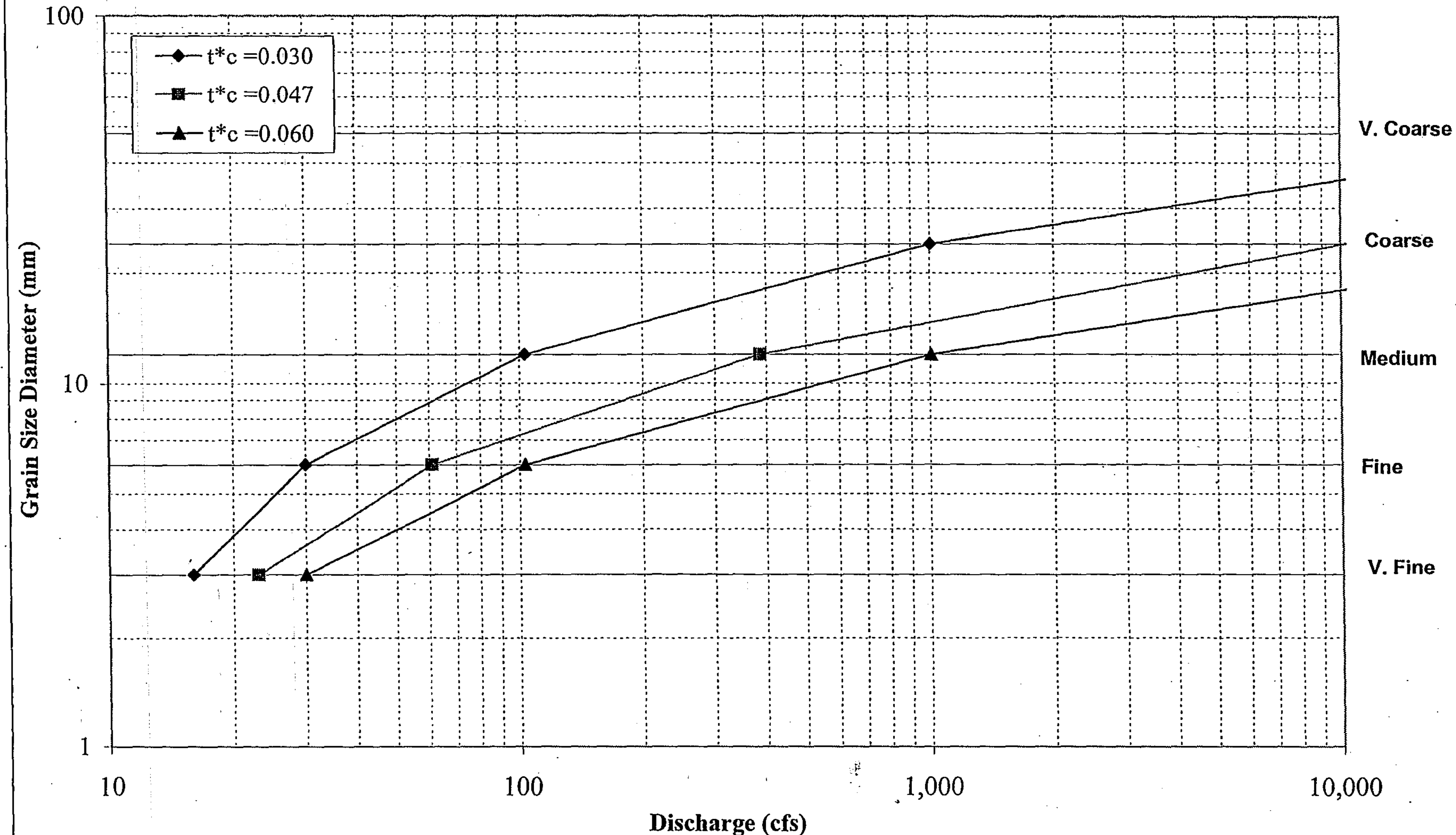


FIGURE 13
Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR- Poe Sub-Reach 1 - Transect 5 POW

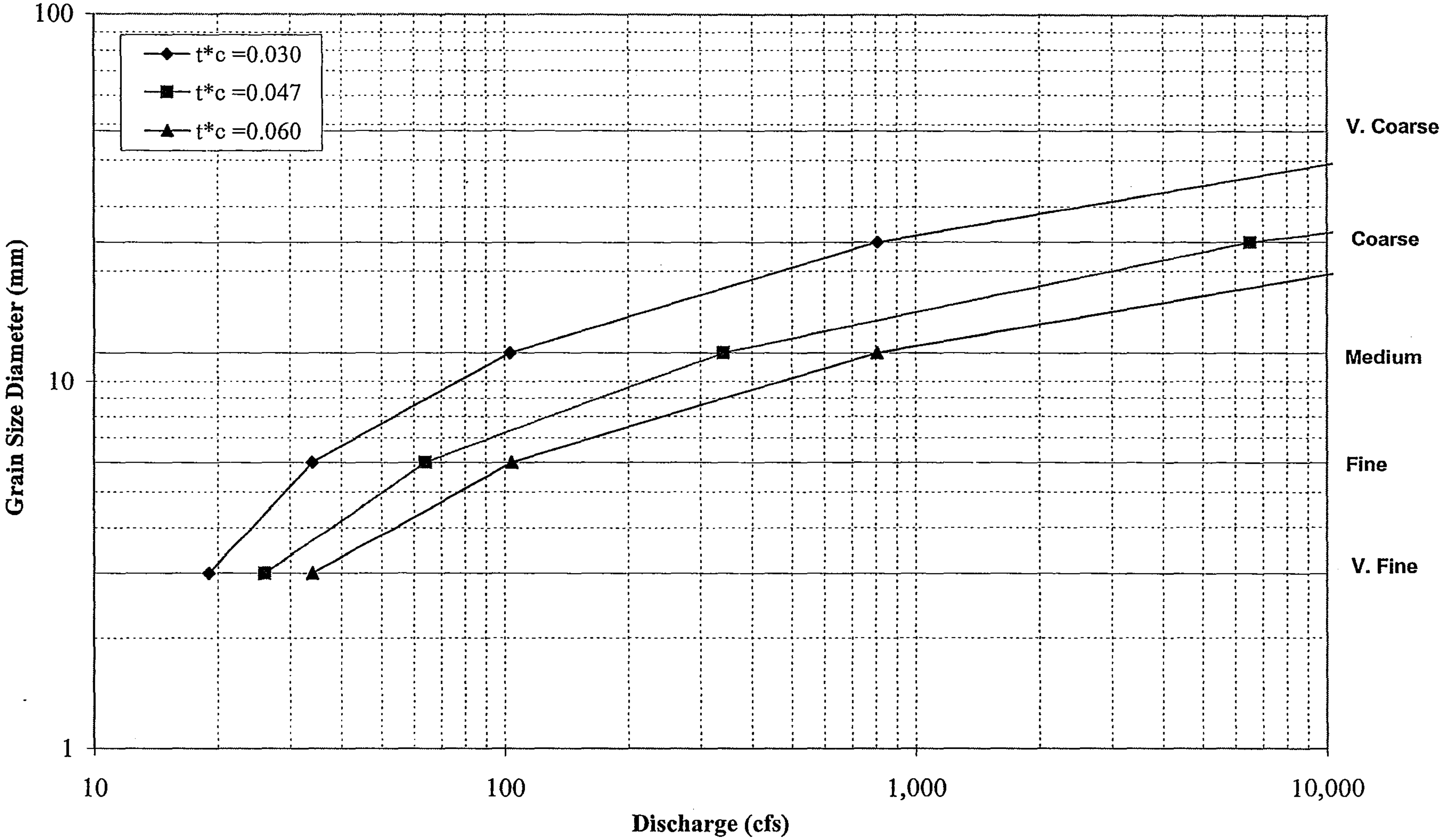
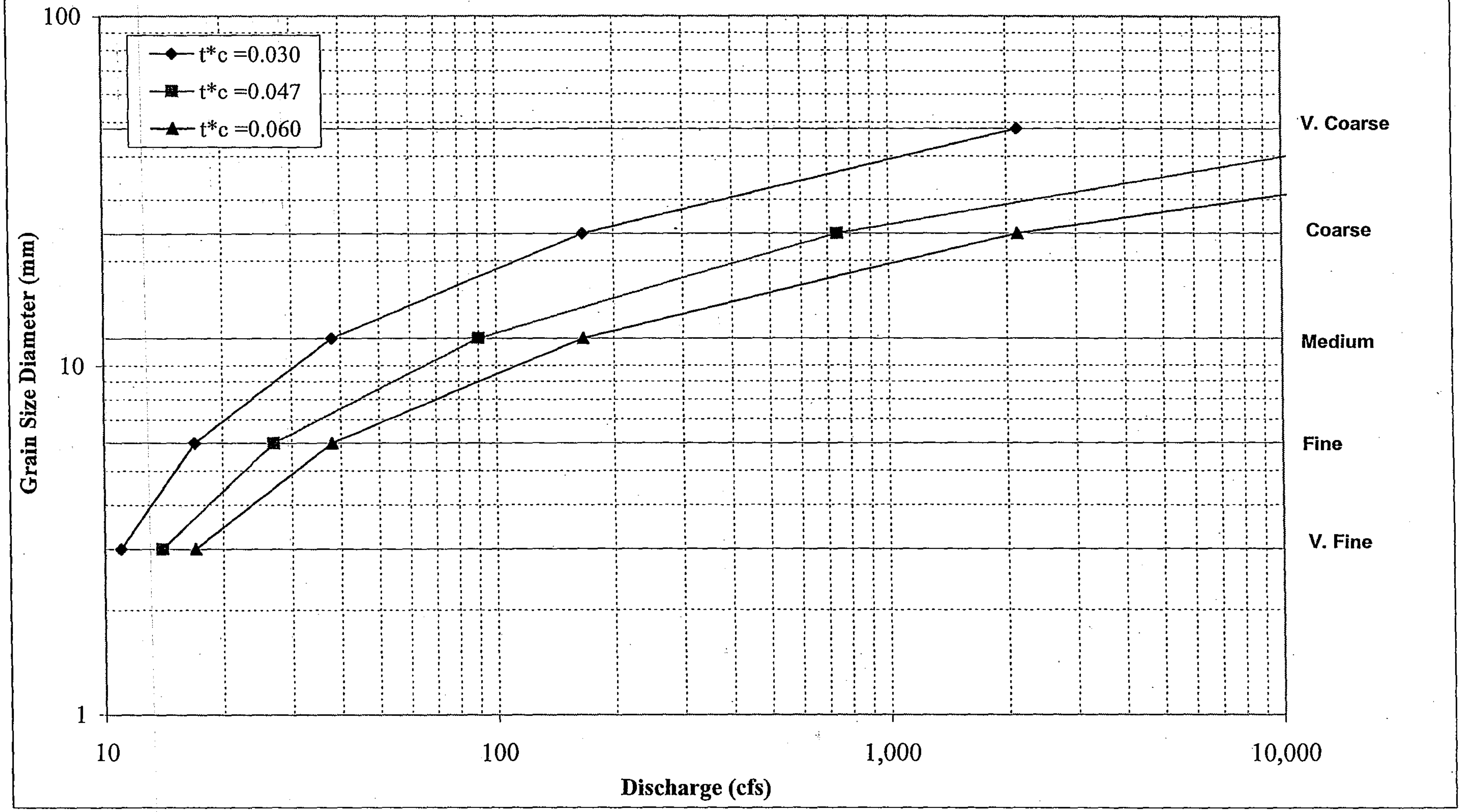


FIGURE 14
Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR- Poe Sub-Reach 1 - Transect 8 LGR



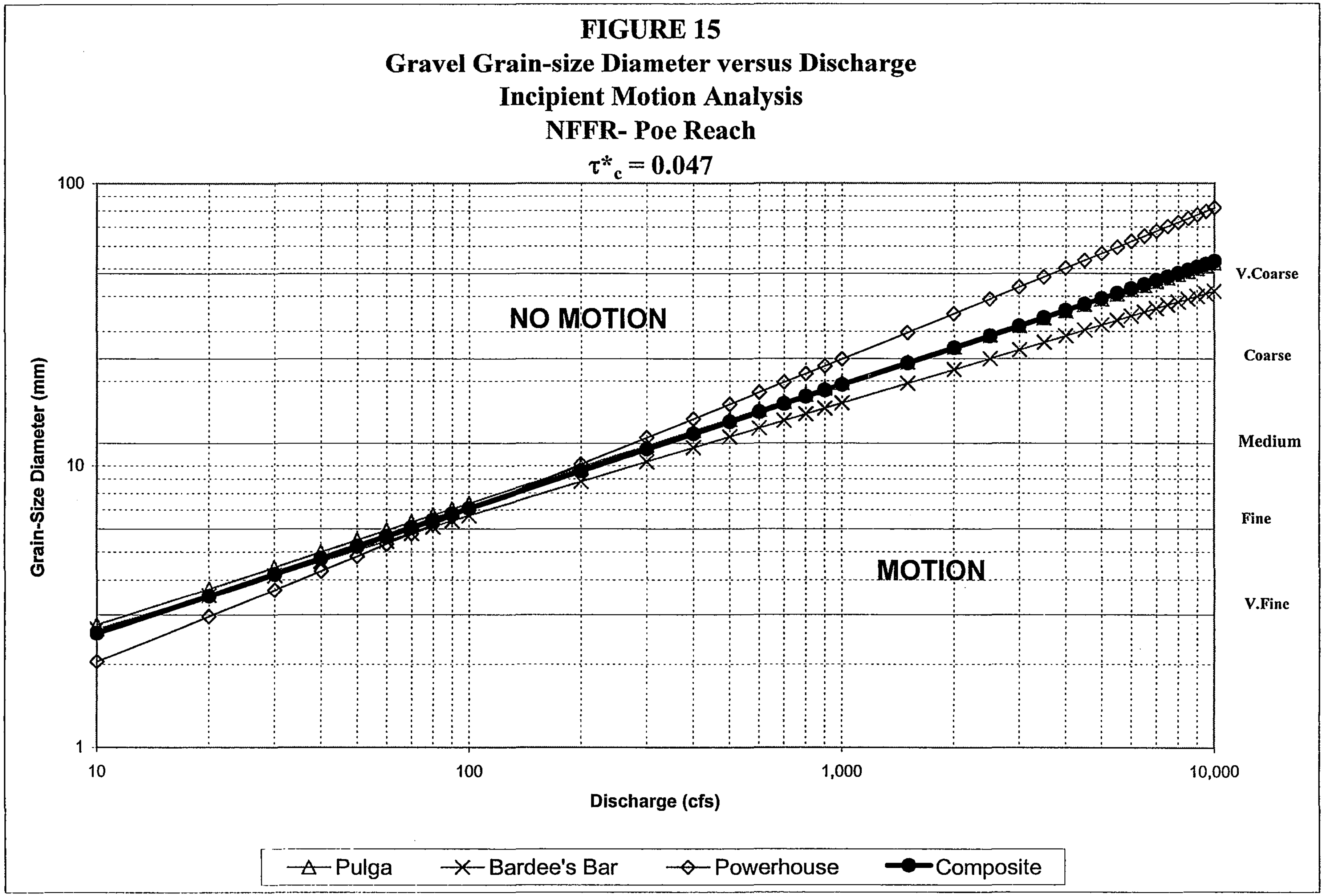
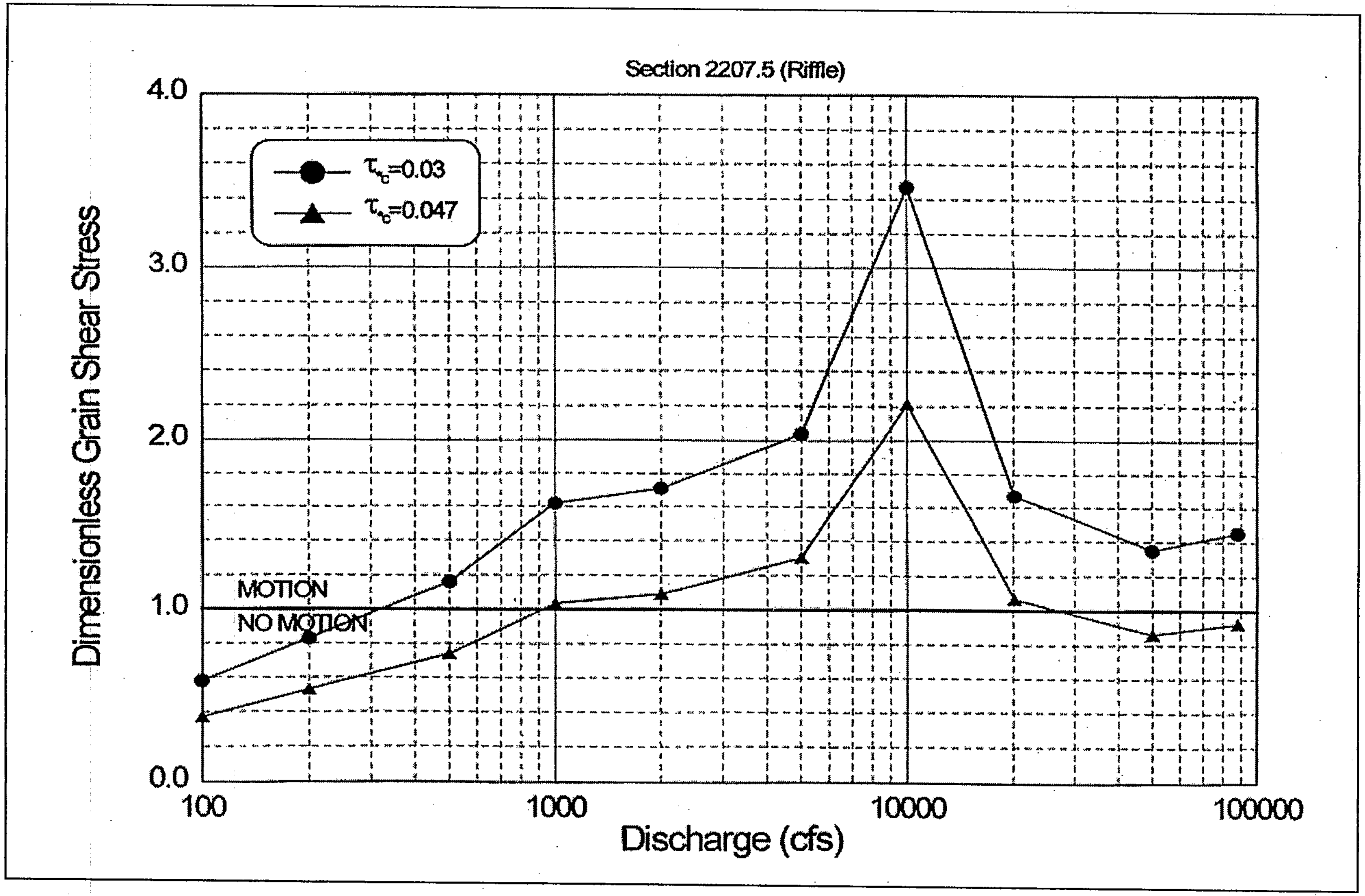


FIGURE 15
Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR- Poe Reach
τ*c = 0.047
100
10
1
Grain-Size Diameter (mm)
NO MOTION
MOTION
V.Coarse
Coarse
Medium
Fine
V.Fine
10
100
1,000
10,000
Discharge (cfs)
Pulga
Bardee's Bar
Powerhouse
Composite

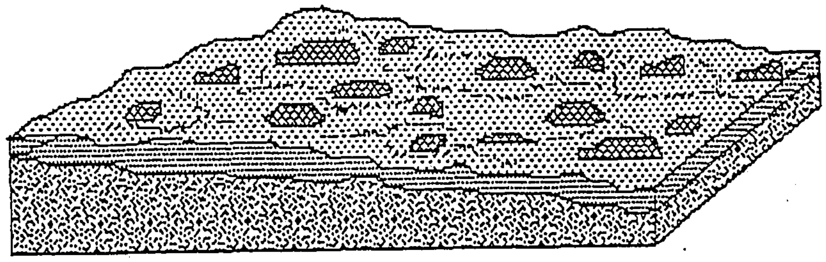


Incipient Motion Analysis Results: RCE Bar Dynamics Assessment, RM 17.7 – RM18.2, April 1994	FIGURE 16
Lower NFFR Incipient Motion Study	March 2003

Appendix A.

Habitat Types (US Department of Fish and Game)

Riffle



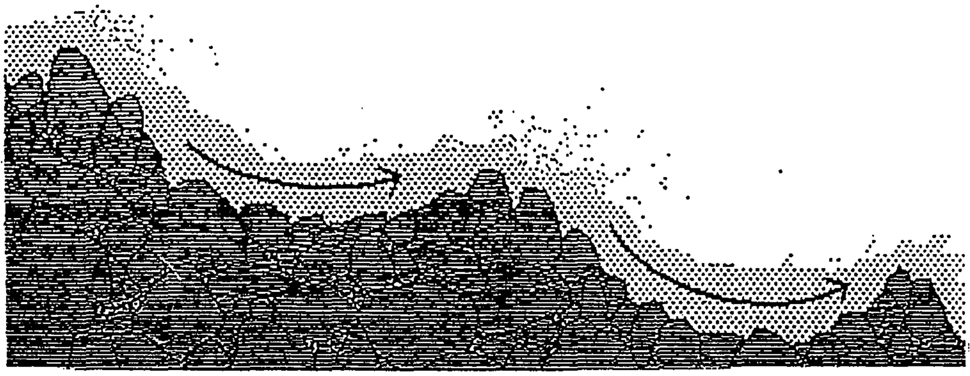
LOW GRADIENT RIFFLE - "LGR"

Shallow reaches with swiftly flowing turbulent water with some partially exposed substrate; gradient <4%, substrate is usually cobble dominated.

HIGH GRADIENT RIFFLES - "HGR"

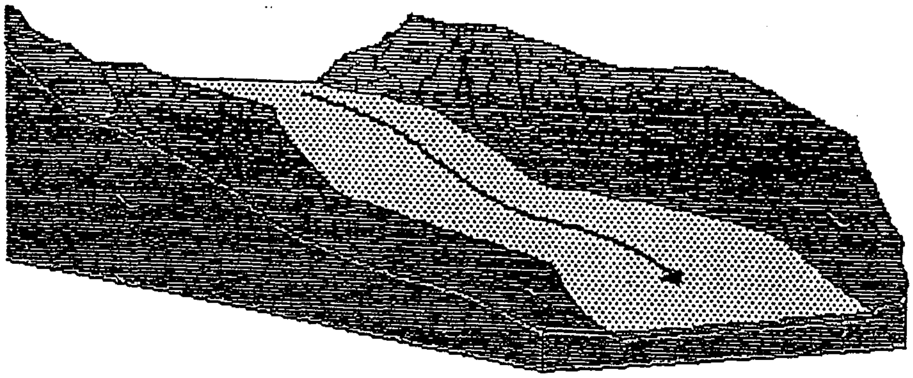
Steep reaches of moderately deep, swift, and very turbulent water, amount of exposed substrate is relatively high; gradient is >4%, and substrate is boulder dominated.

Cascade



CASCADE - "CAS"

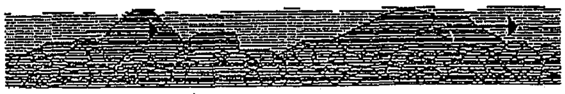
The steepest riffle habitat, consisting of alternating small waterfalls and shallow pools; substrate is usually bedrock and boulders.



BEDROCK SHEET - "BRS"

A thin sheet of water flowing over a smooth bedrock surface; gradients are usually variable.

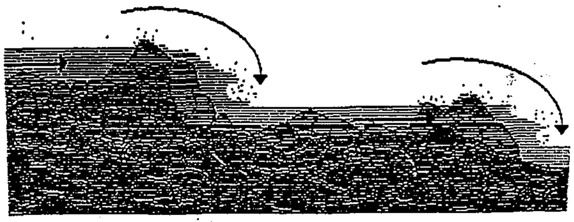
Flatwater



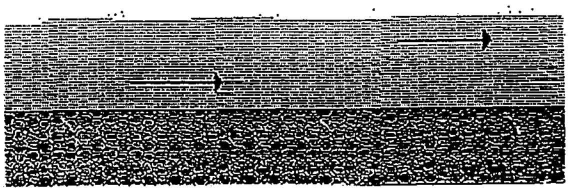
RUN - "RUN"

Swiftly flowing reaches with little surface agitation and no major flow obstructions; often appears as flooded riffles; typical substrate consists of gravel, cobble, and boulders.

A sequence of runs separated by short riffle steps; substrate is usually cobble and boulder dominated.

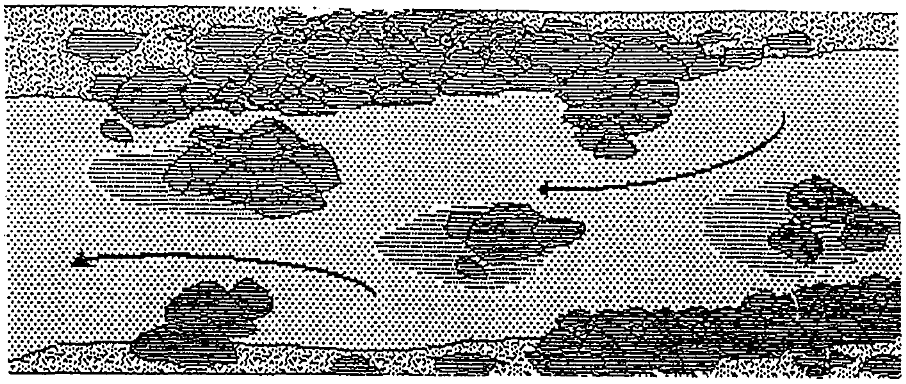


STEP RUN - "SRN"



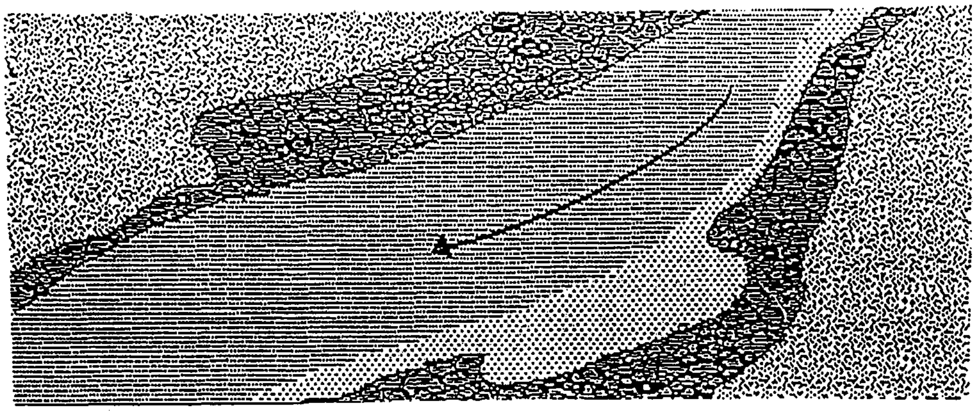
GLIDE - "GLD"

A wide uniform channel bottom; flow with low to moderate velocities; lacking pronounced turbulence; substrate usually consists of cobble, gravel, and sand.



POCKET WATER - "POW"

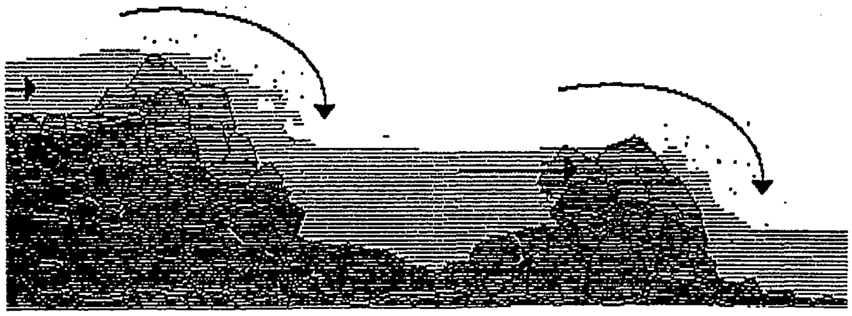
A section of swift flowing stream containing numerous boulders or other large obstructions which create eddies or scour holes (pockets) behind the obstructions.



EDGEWATER - "EDW"

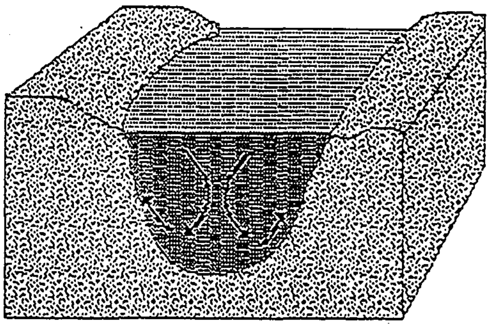
Quiet, shallow area found along the margins of the stream, typically associated with riffles; water velocity is low and sometimes lacking; substrate varies from cobbles to boulders.

Main Channel Pool



STEP POOL - "STP"

A series of pools separated by short riffles or cascades; generally found in high gradient, confined mountain streams dominated by boulder substrate.

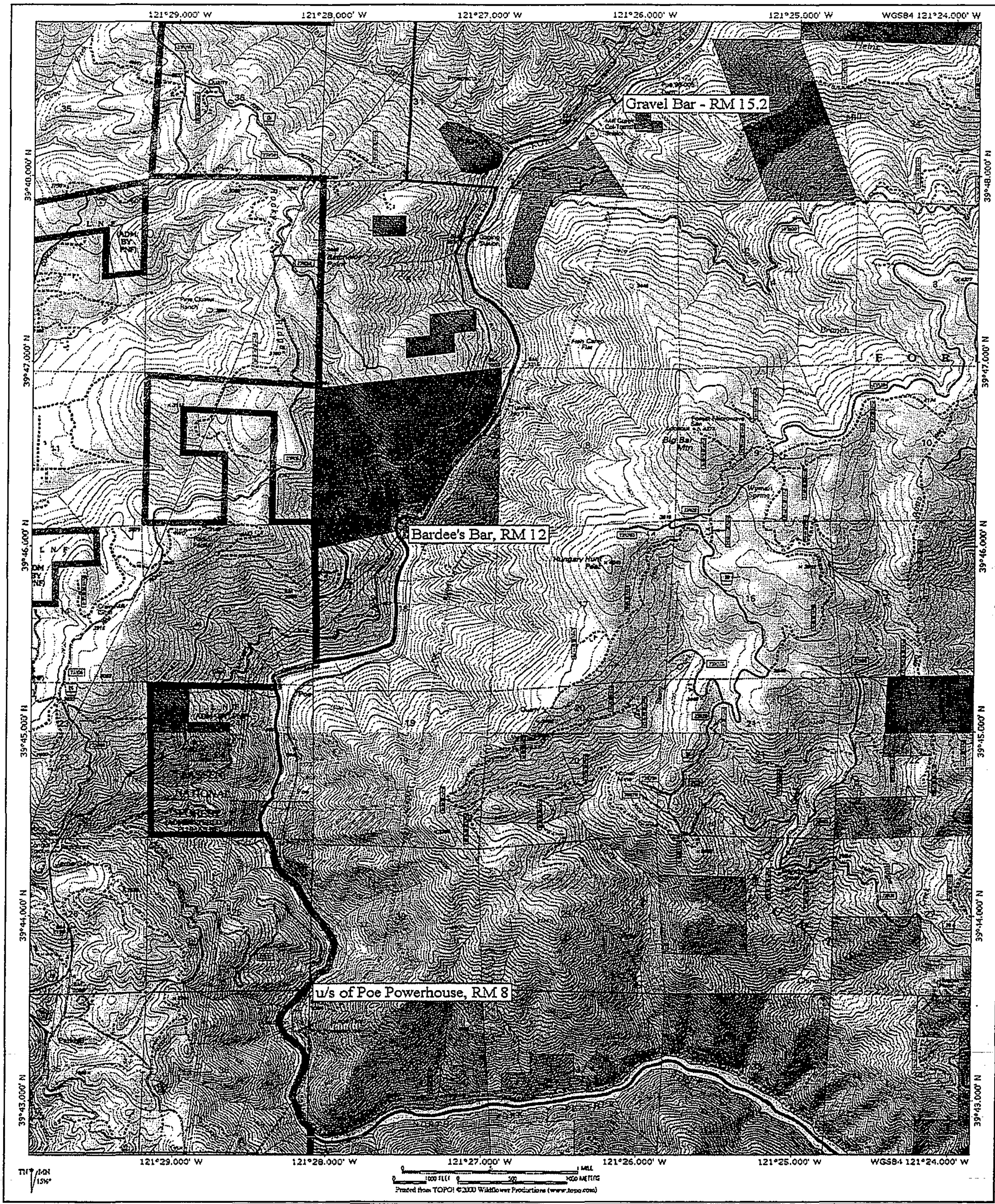


TRENCH/CHUTE - "TRP"

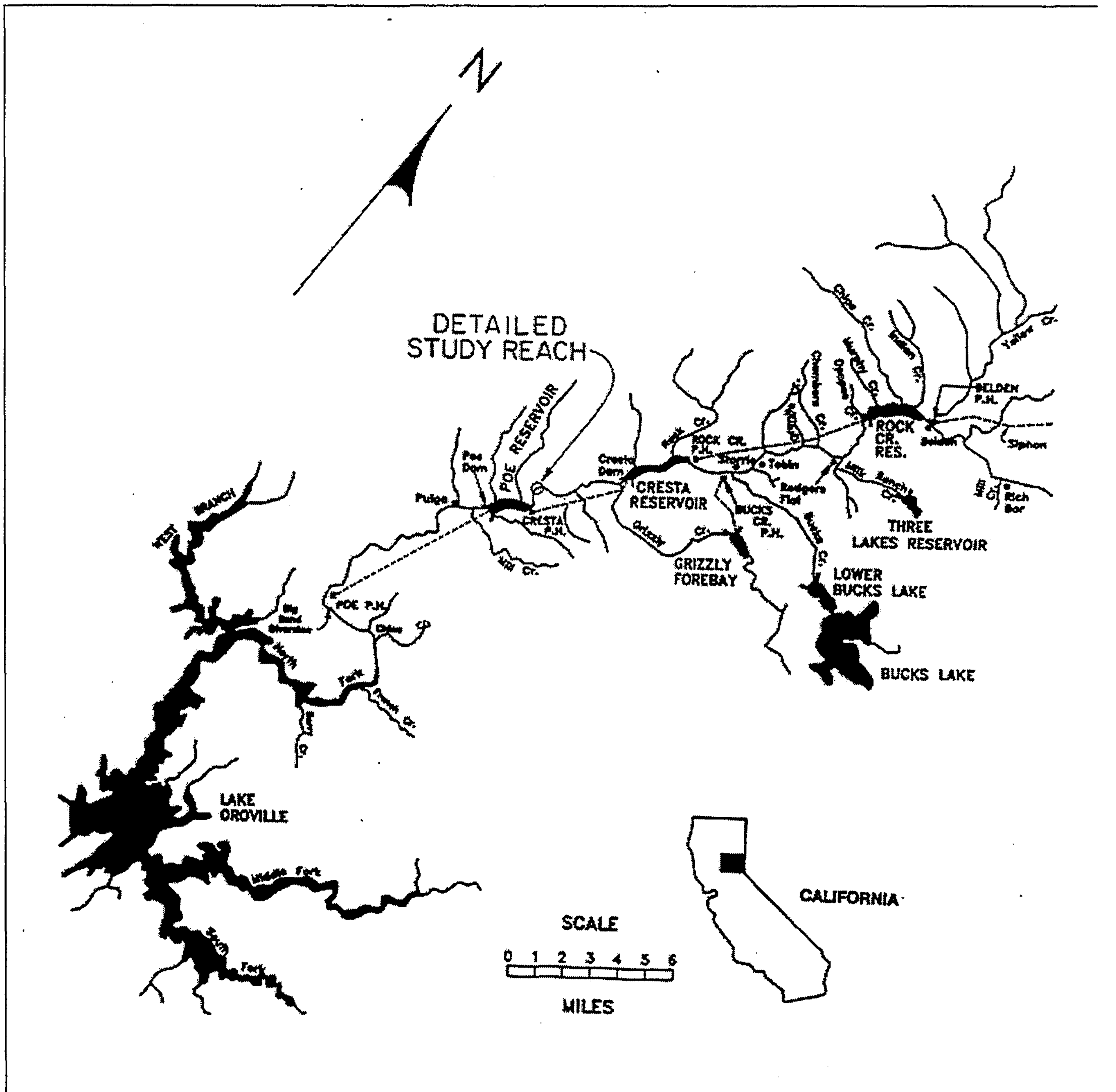
Channel cross-sections typically "U" shaped with bedrock or coarse grained bottom flanked by bedrock walls; current velocities are swift and the direction of flow is uniform.

Appendix B.

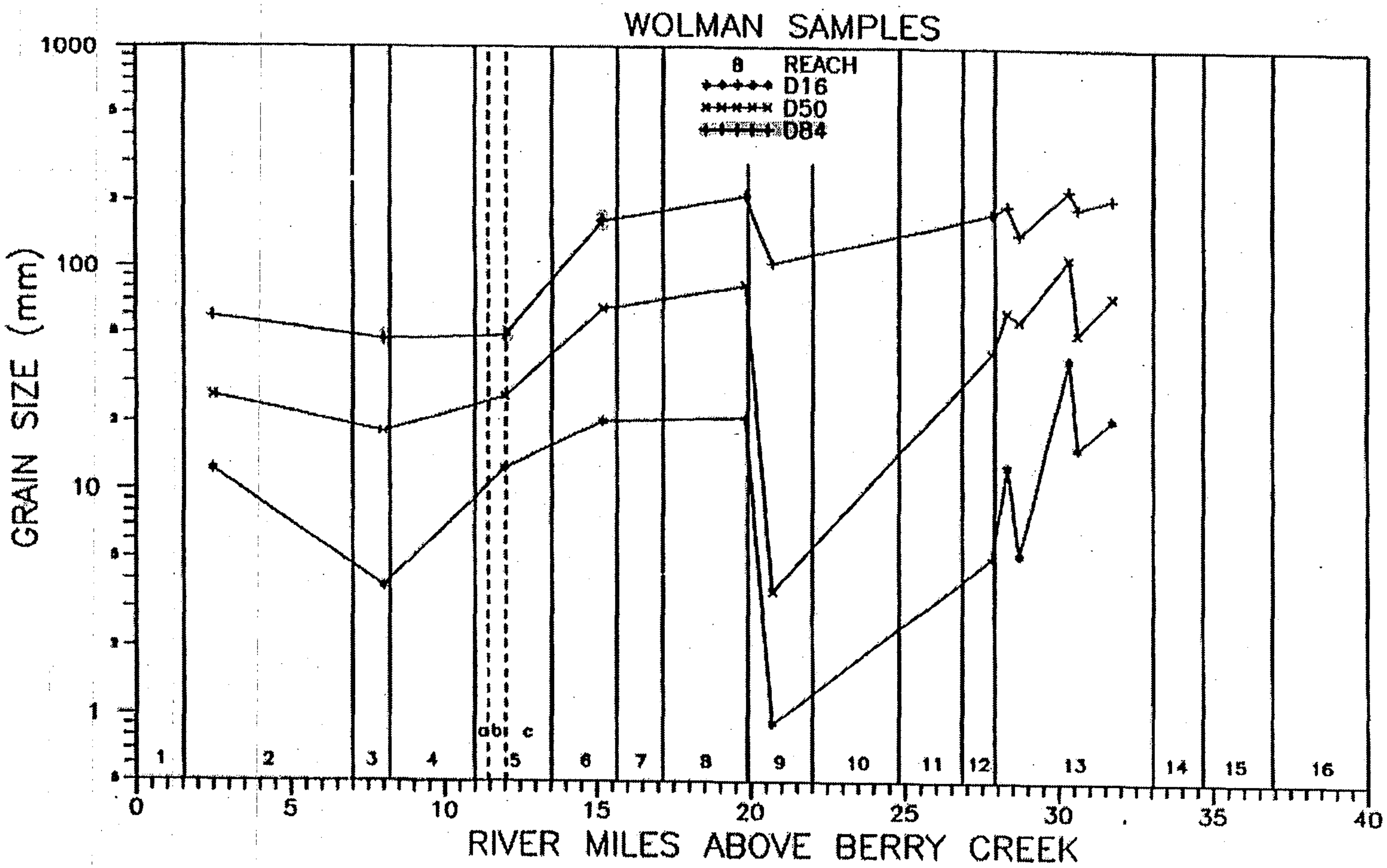
Sediment Samples Data



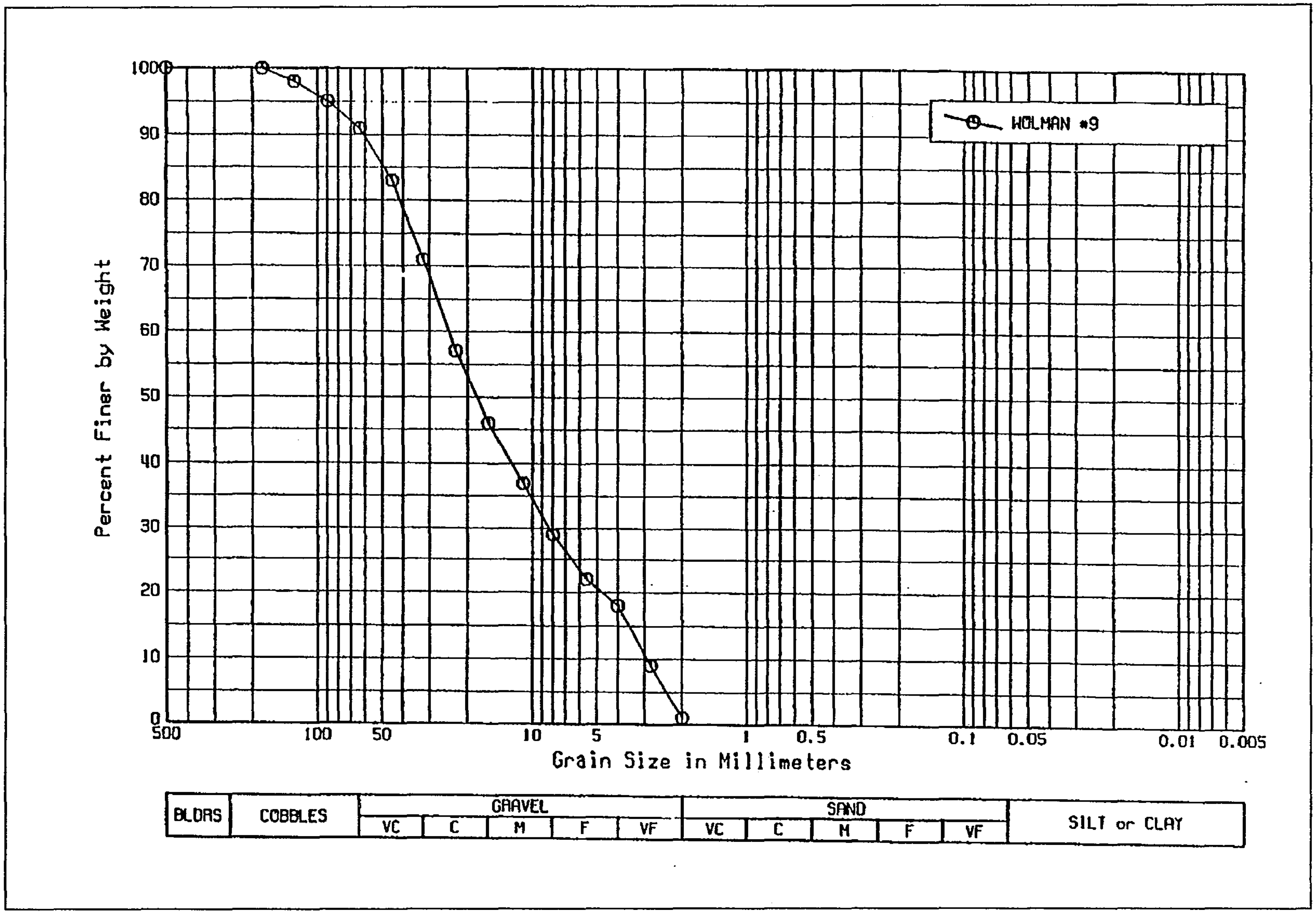
Sediment Sampling Sites For Incipient Motion Analysis	
Lower NFFR Incipient Motion Study	March 2003



Location Map of RCE Bar Dynamics Assessment, RM 17.7 – RM 18.2, April 1994	
Lower NFFR Incipient Motion Study	March 2003



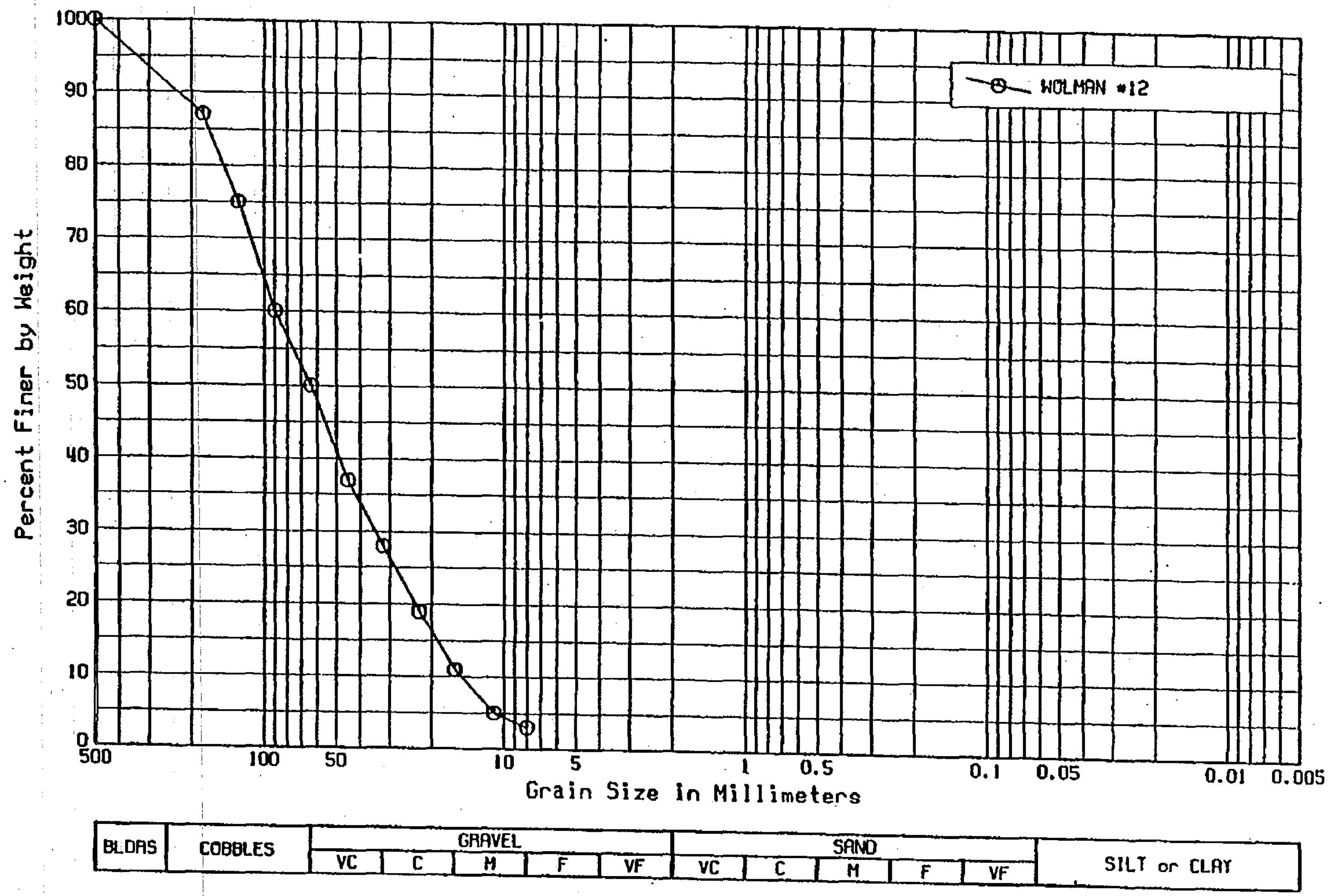
Wolman Count Grain-Size Summary **RCE, October 1992**	
Lower NFFR Incipient Motion Study	**March 2003**



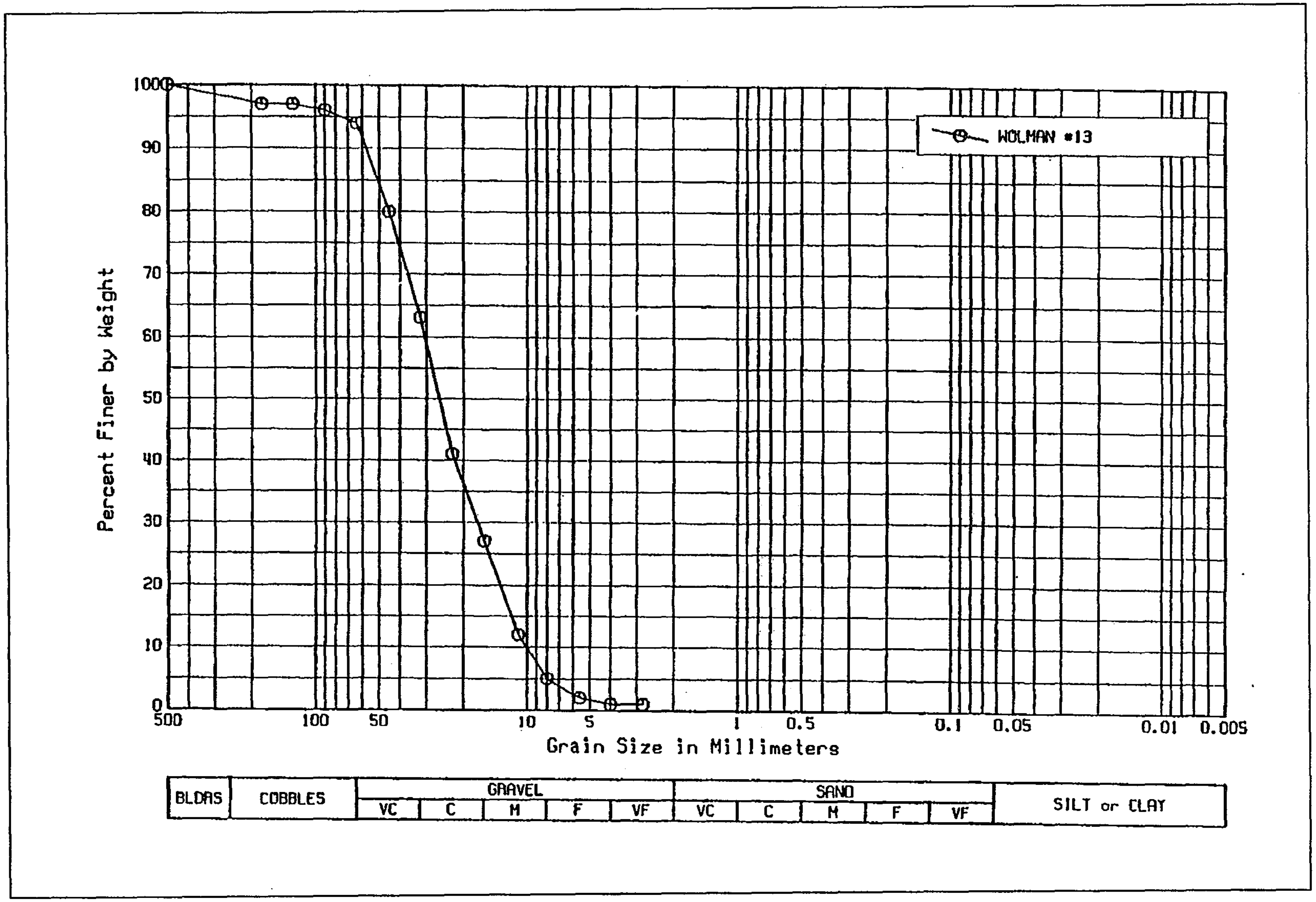
Wolman Count Grain-Size Analysis – River Mile 8.0
RCE, October 1992

Lower NFFR Incipient Motion Study

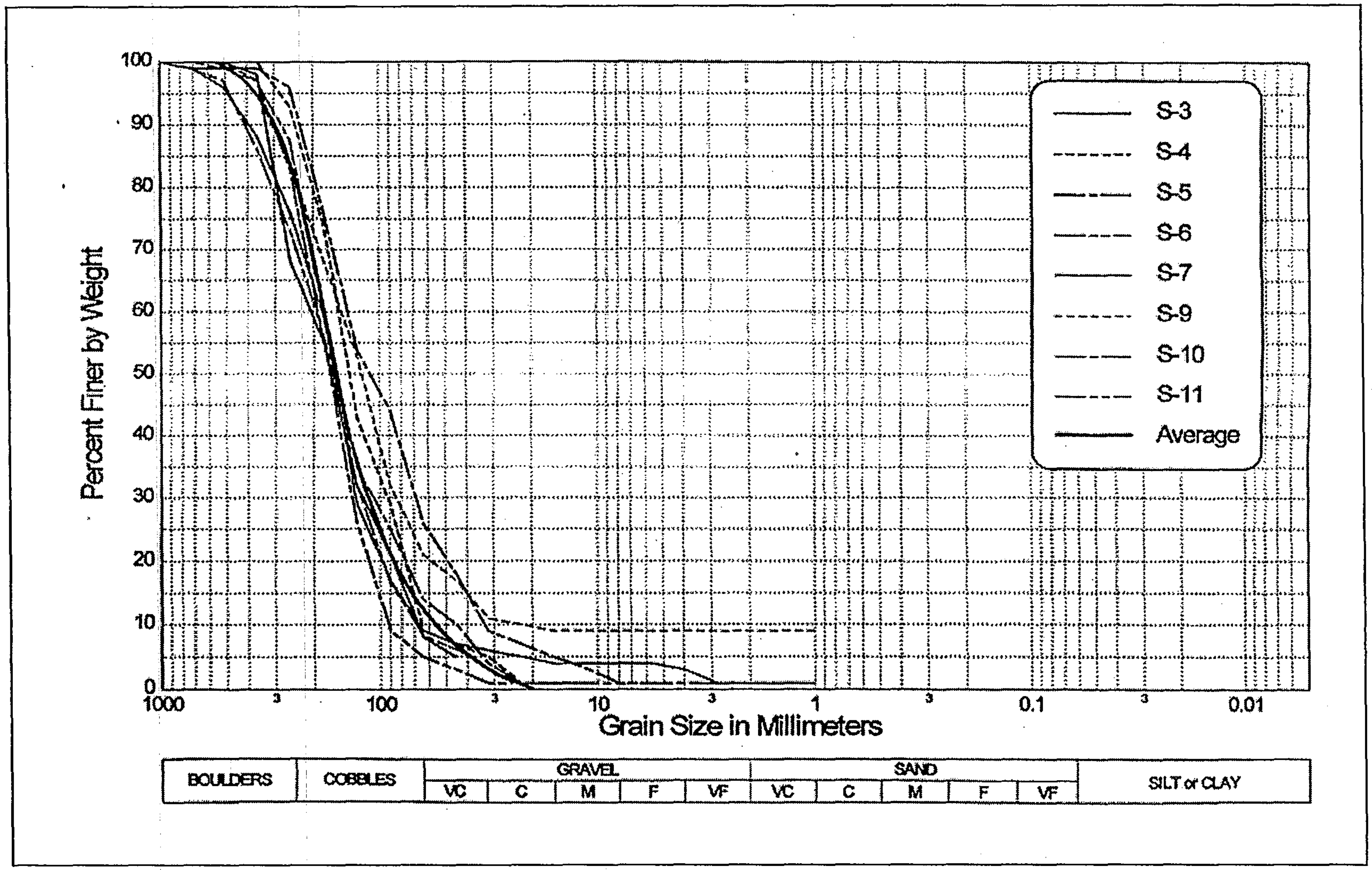
March 2003



Wolman Count Grain-Size Analysis – River Mile 15.2 **RCE, October 1992**	
Lower NFFR Incipient Motion Study	**March 2003**



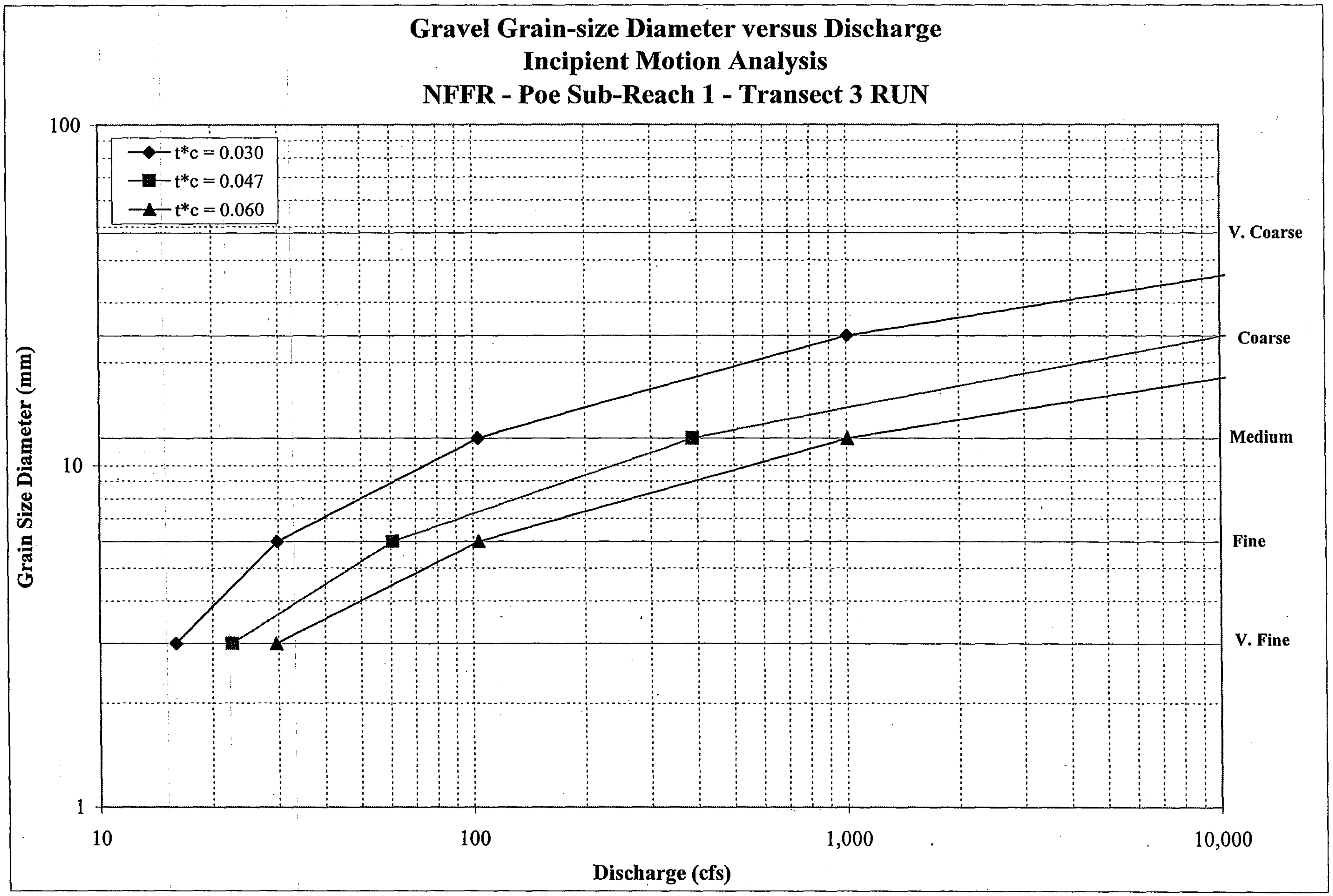
Wolman Count Grain-Size Analysis – River Mile 12.0 RCE, October 1992	
Lower NFFR Incipient Motion Study	**March 2003**

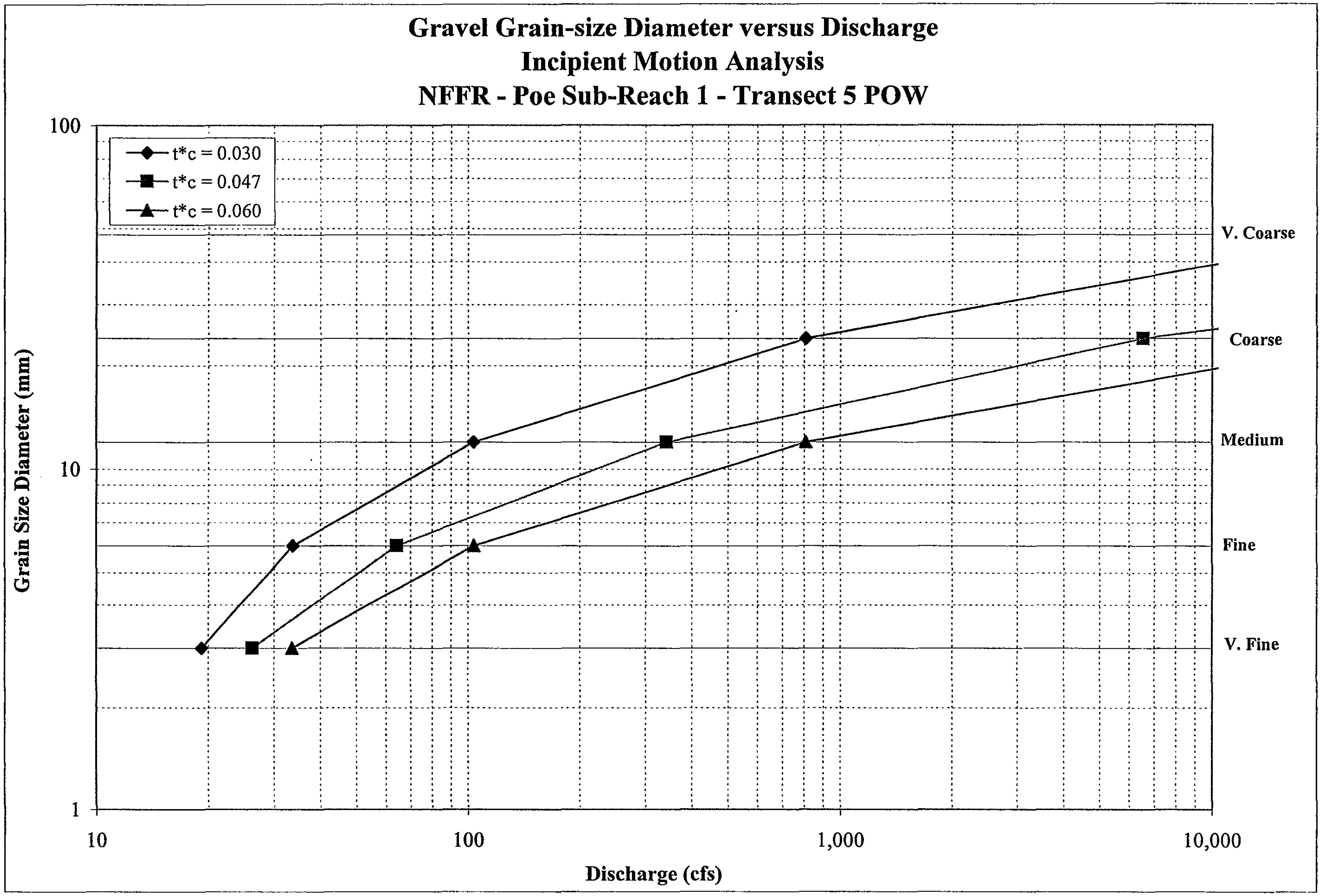


Grain-Size Distribution: RCE Bar Dynamics Assessment, RM 17.7 – RM18.2, April 1994	
Lower NFFR Incipient Motion Study	**March 2003**

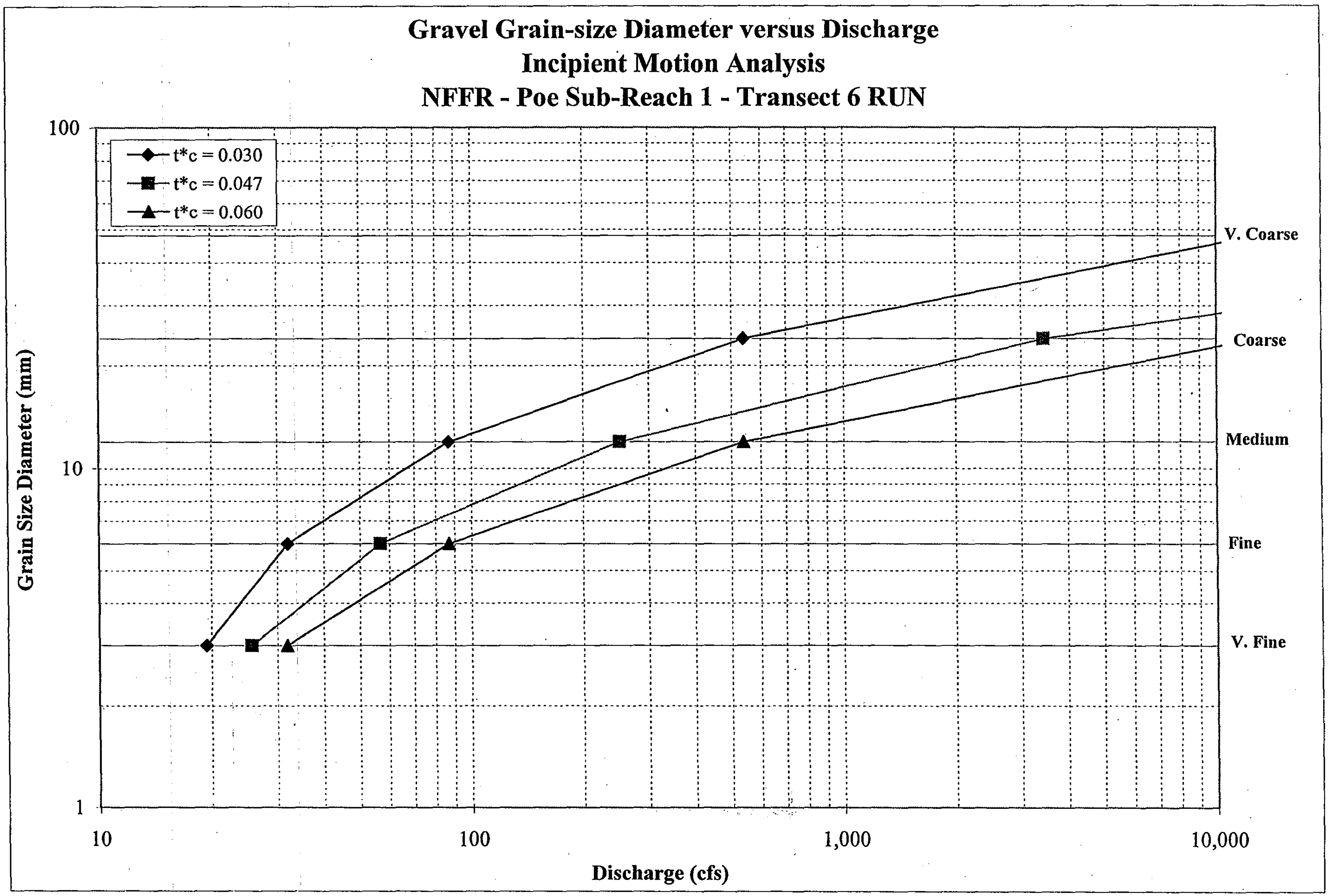
Appendix C.

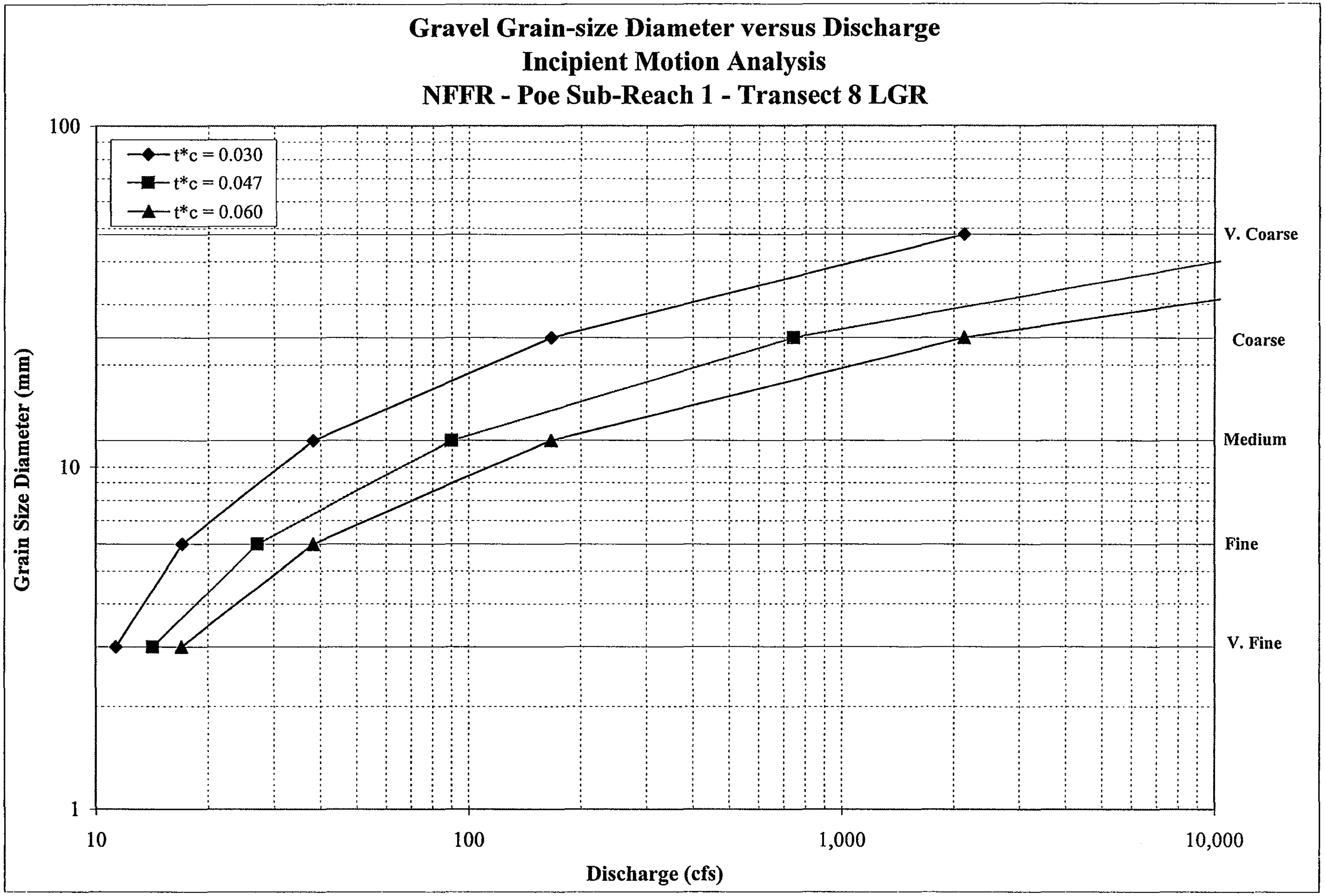
Results of Incipient Motion Analysis for Each Transect

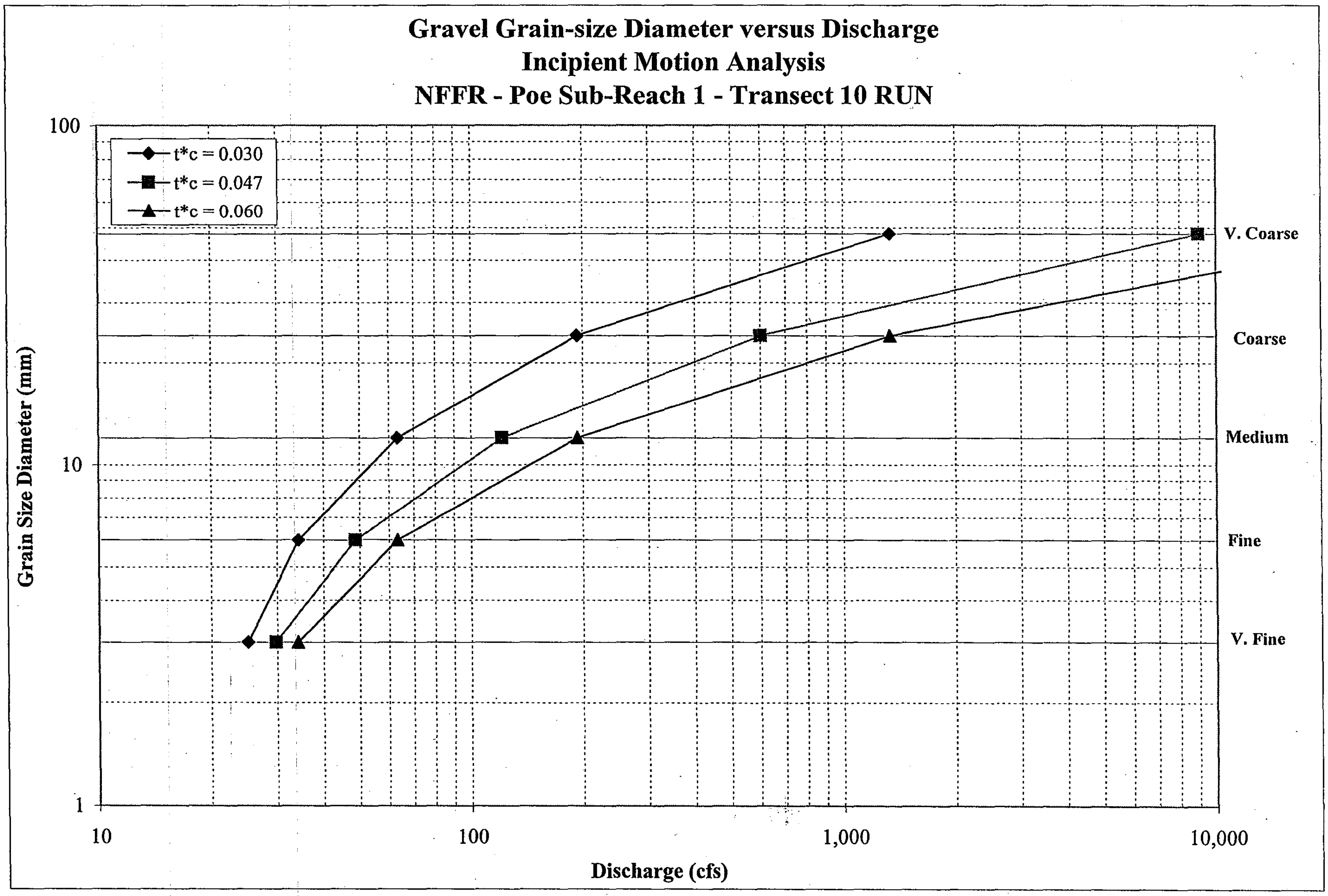

Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 1 - Transect 3 RUN
t*c = 0.030
t*c = 0.047
t*c = 0.060
V. Coarse
Coarse
Medium
Fine
V. Fine
Grain Size Diameter (mm)
100
10
1
10
100
1,000
10,000
Discharge (cfs)



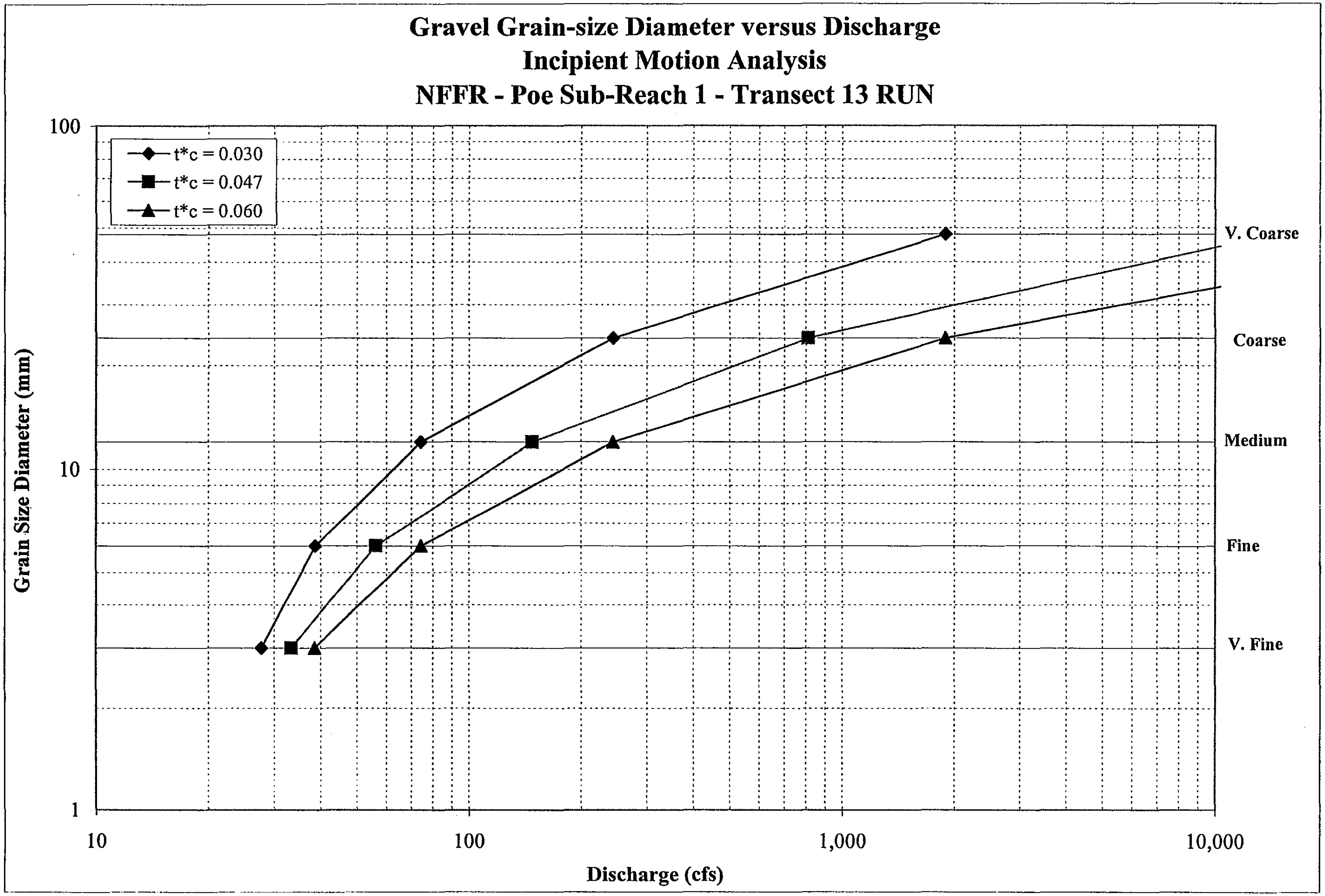
Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 1 - Transect 5 POW
t*c = 0.030
t*c = 0.047
t*c = 0.060
V. Coarse
Coarse
Medium
Fine
V. Fine
Grain Size Diameter (mm)
100
10
1
10
100
1,000
10,000
Discharge (cfs)


Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 1 - Transect 6 RUN
t*c = 0.030
t*c = 0.047
t*c = 0.060
V. Coarse
Coarse
Medium
Fine
V. Fine
Grain Size Diameter (mm)
100
10
1
10
100
1,000
10,000
Discharge (cfs)

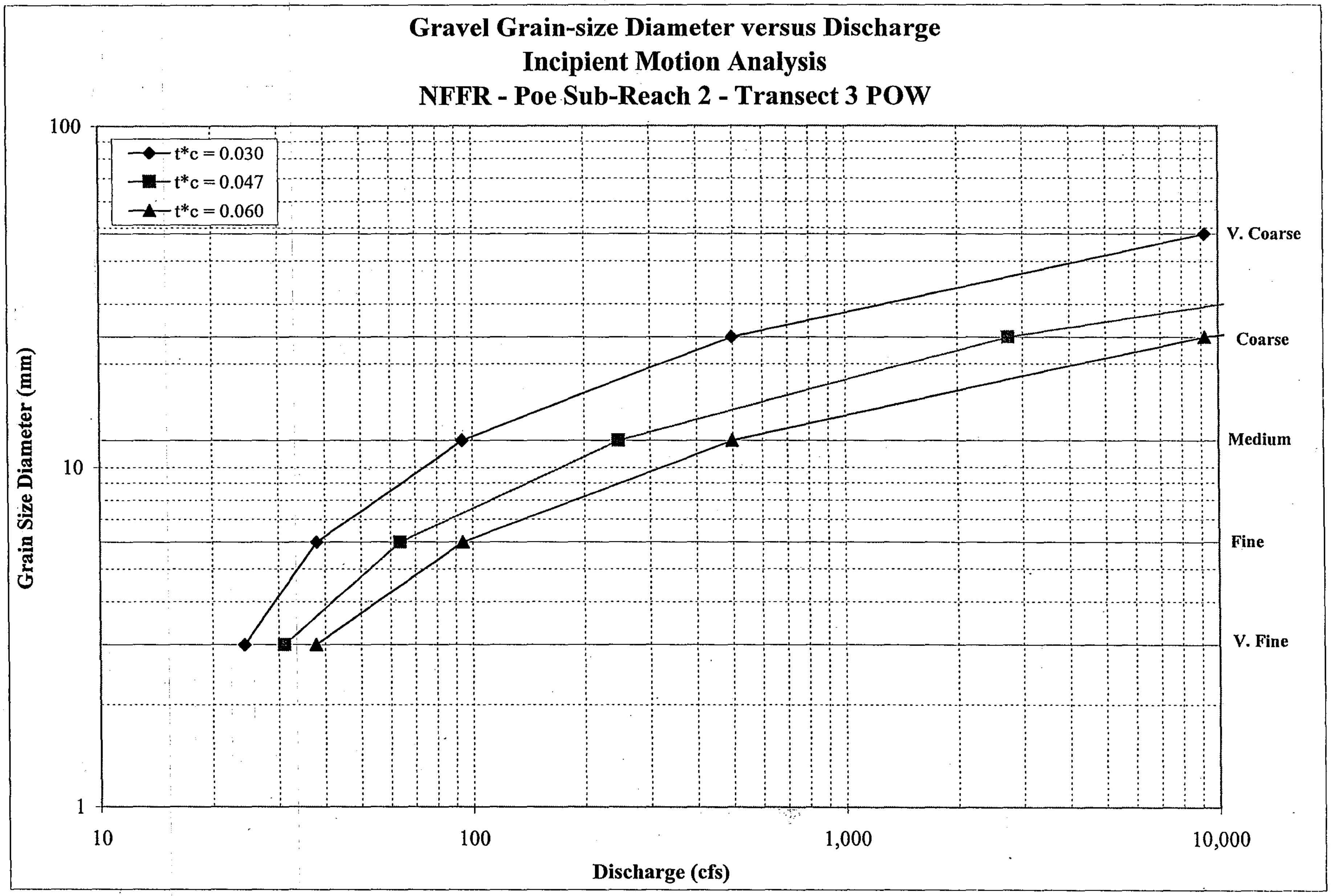

Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 1 - Transect 8 LGR
t*c = 0.030
t*c = 0.047
t*c = 0.060
Grain Size Diameter (mm)
100
10
1
10
100
1,000
10,000
Discharge (cfs)
V. Coarse
Coarse
Medium
Fine
V. Fine



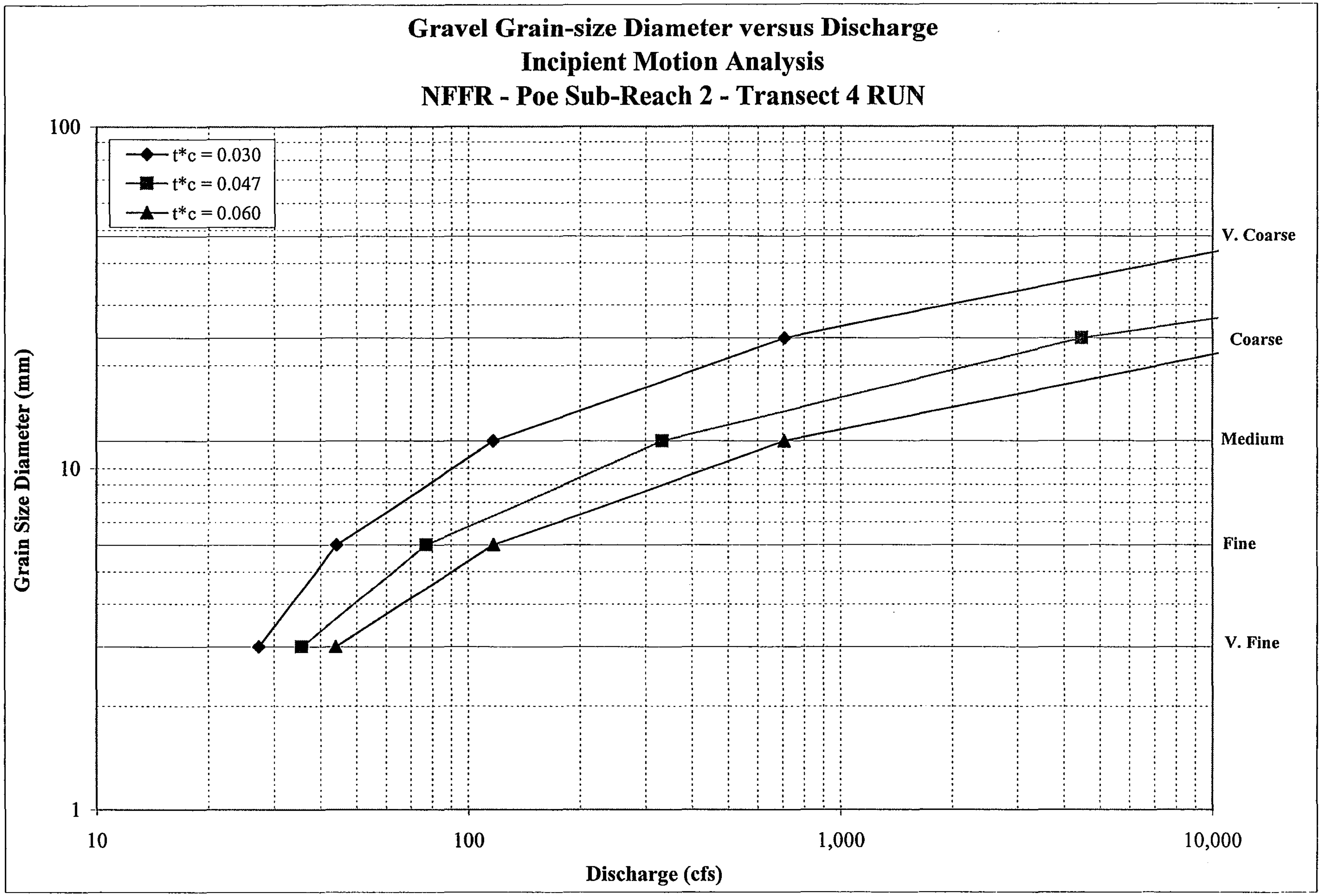
Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 1 - Transect 10 RUN
t*c = 0.030
t*c = 0.047
t*c = 0.060
Grain Size Diameter (mm)
100
10
1
10
100
1,000
10,000
Discharge (cfs)
V. Coarse
Coarse
Medium
Fine
V. Fine



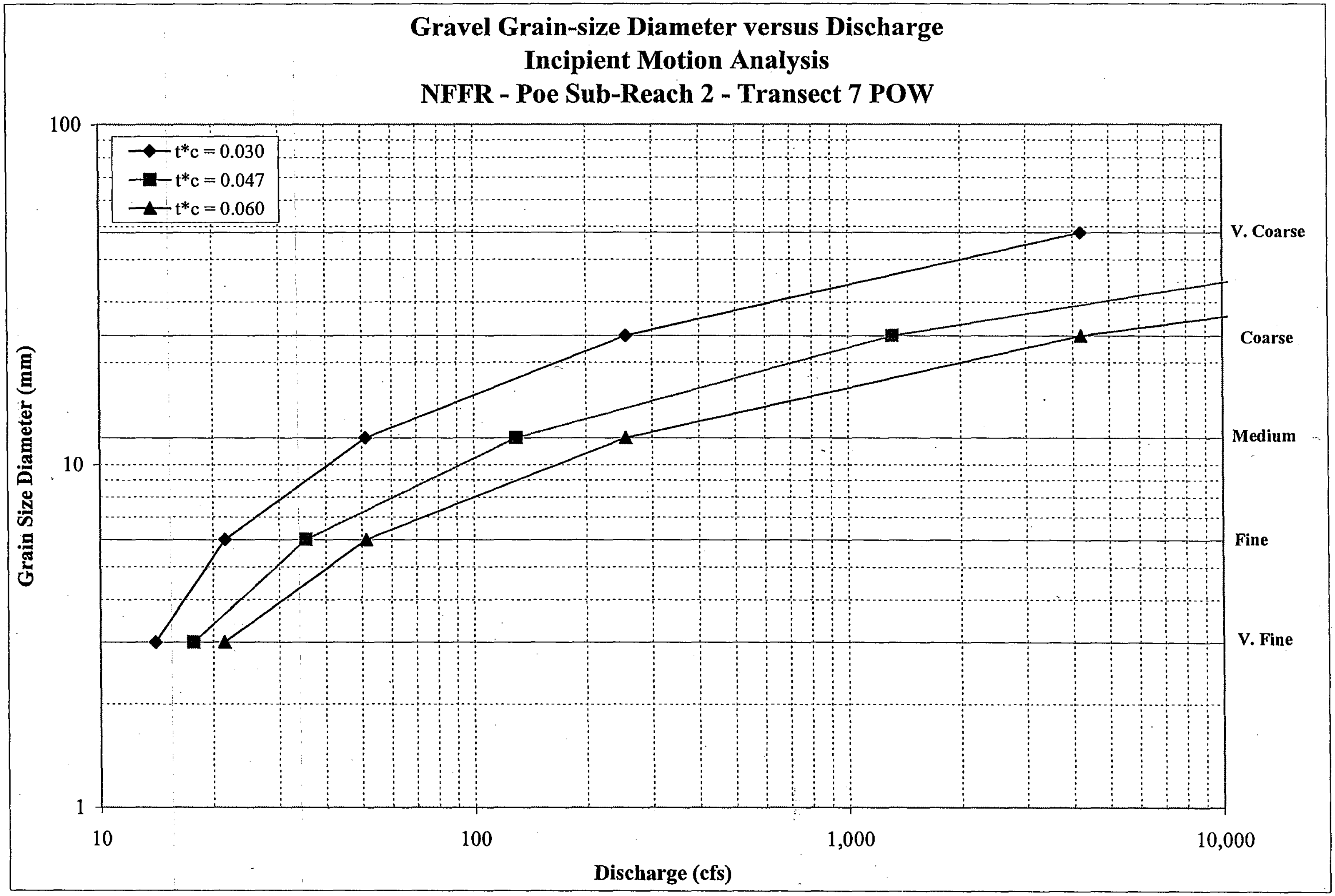
Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 1 - Transect 13 RUN
t*c = 0.030
t*c = 0.047
t*c = 0.060
Grain Size Diameter (mm)
100
10
1
10
100
1,000
10,000
Discharge (cfs)
V. Coarse
Coarse
Medium
Fine
V. Fine



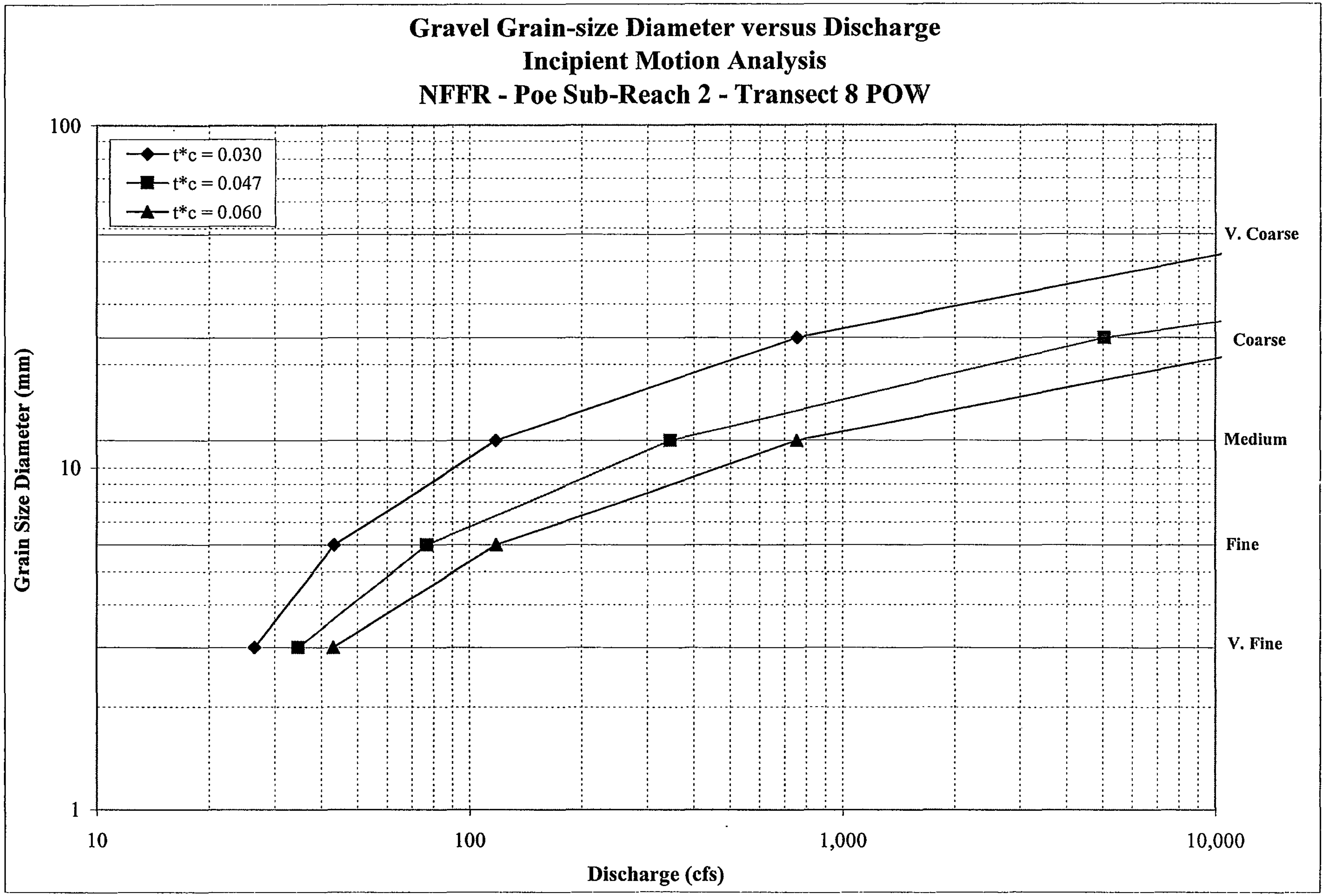
Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 2 - Transect 3 POW
t*c = 0.030
t*c = 0.047
t*c = 0.060
V. Coarse
Coarse
Medium
Fine
V. Fine
Grain Size Diameter (mm)
100
10
1
10
100
1,000
10,000
Discharge (cfs)



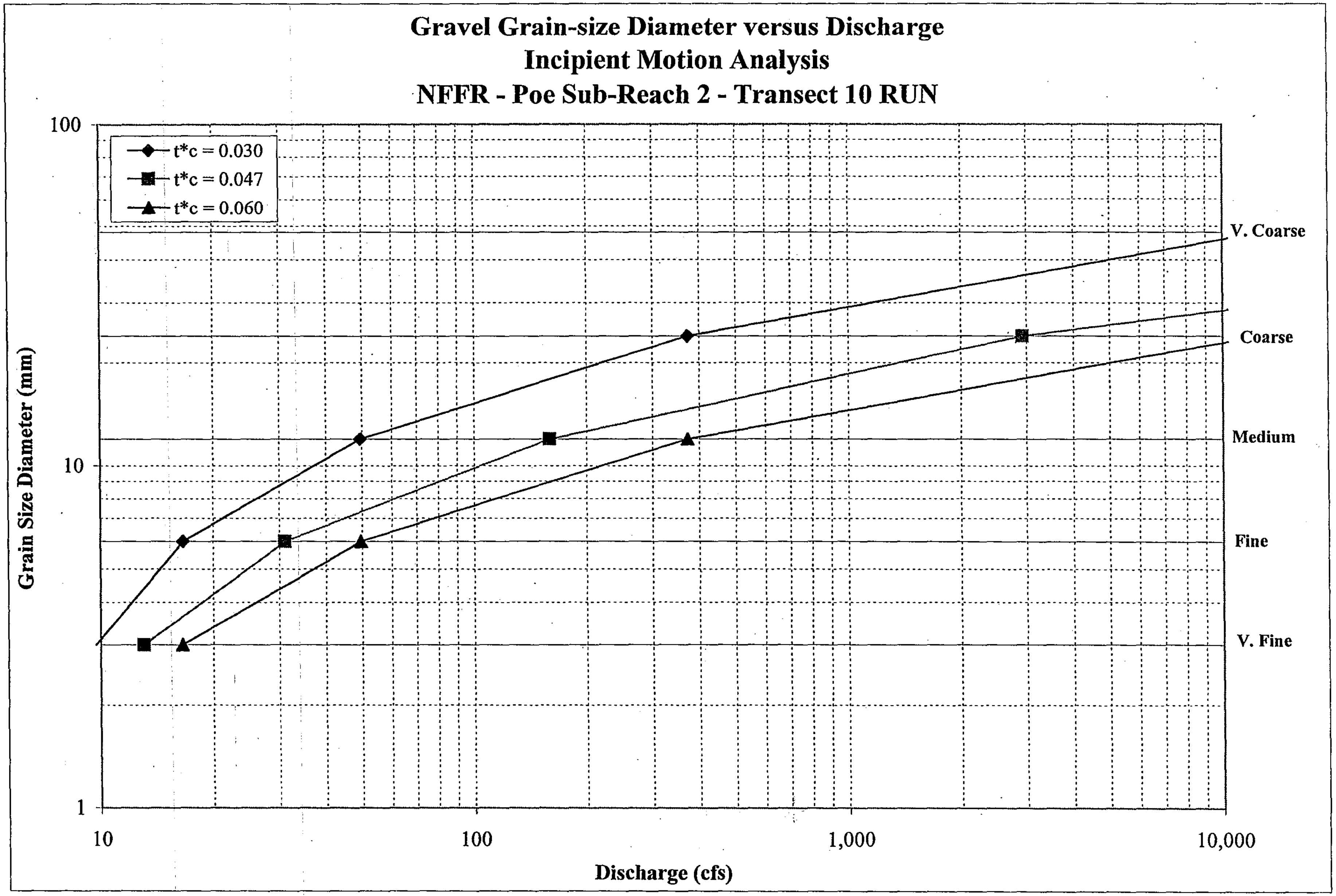
Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 2 - Transect 4 RUN
t*c = 0.030
t*c = 0.047
t*c = 0.060
V. Coarse
Coarse
Medium
Fine
V. Fine
100
10
1
Grain Size Diameter (mm)
10
100
1,000
10,000
Discharge (cfs)

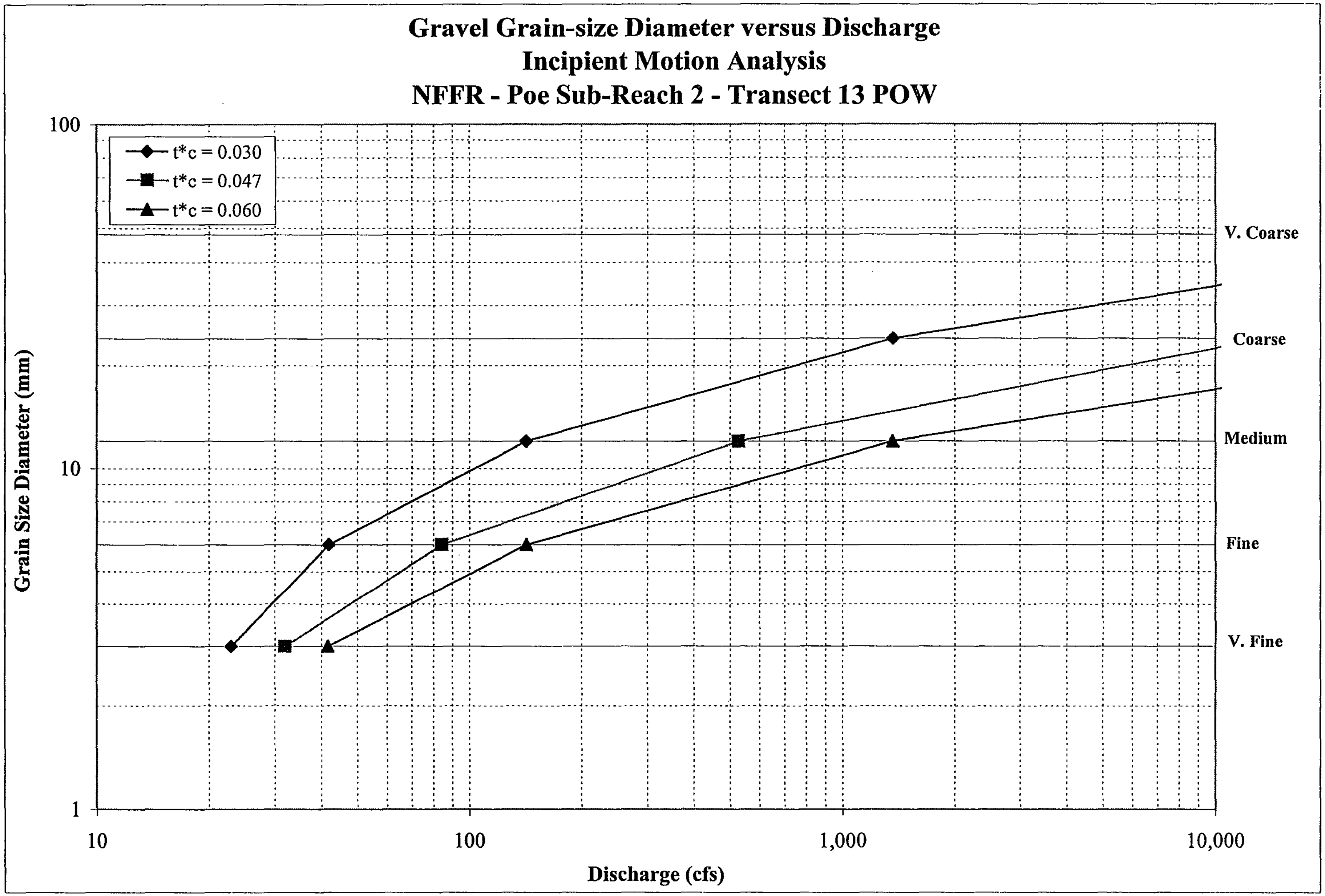


Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 2 - Transect 7 POW
t*c = 0.030
t*c = 0.047
t*c = 0.060
V. Coarse
Coarse
Medium
Fine
V. Fine
Grain Size Diameter (mm)
100
10
1
10
100
1,000
10,000
Discharge (cfs)

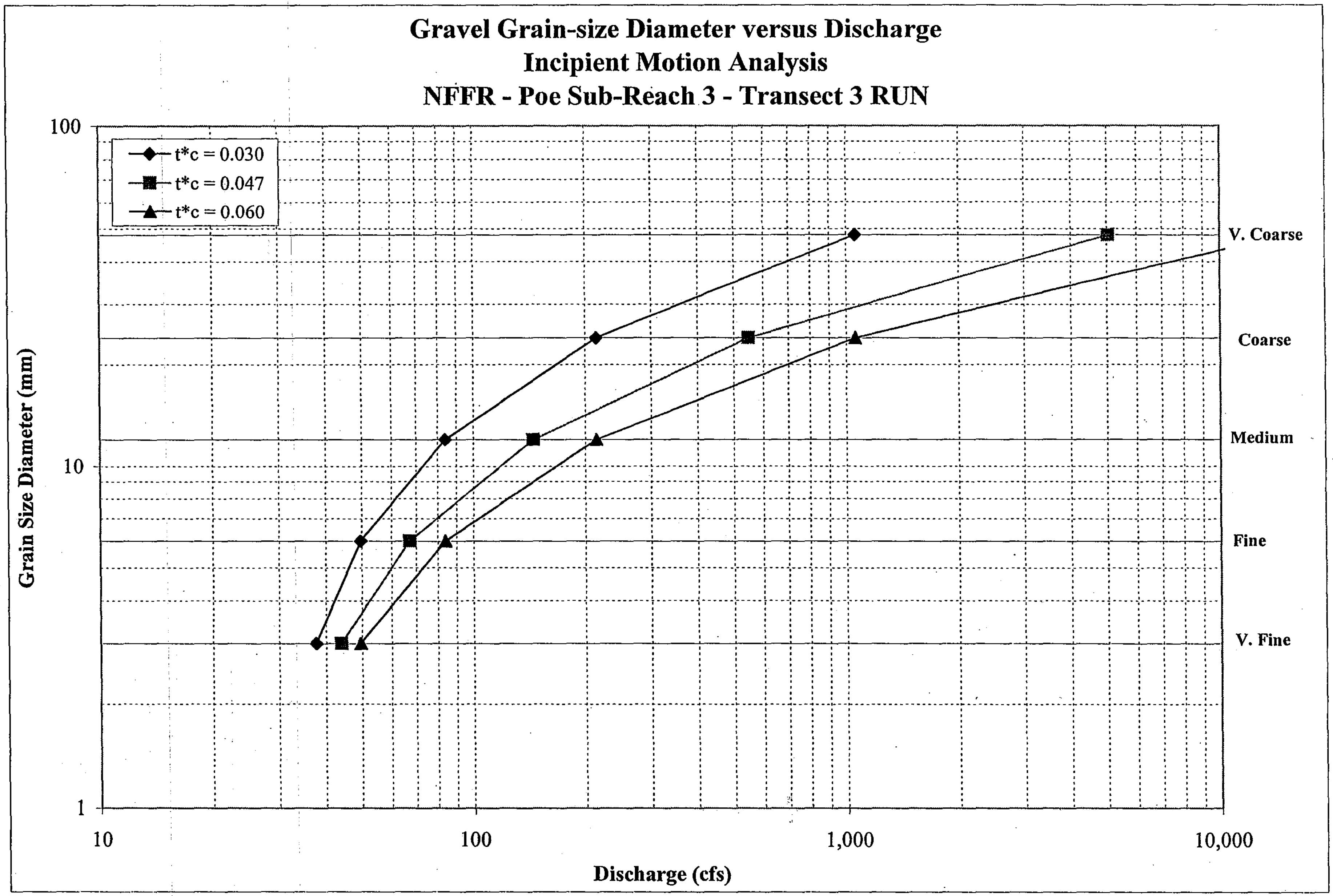


Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 2 - Transect 8 POW
t*c = 0.030
t*c = 0.047
t*c = 0.060
V. Coarse
Coarse
Medium
Fine
V. Fine
100
10
1
Grain Size Diameter (mm)
10
100
1,000
10,000
Discharge (cfs)

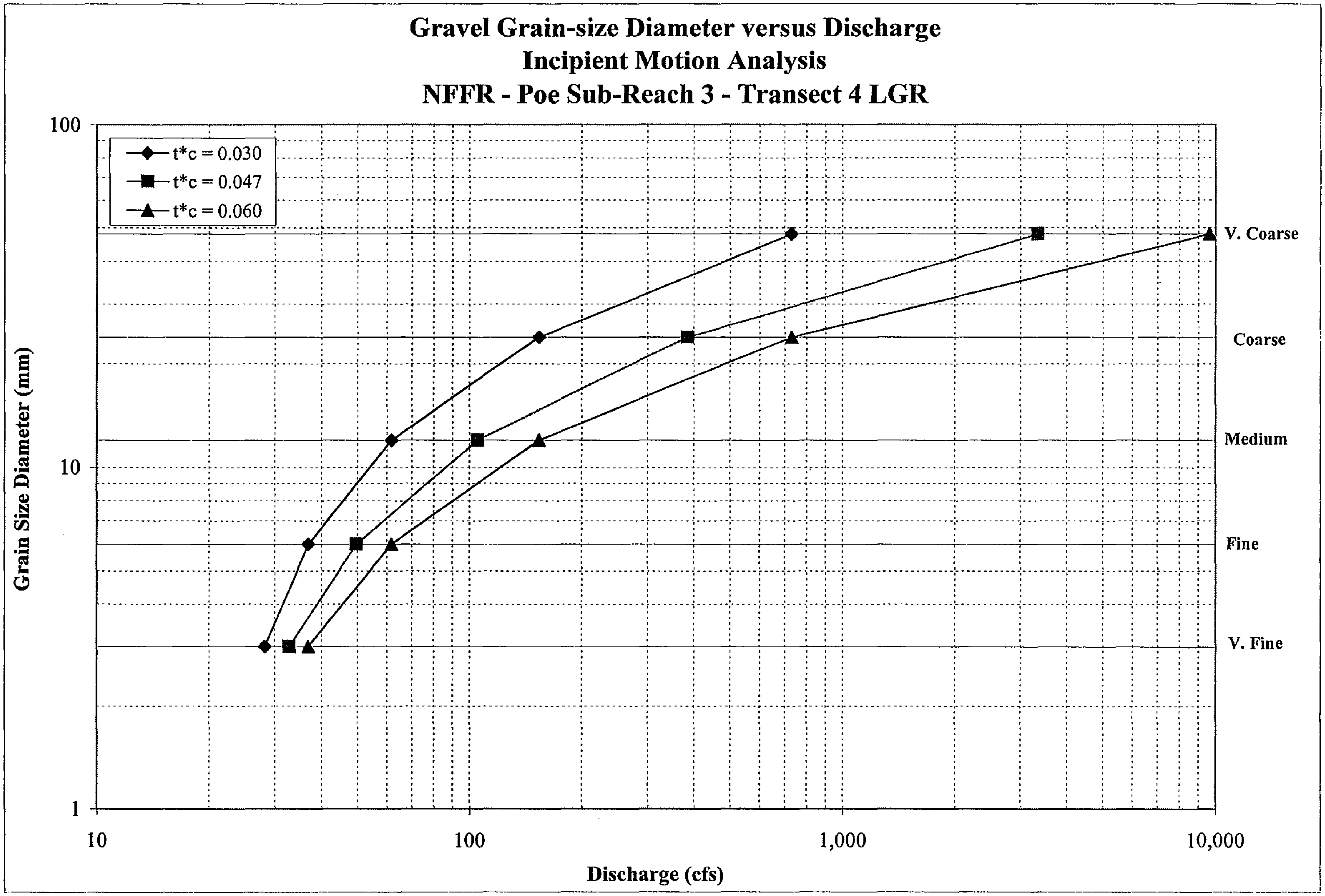

Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 2 - Transect 10 RUN
t*c = 0.030
t*c = 0.047
t*c = 0.060
V. Coarse
Coarse
Medium
Fine
V. Fine
Grain Size Diameter (mm)
100
10
1
10
100
1,000
10,000
Discharge (cfs)



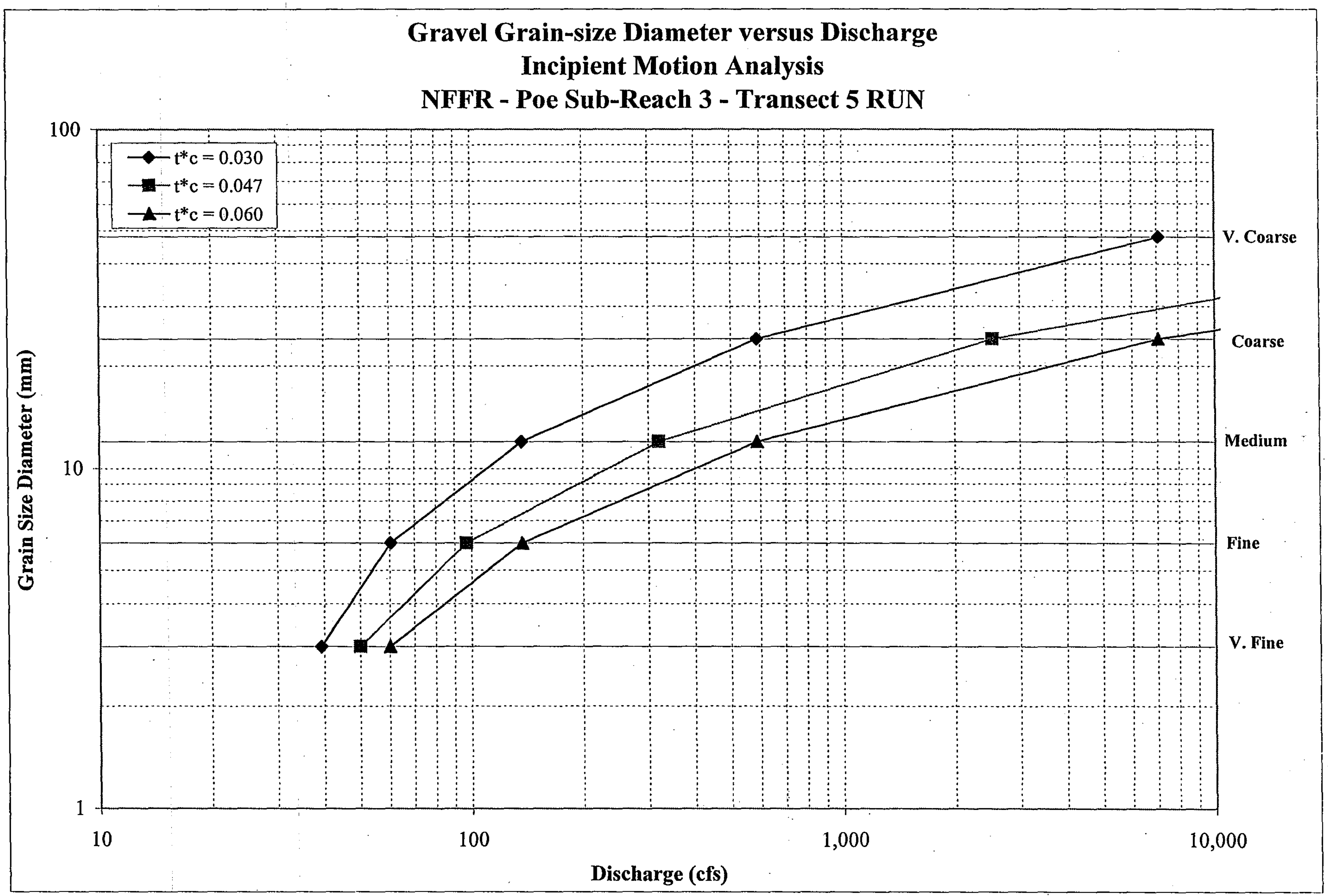
Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 2 - Transect 13 POW
t*c = 0.030
t*c = 0.047
t*c = 0.060
V. Coarse
Coarse
Medium
Fine
V. Fine
Grain Size Diameter (mm)
100
10
1
10
100
1,000
10,000
Discharge (cfs)



Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 3 - Transect 3 RUN
t*c = 0.030
t*c = 0.047
t*c = 0.060
V. Coarse
Coarse
Medium
Fine
V. Fine
Grain Size Diameter (mm)
100
10
1
10
100
1,000
10,000
Discharge (cfs)



Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 3 - Transect 4 LGR
t*c = 0.030
t*c = 0.047
t*c = 0.060
Grain Size Diameter (mm)
100
10
1
10
100
1,000
10,000
Discharge (cfs)
V. Coarse
Coarse
Medium
Fine
V. Fine



Gravel Grain-size Diameter versus Discharge
Incipient Motion Analysis
NFFR - Poe Sub-Reach 3 - Transect 5 RUN
t*c = 0.030
t*c = 0.047
t*c = 0.060
100
10
1
Grain Size Diameter (mm)
10
100
1,000
10,000
Discharge (cfs)
V. Coarse
Coarse
Medium
Fine
V. Fine

Hourly Temp. Data Summary

POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX E2-3

Summary of 1999, 2000 and 2003 Hourly Water Temperature Data in the Poe Project Area

APPENDIX E2-3

Summary of 1999, 2000, and 2003 Hourly Water Temperature Data in the Poe Project Area

Station	Year	Month	Hourly Temperatures[1] max	min	mean
NFFR above Cresta PH (Poe-1C)	1999	June	22.1	14.8	18.6
	1999	July	23.5	17.5	20.2
	1999	Aug	21.6	16.9	19.6
	1999	Sept	19.3	15.8	17.6
	2000	June	22.8	16.9	20.1
	2000	July	21.6	17.1	19.6
	2000	Aug	23.1	17.2	19.9
	2000	Sept	18.8	14.4	16.4
	2003	June	20.4	13.2	17.2
	2003	July	23.9	16.1	20.0
	2003	Aug	22.8	18.0	20.2
	2003	Sept	21.6	15.3	18.3
NFFR below Cresta PH (Poe-1A)	1999	June	19.6	16.3	17.9
	1999	July	20.7	18.1	19.3
	1999	Aug	20.3	18.1	19.2
	1999	Sept	18.9	16.2	18.1
	2000	June	20.8	17.6	18.9
	2000	July	20.4	17.0	19.2
	2000	Aug	21.9	16.8	19.9
	2000	Sept	19.3	16.3	17.3
	2003	June	19.1	13.5	16.8
	2003	July	22.7	16.7	19.7
	2003	Aug	22.7	18.9	20.1
	2003	Sept	20.6	16.5	18.3
Cresta PH Internal (Poe-1B)	1999	June	---	---	---
	1999	July	20.8	18.7	19.6
	1999	Aug	20.5	17.9	19.4
	1999	Sept	19.5	16.6	18.3
	2000	June	---	---	---
	2000	July	---	---	---
	2000	Aug	---	---	---
	2000	Sept	---	---	---
	2003	June	19.2	13.4	16.8
	2003	July	22.7	17.2	19.7
	2003	Aug	22.3	18.9	20.2
	2003	Sept	20.5	16.6	18.3

[redacted]

Appendix E2-3

Continued

Station	Year	Month	Hourly Temperatures [1] max	min	mean
NFFR below Poe Dam (Poe-5)	1999	June	20.3	12.5	17.0
	1999	July	21.1	17.8	19.4
	1999	Aug	20.6	18.3	19.3
	1999	Sept	18.7	16.6	17.9
	2000	May	16.3	10.4	14.4
	2000	June	21.2	13.8	17.5
	2000	July	20.8	17.6	19.2
	2000	Aug	21.6	18.1	19.9
	2000	Sept	19.1	16.4	17.2
	2003	June	19.2	13.7	17.0
	2003	July	22.8	17.1	19.9
	2003	Aug	22.5	19.2	20.3
	2003	Sept	20.6	16.5	18.4
NFFR at Pulga Bridge (Poe-2A)	1999	June	---	---	---
	1999	July	22.8	17.4	19.5
	1999	Aug	22.4	17.3	19.5
	1999	Sept	20.2	15.8	17.8
	2000	May	18.9	11.5	15.3
	2000	June	23.2	13.2	17.9
	2000	July	22.6	16.8	19.5
	2000	Aug	23.3	17.4	20.0
	2000	Sept	19.1	15.7	17.1
	2003	June	20.9	13.3	17.3
	2003	July	24.3	16.3	20.2
	2003	Aug	23.5	18.3	20.4
	2003	Sept	22.2	15.9	18.4
NFFR below Pulga Bridge (Poe-2B)	1999	June	21.9	12.2	17.4
	1999	July	22.7	16.9	19.6
	1999	Aug	21.8	17.0	19.4
	1999	Sept	20.0	15.4	17.8
	2000	June	23.3	16.8	20.0
	2000	July	22.5	16.9	19.7
	2000	Aug	23.1	17.5	20.1
	2000	Sept	19.4	15.5	17.2
	2003	June	---	---	---
	2003	July	---	---	---
	2003	Aug	---	---	---
	2003	Sept	---	---	---

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Appendix E2-3

Continued

Station	Year	Month	Hourly Temperatures [1] max	min	mean
NFFR at Bardees Bar (Poe-6)	1999	June	21.9	12.2	17.8
	1999	July	22.8	16.9	19.9
	1999	Aug	21.9	16.8	19.6
	1999	Sept	19.3	15.5	17.7
	2000	June	23.4	17.1	20.4
	2000	July	22.6	17.0	20.0
	2000	Aug	23.2	17.3	20.2
	2000	Sept	19.7	15.0	17.1
	2003	June	21.2	13.7	18.0
	2003	July	24.5	16.2	20.7
	2003	Aug	23.6	17.8	20.6
	2003	Sept	22.1	15.5	18.6
NFFR above Poe PH (Poe-3)	1999	June	24.0	15.1	19.9
	1999	July	25.1	18.7	21.5
	1999	Aug	23.7	17.6	20.9
	1999	Sept	20.9	16.6	18.4
	2000	May	21.9	13.2	17.8
	2000	June	25.6	15.3	20.3
	2000	July	24.0	18.6	21.4
	2000	Aug	24.9	18.4	21.2
	2000	Sept	20.4	15.9	17.8
	2003	June	22.9	16.1	19.7
	2003	July	26.0	18.2	22.1
	2003	Aug	24.7	19.3	21.5
	2003	Sept	23.4	15.8	19.2
Poe Powerhouse Tailrace (Poe-4B)	1999	June	20.8	13.8	17.6
	1999	July	21.1	16.1	19.3
	1999	Aug	20.6	17.3	19.2
	1999	Sept	18.7	13.9	17.7
	2000	June	21.1	17.8	19.3
	2000	July	20.6	17.9	19.4
	2000	Aug	21.5	18.3	20.2
	2000	Sept	19.5	16.3	17.7
	2003	June	19.1	13.8	16.9
	2003	July	22.9	16.9	20.0
	2003	Aug	22.9	19.1	20.4
	2003	Sept	20.7	16.5	18.6

36+1=37

Appendix E2-3

Continued

Station	Year	Month	Daily Temperatures[1] max	min	mean
Flea Valley Creek (FVC)	1999	June	17.1	9.7	13.6
	1999	July	18.0	12.2	14.7
	1999	Aug	17.6	12.9	14.9
	1999	Sept	16.1	12.2	14.2
	2000	June	18.4	13.9	15.8
	2000	July	17.8	13.2	15.3
	2000	Aug	18.6	13.7	15.6
	2000	Sept	15.7	11.9	13.7
	2003	June	16.6	12.1	14.2
	2003	July	18.7	12.4	15.6
	2003	Aug	17.7	13.4	15.4
	2003	Sept	17.6	12.9	14.8
Mill Creek (MC)	1999	June	17.3	8.7	13.6
	1999	July	18.6	12.0	15.0
	1999	Aug	17.4	12.7	14.9
	1999	Sept	15.4	11.8	13.7
	2000	June	18.8	13.4	16.0
	2000	July	17.7	12.7	15.3
	2000	Aug	18.6	13.4	15.6
	2000	Sept	15.0	11.0	12.9
	2003	June	16.7	11.3	14.0
	2003	July	19.4	11.9	15.9
	2003	Aug	18.2	13.0	15.5
	2003	Sept	17.3	11.9	14.3
NFFR above Poe PH (Poe-3)	2003	June	19.6	15.8	17.6
	2003	July	23.1	17.1	20.2
	2003	Aug	22.6	18.3	20.5
	2003	Sept	21.3	16.3	18.5

1. Hourly values are based on hourly average data; month statistics represent the maximum, minimum, and mean based on these hourly average temperatures.

POE HYDROELECTRIC PROJECT

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APPENDIX E2-4

Comparison of Poe Project Water Quality Data with Regulatory Criteria for 1999-2000, 2000-2001, 2001-2002, and 2003 and USEPA Method 1631 e and 1638 Reference Documents

1999-2000 Historical Poe Water Quality Data

and

Comparison to Applicable Regulatory Criteria

Poe-1A (Above Poe Reservoir)

	1999						2000
	March	June	July	August	September	December	March
Time	11:00	12:45	17:15	9:08	10:20	10:15	9:40
In situ Paramaters							
Water Temperature (°C)	7.20	17.30	20.20	19.10	18.00	4.10	8.30
Dissolved Oxygen (DO), (mg/L)	12.50	9.10	10.80	9.80	9.30	13.60	10.70
DO Percent Saturation (%)	109	99	125	111	103	110	96
Specific Conductance (µmhos/cm)	101	92	97	103	123	110	85
pH	8.00	7.20	7.50	7.50	7.60	7.70	7.40
Turbidity (NTU)	7.00 [a]	2.3	2.6	1.8	5.6 [b]	1.5 [c]	7.2 [d]
Analytical Paramaters							
Total Coliform (MPN/100 mL)	23	NQ [e]	23	50	30	8	8
Fecal Coliform (MPN/100 mL)	8	NQ [e]	<2	<2	<2	4	8
Total Metals:							
Arsenic (µg/L)	<2.0	<5.0	<5.0	<5.0	<5.0	<5.0	<3.2
Barium (µg/L)	17	14	12	11	19	13	17
Cadmium (µg/L)	<0.5	<2.0	<2.0	<2.0	<2.0	<2.0	<0.36
Chromium (µg/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<0.47
Copper (µg/L)	3.5	<5.0	<5.0	<5.0	<5.0	<5.0	<0.40
Iron (µg/L)	340	210	140	100	540	95	280
Lead (µg/L)	<0.5	<5.0	<5.0	<5.0	<5.0	<5.0	<1.3
Manganese (µg/L)	17	26	LE	32	41	15	25
Mercury (µg/L)	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
Selenium (µg/L)	<4.0	<5.0	<5.0	<5.0	<5.0	<5.0	<4.2
Silver (µg/L)	<0.5	0.1	<3.6	<3.6	0.6	<3.6	<0.36
Zinc (µg/L)	3.4	7.8	1.6	<1.3	3.4	3.4	<1.3
Ammonia - Total (mg/L)	<0.10	<0.50	<0.10	<0.10	<0.10	<0.50	<0.10
Total Hardness, as $CaCO_3$ (mg/L)	41	39	39	40	56	40	43
Chloride (mg/L)	0.87	1.00	0.70	0.60	1.00	1.00	<0.20
Sulfate (mg/L)	2.40	4.00	1.40	1.30	2.00	2.00	2.00
Nitrate, as NO_3 (mg/L)	<0.10	<1.0	<0.10	<0.10	<0.10	<0.10	<0.10
Alkalinity - Total (mg/L)	122	50	50	50	70	50	50
Total Dissolved Solids (mg/L)	74	56	45	65	90	67	110
Total Suspended Solids (mg/L)	5.0	2.3	<1.0	1.7	2.6	<1.0	5.9
Total Phosphorous (mg/L)	NA	<0.01	0.04	<1.0	<1.0	<0.01	<0.01
Orthophosphate (mg/L)	<0.50	<0.01	0.03	<1.0	<0.01	<0.01	<0.01
Total Kjeldahl Nitrogen (mg/L)	0.22	<0.50	<0.20	<0.20	<0.20	<0.50	<0.20
Total Organic Nitrogen (mg/L)	0.22	<0.50	<0.50	<0.50	<0.50	<0.50	<0.20
Total Calcium (mg/L)	9.60	9.80	9.30	9.00	12.00	11.00	8.70
Total Magnesium (mg/L)	3.70	3.90	4.10	4.00	5.40	4.90	3.60
Total Potassium (mg/L)	0.77	0.89	1.40	0.98	1.10	1.10	0.89
Total Sodium (mg/L)	3.30	3.60	3.80	3.70	6.30	4.60	5.20
Total Boron (mg/L)	<0.006	<0.0001	<0.0005	<0.0001	<0.0001	<0.0001	<0.1
Silica (mg/L)	19.0	13.0	12.0	12.4	13.0	14.0	18.0
MBAS (mg/L)	<0.025	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
PCBs							
Aroclor 1016 (µg/L)	NS	NS	NS	NS	NS	NS	NS
Aroclor 1221 (µg/L)	NS	NS	NS	NS	NS	NS	NS
Aroclor 1232 (µg/L)	NS	NS	NS	NS	NS	NS	NS
Aroclor 1242 (µg/L)	NS	NS	NS	NS	NS	NS	NS
Aroclor 1248 (µg/L)	NS	NS	NS	NS	NS	NS	NS
Aroclor 1254 (µg/L)	NS	NS	NS	NS	NS	NS	NS
Aroclor 1260 (µg/L)	NS	NS	NS	NS	NS	NS	NS

Sequoia Laboratory in Pleasant Hill analyzed samples from March 1999 for metals and nutrients, all other samples were analyzed by Chromalab in Pleasenton for metals and nutrients.
Monarch Lab in Chico analyzed coliform samples
J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.
J values applicable to 2000 data only, this is when the lab started to report J flag values
<VALUE = less than the detection limit for 1999 data, less than the MDL for 2000 data
NS = Constituent not sampled for during monitoring program
NQ = Not quantified
LE = Laboratory error in method of detection, no value to report
[a] = raining during sampling event, lots of tributary runoff to main stem.
[b] = smoke from fire in project area
[c] = flows near minimum levels
[d] = Cresta Powerhouse operating
[e] = Laboratory error in method of detection, coliform present but unable to quantify due to laboratory error

Poe-1A (Above Poe Reservoir)	March '99	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	11:00														
In situ Parameters															
Water Temperature (°C)	7.20														
Dissolved Oxygen (mg/L)	12.50												>7		
Specific Conductance (µmhos/cm)	101									900			150		
pH (Standard Units)	8.00							6.5-9.0					6.5-8.5		
Turbidity (NTU)	7.0									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (µg/L)	<2.0								50		10				
Barium (µg/L)	17								1,000		2,000			1,000	
Cadmium (µg/L)	<0.5		1.2225	1.6524		0.13979	0.86176		5		5				
Chromium (µg/L) [7]	<5.0		99.7249	836.6581		41.5217	868.7154		50		100				
Copper (µg/L)	3.5		4.3547	6.0432		4.3547	6.0432		1,300	1,000	1,300	1,000		1,300	
Iron (µg/L)	340					1,000				300		300			
Lead (µg/L)	<0.5		1.0226	26.2424		1.0226	26.2424		15		15				
Manganese (µg/L)	17									50		50			100
Mercury (µg/L)	<0.0002								2		2			0.05	0.051
Selenium (µg/L)	<4.0		5	20		5			50		50			170	4,200
Silver (µg/L)	<0.5				0.8758			0.8166		100		100			
Zinc (µg/L)	3.40		56.2896	56.2896		56.2896	56.2896			5,000		5,000		7,400	26,000
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	8.0												200/400		
Ammonia - Total (mg/L) [5]	<0.10					2.43	5.62								
Total Hardness, as CaCO3 (mg/L)	41.0														
Chloride (mg/L) [9]	0.9					230	860			250		250			
Nitrate, as NO3 (mg/L) [8]	<0.10								45		10			10	
Alkalinity - Total (mg/L)	122.0					≥ 20									
Total Dissolved Solids (mg/L)	74.0									500		500			
PCBs (µg/L)	0.0		0.014			0.014			0.5		0.5			0.00017	0.00017

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

NQ = Not quantified

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

LE = Laboratory error in method of detection, no value to report

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. Criteria for CTR and USEPA chromium total recoverable expressed as chromium III
8. Criteria for total nitrate as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Should this be counted as 1 sample or 2?

compare to both

Poe-1A (Above Poe Reservoir)	June '99	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	12:45														
In situ Parameters															
Water Temperature (°C)	17.30														
Dissolved Oxygen (mg/L)	9.10												>7		
Specific Conductance (µmhos/cm)	92									900			150		
pH (Standard Units)	7.20							6.5-9.0					6.5-8.5		
Turbidity (NTU)	2.3									5					
Analytical Parameters															
Total Metals (units of milligrams per liter)[6]															
Arsenic (µg/L)	<5.0								50		10				
Barium (µg/L)	14								1,000		2,000			1,000	
Cadmium (µg/L)	<2.0		1.1754	1.5617		0.13471	0.81904		5		5				
Chromium (µg/L)[7]	<5.0		95.7228	803.0821		39.8554	833.8529		50		100				
Copper (µg/L)	<5.0		4.1725	5.7650		4.1725	5.7650		1,300	1,000	1,300	1,000		1,300	
Iron (µg/L)	210					1,000				300		300			
Lead (µg/L)	<5.0		0.9596	24.6238		0.9596	24.6238		15		15				
Manganese (µg/L)	26									50		50			100
Mercury (µg/L)	<0.0005								2		2			0.05	0.051
Selenium (µg/L)	<5.0		5	20		5			50		50			170	4,200
Silver (µg/L)	0.10				0.8036			0.7493		100		100			
Zinc (µg/L)	7.80		53.9542	53.9542		53.9542	53.9542			5,000		5,000		7,400	26,000
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL)[10]	NQ												200/400		
Ammonia - Total (mg/L)[5]	<0.50					4.50	19.73								
Total Hardness, as CaCO3 (mg/L)	39.0														
Chloride (mg/L)[9]	1.0					230	860			250		250			
Nitrate, as NO3 (mg/L)[8]	<1.0								45		10			10	
Alkalinity - Total (mg/L)	50.0					≥ 20									
Total Dissolved Solids (mg/L)	56.0									500		500			
PCBs (µg/L)	0.0		0.014			0.014			0.5		0.5			0.00017	0.00017

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
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CCC = Continuous concentration (4-day average)
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1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
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9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Poe-1A (Above Poe Reservoir)	July '99	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	17:15														
In situ Parameters															
Water Temperature (°C)	20.20														
Dissolved Oxygen (mg/L)	10.80												*>7*		
Specific Conductance (μmhos/cm)	97									*900*			*150*		
pH (Standard Units)	7.50							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	2.6									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter)[6]															
Arsenic (μg/L)	<5.0								*50*		*10*				
Barium (μg/L)	12								*1,000*		*2,000*			*1,000*	
Cadmium (μg/L)	<2.0		*1.1754*	*1.5617*		*0.13471*	*0.81904*		*5*		*5*				
Chromium (μg/L)[7]	<5.0		*95.7228*	*803.0821*		*39.8554*	*833.8529*		*50*		*100*				
Copper (μg/L)	<5.0		*4.1725*	*5.7650*		*4.1725*	*5.7650*		*1,300*	*1,000*	*1,300*	*1,000*		*1,300*	
Iron (μg/L)	140					*1,000*				*300*		*300*			
Lead (μg/L)	<5.0		*0.9596*	*24.6238*		*0.9596*	*24.6238*		*15*		*15*				
Manganese (μg/L)	LE									*50*		*50*			*100*
Mercury (μg/L)	<0.0005								*2*		*2*			*0.05*	*0.051*
Selenium (μg/L)	<5.0		*5*	*20*		*5*			*50*		*50*			*170*	*4,200*
Silver (μg/L)	<3.6				*0.8036*			*0.7493*		*100*		*100*			
Zinc (μg/L)	1.60		*53.9542*	*53.9542*		*53.9542*	*53.9542*			*5,000*		*5,000*		*7,400*	*26,000*
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL)[10]	<2												*200/400*		
Ammonia - Total (mg/L)[5]	<0.10					*3.03*	*13.28*								
Total Hardness, as CaCO3 (mg/L)	39.0														
Chloride (mg/L)[9]	0.7					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L)[8]	<0.10								*45*		*10*			*10*	
Alkalinity - Total (mg/L)	50.0					*≥ 20*									
Total Dissolved Solids (mg/L)	45.0									*500*		*500*			
PCBs (μg/L)	0.0		*0.014*			*0.014*			*0.5*		*0.5*			*0.00017*	*0.00017*

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory
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1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*]
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9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 / 100 mL.

Poe-1A (Above Poe Reservoir)	August '99	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	9:08														
In situ Parameters															
Water Temperature (°C)	19.10														
Dissolved Oxygen (mg/L)	9.80												>7		
Specific Conductance (μmhos/cm)	103									900			150		
pH (Standard Units)	7.50							6.5-9.0					6.5-8.5		
Turbidity (NTU)	1.8									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (μg/L)	<5.0								50		10				
Barium (μg/L)	11								1,000		2,000			1,000	
Cadmium (μg/L)	<2.0		1.1990	1.6070		0.13726	0.84039		5		5				
Chromium (μg/L) [7]	<5.0		97.7284	819.9081		40.6904	851.3236		50		100				
Copper (μg/L)	<5.0		4.2637	5.9042		4.2637	5.9042		1,300	1,000	1,300	1,000		1,300	
Iron (μg/L)	100					1,000				300		300			
Lead (μg/L)	<5.0		0.9910	25.4304		0.9910	25.4304		15		15				
Manganese (μg/L)	32									50		50			100
Mercury (μg/L)	<0.0002								2		2			0.05	0.051
Selenium (μg/L)	<5.0		5	20		5			50		50			170	4,200
Silver (μg/L)	<3.6				0.8394			0.7826		100		100			
Zinc (μg/L)	<1.3		55.1241	55.1241		55.1241	55.1241			5,000		5,000		7,400	26,000
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	<2												200/400		
Ammonia - Total (mg/L) [5]	<0.10					3.25	13.28								
Total Hardness, as CaCO3 (mg/L)	40.0														
Chloride (mg/L) [9]	0.6					230	860			250		250			
Nitrate, as NO3 (mg/L) [8]	<0.10								45		10			10	
Alkalinity - Total (mg/L)	50.0					≥ 20									
Total Dissolved Solids (mg/L)	65.0									500		500			
PCBs (μg/L)	0.0		0.014			0.014			0.5		0.5			0.00017	0.00017

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

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Shaded cells represent exceedances of the criteria

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CCC = Continuous concentration (4-day average)

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Poe-1A (Above Poe Reservoir)	September '99	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	10:20														
In situ Parameters															
Water Temperature (°C)	18.00														
Dissolved Oxygen (mg/L)	9.30												*>7*		
Specific Conductance (µmhos/cm)	123									*900*			*150*		
pH (Standard Units)	7.60							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	5.6									*5*					
Analytical Paramaters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (µg/L)	<5.0								*50*		*10*				
Barium (µg/L)	19								*1,000*		*2,000*			*1,000*	
Cadmium (µg/L)	<2.0		*1.5616*	*2.3488*		*0.17612*	*1.18314*		*5*		*5*				
Chromium (µg/L) [7]	<5.0		*128.7359*	*1080.0505*		*53.6007*	*1121.4335*		*50*		*100*				
Copper (µg/L)	<5.0		*5.6840*	*8.1067*		*5.6840*	*8.1067*		*1,300*	*1,000*	*1,300*	*1,000*		*1,300*	
Iron (µg/L)	540					*1,000*				*300*		*300*			
Lead (µg/L)	<5.0		*1.5209*	*39.0277*		*1.5209*	*39.0277*		*15*		*15*				
Manganese (µg/L)	41									*50*		*50*			*100*
Mercury (µg/L)	<0.0002								*2*		*2*			*0.05*	*0.051*
Selenium (µg/L)	<5.0		*5*	*20*		*5*			*50*		*50*			*170*	*4,200*
Silver (µg/L)	0.60				*1.4972*			*1.3960*		*100*		*100*			
Zinc (µg/L)	3.40		*73.3088*	*73.3088*		*73.3088*	*73.3088*			*5,000*		*5,000*		*7,400*	*26,000*
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	<2												*200/400*		
Ammonia - Total (mg/L) [5]	<0.10					*3.18*	*11.37*								
Total Hardness, as CaCO3 (mg/L)	56.0														
Chloride (mg/L) [9]	1.0					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L) [8]	<0.10								*45*		*10*			*10*	
Alkalinity - Total (mg/L)	70.0					*≥ 20*									
Total Dissolved Solids (mg/L)	90.0									*500*		*500*			
PCBs (µg/L)	0.0		*0.014*			*0.014*			*0.5*		*0.5*			*0.00017*	*0.00017*

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
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Poe-1A (Above Poe Reservoir)	December '99	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	10:15														
In situ Parameters															
Water Temperature (°C)	4.10														
Dissolved Oxygen (mg/L)	13.60												>7		
Specific Conductance (µmhos/cm)	110									900			150		
pH (Standard Units)	7.70							6.5-9.0					6.5-8.5		
Turbidity (NTU)	1.5									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (µg/L)	<5.0								50		10				
Barium (µg/L)	13								1,000		2,000			1,000	
Cadmium (µg/L)	<2.0		1.1990	1.6070		0.13726	0.84039		5		5				
Chromium (µg/L) [7]	<5.0		97.7284	819.9081		40.6904	851.3236		50		100				
Copper (µg/L)	<5.0		4.2637	5.9042		4.2637	5.9042		1,300	1,000	1,300	1,000		1,300	
Iron (µg/L)	95					1,000				300		300			
Lead (µg/L)	<5.0		0.9910	25.4304		0.9910	25.4304		15		15				
Manganese (µg/L)	15									50		50			100
Mercury (µg/L)	<0.0002								2		2			0.05	0.051
Selenium (µg/L)	<5.0		5	20		5			50		50			170	4,200
Silver (µg/L)	<3.6				0.8394			0.7826		100		100			
Zinc (µg/L)	3.40		55.1241	55.1241		55.1241	55.1241			5,000		5,000		7,400	26,000
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	4.0												200/400		
Ammonia - Total (mg/L) [5]	<0.50					3.58	9.64								
Total Hardness, as CaCO3 (mg/L)	40.0														
Chloride (mg/L) [9]	1.0					230	860			250		250			
Nitrate, as NO3 (mg/L) [8]	<0.10								45		10			10	
Alkalinity - Total (mg/L)	50.0					≥ 20									
Total Dissolved Solids (mg/L)	67.0									500		500			
PCBs (µg/L)	0.0		0.014			0.014			0.5		0.5			0.00017	0.00017

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

NQ = Not quantified

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

LE = Laboratory error in method of detection, no value to report

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. Criteria for CTR and USEPA chromium total recoverable expressed as chromium III
8. Criteria for total nitrate as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Poe-1A (Above Poe Reservoir)	March '00	Flag	California Toxics Rules Criteria (USEPA) [1] Freshwater Aquatic Life Protection			USEPA National Recommended [2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) [3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB [4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	9:40														
In situ Parameters															
Water Temperature (°C)	8.30														
Dissolved Oxygen (mg/L)	10.70												*>7*		
Specific Conductance (µmhos/cm)	85									*900*			*150*		
pH (Standard Units)	7.40							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	7.2									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (µg/L)	<3.2								*50*		*10*				
Barium (µg/L)	17								*1,000*		*2,000*			*1,000*	
Cadmium (µg/L)	<0.36		*1.2691*	*1.7436*		*0.14481*	*0.90451*		*5*		*5*				
Chromium (µg/L) [7]	<0.47		*103.6918*	*869.9388*		*43.1733*	*903.2712*		*50*		*100*				
Copper (µg/L)	<0.40		*4.5355*	*6.3205*		*4.5355*	*6.3205*		*1,300*	*1,000*	*1,300*	*1,000*		*1,300*	
Iron (µg/L)	280					*1,000*				*300*		*300*			
Lead (µg/L)	<1.3		*1.0866*	*27.8827*		*1.0866*	*27.8827*		*15*		*15*				
Manganese (µg/L)	25									*50*		*50*			*100*
Mercury (µg/L)	<0.0002								*2*		*2*			*0.05*	*0.051*
Selenium (µg/L)	<4.2		*5*	*20*		*5*			*50*		*50*			*170*	*4,200*
Silver (µg/L)	<0.36				*0.9505*			*0.8863*		*100*		*100*			
Zinc (µg/L)	<1.3		*58.6076*	*58.6076*		*58.6076*	*58.6076*			*5,000*		*5,000*		*7,400*	*26,000*
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	8.0												*200/400*		
Ammonia - Total (mg/L) [5]	<0.10					*4.73*	*15.34*								
Total Hardness, as CaCO3 (mg/L)	43.0														
Chloride (mg/L) [9]	<0.20					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L) [8]	<0.10								*45*		*10*			*10*	
Alkalinity - Total (mg/L)	50.0					*≥ 20*									
Total Dissolved Solids (mg/L)	110.0									*500*		*500*			
PCBs (µg/L)	0.0		*0.014*			*0.014*			*0.5*		*0.5*			*0.00017*	*0.00017*

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

NQ = Not quantified

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

LE = Laboratory error in method of detection, no value to report

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California (*California Toxics Rule*).
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Poe-2 (NFFR at Pulga)

	1999						2000
	March	June	July	August	September	December	March
Time	12:00	13:30	13:30	11:30	13:42	11:00	10:15
In situ Parameters							
Water Temperature (°C)	7.20	18.50	21.40	19.20	19.00	4.50	7.90
Dissolved Oxygen (DO), (mg/L)	12.20	8.30	10.10	8.20	9.10	10.20	11.20
DO Percent Saturation (%)	106	92	119	93	102	83	99
Specific Conductance (µmhos/cm)	93	94	109	106	125	110	83
pH	8.00	7.30	7.90	7.70	8.10	7.60	7.40
Turbidity (NTU)	6.00 [a]	1.2	0.9	1.5	2.2 [b]	1.3 [c]	3.9 [d]
Analytical Parameters							
Total Coliform (MPN/100 mL)	NS	NS	NS	NS	110	17	4
Fecal Coliform (MPN/100 mL)	NS	NS	NS	NS	4	2	2
Total Metals:							
Arsenic (µg/L)	<2.0	<5.0	<5.0	<5.0	<5.0	<5.0	<3.2
Barium (µg/L)	16	14	13	12	18	13	14
Cadmium (µg/L)	<0.50	<2.0	<2.0	<2.0	<2.0	<2.0	<0.36
Chromium (µg/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<0.47
Copper (µg/L)	3.1	<5.0	<5.0	<5.0	<5.0	<5.0	<0.40
Iron (µg/L)	260	88	31	79	190	69	150
Lead (µg/L)	<0.5	<5.0	<5.0	<5.0	<5.0	<5.0	<1.3
Manganese (µg/L)	14	15	16	22	26	11	7
Mercury (µg/L)	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
Selenium (µg/L)	<4.0	<5.0	<5.0	<5.0	<5.0	<5.0	<4.2
Silver (µg/L)	<0.50	0.1	<3.6	<3.6	0.74	<3.6	<0.36
Zinc (µg/L)	2.0	4.8	<1.3	<1.3	4.0	<1.3	<1.3
Ammonia - Total (mg/L)	<0.10	<0.50	<0.10	<0.10	<0.10	<0.50	<0.10
Total Hardness, as CaCO3 (mg/L)	35	39	43	40	59	41	36
Chloride (mg/L)	0.80	1.00	0.90	1.30	1.10	1.00	<0.20
Sulfate (mg/L)	2.20	4.00	1.60	1.60	2.10	2.00	2.00
Nitrate, as NO3 (mg/L)	<0.10	<1.0	<0.10	<0.10	<0.10	<0.10	<0.10
Alkalinity - Total (mg/L)	70	50	50	50	60	60	40
Total Dissolved Solids (mg/L)	76	74	55	74	53	LE	84
Total Suspended Solids (mg/L)	5.0	<1.3	<1.0	<1.0	1.7	<1.0	<1.0
Total Phosphorous (mg/L)	NS	<0.01	0.03	<1.0	<1.0	<0.01	0.04
Orthophosphate (mg/L)	<0.50	<0.01	0.02	<1.0	<0.01	<0.01	<0.01
Total Kjeldahl Nitrogen (mg/L)	<0.20	<0.50	<0.20	<0.20	<0.20	<0.50	<0.20
Total Organic Nitrogen (mg/L)	<0.20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.20
Total Calcium (mg/L)	8.10	9.20	9.30	9.00	11.00	11.00	7.10 J
Total Magnesium (mg/L)	3.40	4.40	4.70	4.40	5.40	5.30	4.80
Total Potassium (mg/L)	0.72	1.20	2.40	0.97	1.10	1.00	0.91
Total Sodium (mg/L)	3.10	4.90	4.30	3.60	5.20	4.40	4.50
Total Boron (mg/L)	<0.006	<0.0001	<0.0005	<0.0001	<0.0001	<0.0001	<0.10
Silica (mg/L)	18.0	13.0	13.0	12.4	13.0	14.0	16.0
MBAS (mg/L)	<0.025	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
PCBs							
Aroclor 1016 (µg/L)	NS	NS	NS	NS	NS	NS	NS
Aroclor 1221 (µg/L)	NS	NS	NS	NS	NS	NS	NS
Aroclor 1232 (µg/L)	NS	NS	NS	NS	NS	NS	NS
Aroclor 1242 (µg/L)	NS	NS	NS	NS	NS	NS	NS
Aroclor 1248 (µg/L)	NS	NS	NS	NS	NS	NS	NS
Aroclor 1254 (µg/L)	NS	NS	NS	NS	NS	NS	NS
Aroclor 1260 (µg/L)	NS	NS	NS	NS	NS	NS	NS

Sequoia Laboratory in Pleasant Hill analyzed samples from March 1999 for metals and nutrients, all other samples were analyzed by Chromalab in Pleasanton for metals and nutrients.

Monarch Lab in Chico analyzed coliform samples

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.

J values applicable to 2000 data only, this is when the lab started to report J flag values

<VALUE = less than the detection limit for 1999 data, less than the MDL for 2000 data

NS = Constituent not sampled for during monitoring program

NQ = Not quantified

LE = Laboratory error in method of detection, no value to report

[a] = raining during sampling event, lots of tributary runoff to main stem.

[b] = smoke from fire in project area

[c] = flows near minimum levels

[d] =Flows controlled, no spill

Poe-2 (NFFR at Pulga)	March '99	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	12:00														
In situ Parameters															
Water Temperature (°C)	7.20														
Dissolved Oxygen (mg/L)	12.20												*>7*		
Specific Conductance (µmhos/cm)	93									*900*			*150*		
pH (Standard Units)	8.00							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	6.0									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter)[6]															
Arsenic (µg/L)	<2.0								*50*		*10*				
Barium (µg/L)	16								*1,000*		*2,000*			*1,000*	
Cadmium (µg/L)	<0.50		*1.0797*	*1.3823*		*0.12433*	*0.73372*		*5*		*5*				
Chromium (µg/L)[7]	<5.0		*87.6043*	*734.9703*		*36.4751*	*763.1313*		*50*		*100*				
Copper (µg/L)	3.1		*3.8040*	*5.2062*		*3.8040*	*5.2062*		*1,300*	*1,000*	*1,300*	*1,000*		*1,300*	
Iron (µg/L)	260					*1,000*				*300*		*300*			
Lead (µg/L)	<0.5		*0.8361*	*21.4550*		*0.8361*	*21.4550*		*15*		*15*				
Manganese (µg/L)	14									*50*		*50*			*100*
Mercury (µg/L)	<0.0002								*2*		*2*			*0.05*	*0.051*
Selenium (µg/L)	<4.0		*5*	*20*		*5*			*50*		*50*			*170*	*4,200*
Silver (µg/L)	<0.50				*0.6671*			*0.6220*		*100*		*100*			
Zinc (µg/L)	2.00		*49.2272*	*49.2272*		*49.2272*	*49.2272*			*5,000*		*5,000*		*7,400*	*26,000*
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL)[10]	NS												*200/400*		
Ammonia - Total (mg/L)[5]	<0.10					*2.43*	*5.62*								
Total Hardness, as CaCO3 (mg/L)	35.0														
Chloride (mg/L)[9]	0.8					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L)[8]	<0.10								*45*		*10*			*10*	
Alkalinity - Total (mg/L)	70.0					*≥ 20*									
Total Dissolved Solids (mg/L)	76.0									*500*		*500*			
PCBs (µg/L)	0.0		*0.014*			*0.014*			*0.5*		*0.5*			*0.00017*	*0.00017*

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

NQ = Not quantified

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

LE = Laboratory error in method of detection, no value to report

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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7. Criteria for CTR and USEPA chromium total recoverable expressed as chromium III
8. Criteria for total nitrate as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Poe-2 (NFFR at Pulga)	June '99	Flag	California Toxics Rules Criteria (USEPA) [1] Freshwater Aquatic Life Protection			USEPA National Recommended [2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) [3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB [4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	13:30														
In situ Parameters															
Water Temperature (°C)	18.50														
Dissolved Oxygen (mg/L)	8.30												>7		
Specific Conductance (µmhos/cm)	94									900			150		
pH (Standard Units)	7.30							6.5-9.0					6.5-8.5		
Turbidity (NTU)	1.2									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (µg/L)	<5.0								50		10				
Barium (µg/L)	14								1,000		2,000			1,000	
Cadmium (µg/L)	<2.0		1.1754	1.5617		0.13471	0.81904		5		5				
Chromium (µg/L) [7]	<5.0		95.7228	803.0821		39.8554	833.8529		50		100				
Copper (µg/L)	<5.0		4.1725	5.7650		4.1725	5.7650		1,300	1,000	1,300	1,000		1,300	
Iron (µg/L)	88					1,000				300		300			
Lead (µg/L)	<5.0		0.9596	24.6238		0.9596	24.6238		15		15				
Manganese (µg/L)	15									50		50			100
Mercury (µg/L)	<0.0005								2		2			0.05	0.051
Selenium (µg/L)	<5.0		5	20		5			50		50			170	4,200
Silver (µg/L)	0.10				0.8036			0.7493		100		100			
Zinc (µg/L)	4.80		53.9542	53.9542		53.9542	53.9542			5,000		5,000		7,400	26,000
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	NS												200/400		
Ammonia - Total (mg/L) [5]	<0.50					3.93	17.51								
Total Hardness, as $CaCO_3$ (mg/L)	39.0														
Chloride (mg/L) [9]	1.0					230	860			250		250			
Nitrate, as NO_3 (mg/L) [8]	<1.0								45		10			10	
Alkalinity - Total (mg/L)	50.0					≥ 20									
Total Dissolved Solids (mg/L)	74.0									500		500			
PCBs (µg/L)	0.0		0.014			0.014			0.5		0.5			0.00017	0.00017

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL
and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
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9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Poe-2 (NFFR at Pulga)	July '99	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	13:30														
In situ Parameters															
Water Temperature (°C)	21.40														
Dissolved Oxygen (mg/L)	10.10												*>7*		
Specific Conductance (μmhos/cm)	109									*900*			*150*		
pH (Standard Units)	7.90							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	0.9									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (μg/L)	<5.0								*50*		*10*				
Barium (μg/L)	13								*1,000*		*2,000*			*1,000*	
Cadmium (μg/L)	<2.0		*1.2691*	*1.7436*		*0.14481*	*0.90451*		*5*		*5*				
Chromium (μg/L) [7]	<5.0		*103.6918*	*869.9388*		*43.1733*	*903.2712*		*50*		*100*				
Copper (μg/L)	<5.0		*4.5355*	*6.3205*		*4.5355*	*6.3205*		*1,300*	*1,000*	*1,300*	*1,000*		*1,300*	
Iron (μg/L)	31					*1,000*				*300*		*300*			
Lead (μg/L)	<5.0		*1.0866*	*27.8827*		*1.0866*	*27.8827*		*15*		*15*				
Manganese (μg/L)	16.0									*50*		*50*			*100*
Mercury (μg/L)	<0.0005								*2*		*2*			*0.05*	*0.051*
Selenium (μg/L)	<5.0		*5*	*20*		*5*			*50*		*50*			*170*	*4,200*
Silver (μg/L)	<3.6				*0.9505*			*0.8863*		*100*		*100*			
Zinc (μg/L)	<1.3		*58.6076*	*58.6076*		*58.6076*	*58.6076*			*5,000*		*5,000*		*7,400*	*26,000*
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	NS												*200/400*		
Ammonia - Total (mg/L) [5]	<0.10					*1.80*	*6.77*								
Total Hardness, as CaCO3 (mg/L)	43.0														
Chloride (mg/L) [9]	0.9					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L) [8]	<0.10								*45*		*10*			*10*	
Alkalinity - Total (mg/L)	50.0					*≥ 20*									
Total Dissolved Solids (mg/L)	55.0									*500*		*500*			
PCBs (μg/L)	0.0		*0.014*			*0.014*			*0.5*		*0.5*			*0.00017*	*0.00017*

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

NQ = Not quantified

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

LE = Laboratory error in method of detection, no value to report

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
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5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. Criteria for CTR and USEPA chromium total recoverable expressed as chromium III
8. Criteria for total nitrate as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Poe-2 (NFFR at Pulga)	August '99	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	11:30														
In situ Parameters															
Water Temperature (°C)	19.20														
Dissolved Oxygen (mg/L)	8.20												>7		
Specific Conductance (µmhos/cm)	106									900			150		
pH (Standard Units)	7.70							6.5-9.0					6.5-8.5		
Turbidity (NTU)	1.5									5					
Analytical Parameters															
Total Metals (units of milligrams per liter)[6]															
Arsenic (µg/L)	<5.0								50		10				
Barium (µg/L)	12								1,000		2,000			1,000	
Cadmium (µg/L)	<2.0		1.1990	1.6070		0.13726	0.84039		5		5				
Chromium (µg/L)[7]	<5.0		97.7284	819.9081		40.6904	851.3236		50		100				
Copper (µg/L)	<5.0		4.2637	5.9042		4.2637	5.9042		1,300	1,000	1,300	1,000		1,300	
Iron (µg/L)	79					1,000				300		300			
Lead (µg/L)	<5.0		0.9910	25.4304		0.9910	25.4304		15		15				
Manganese (µg/L)	22									50		50			100
Mercury (µg/L)	<0.0002								2		2			0.05	0.051
Selenium (µg/L)	<5.0		5	20		5			50		50			170	4,300
Silver (µg/L)	<3.6				0.8394			0.7826		100		100			
Zinc (µg/L)	<1.3		55.1241	55.1241		55.1241	55.1241			5,000		5,000		7,400	26,000
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL)[10]	NS												200/400		
Ammonia - Total (mg/L)[5]	<0.10					2.65	9.64								
Total Hardness, as CaCO3 (mg/L)	40.0														
Chloride (mg/L)[9]	1.3					230	860			250		250			
Nitrate, as NO3 (mg/L)[8]	<0.10								45		10			10	
Alkalinity - Total (mg/L)	50.0					≥ 20									
Total Dissolved Solids (mg/L)	74.0									500		500			
PCBs (µg/L)	0.0		0.014			0.014			0.5		0.5			0.00017	0.00017

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

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NQ = Not quantified

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

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3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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7. Criteria for CTR and USEPA chromium total recoverable expressed as chromium III
8. Criteria for total nitrate as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Poe-2 (NFFR at Pulga)	September '99	Flag	California Toxics Rules Criteria (USEPA) [1] Freshwater Aquatic Life Protection			USEPA National Recommended [2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) [3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB [4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	13:42														
In situ Parameters															
Water Temperature (°C)	19.00														
Dissolved Oxygen (mg/L)	9.10												*>7*		
Specific Conductance (µmhos/cm)	125									*900*			*150*		
pH (Standard Units)	8.10							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	2.2									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (µg/L)	<5.0								*50*		*10*				
Barium (µg/L)	18								*1,000*		*2,000*			*1,000*	
Cadmium (µg/L)	<2.0		*1.6269*	*2.4912*		*0.18306*	*1.24760*		*5*		*5*				
Chromium (µg/L) [7]	<5.0		*134.3574*	*1127.2126*		*55.9413*	*1170.4027*		*50*		*100*				
Copper (µg/L)	<5.0		*5.9432*	*8.5152*		*5.9432*	*8.5152*		*1,300*	*1,000*	*1,300*	*1,000*		*1,300*	
Iron (µg/L)	190					*1,000*				*300*		*300*			
Lead (µg/L)	<5.0		*1.6253*	*41.7085*		*1.6253*	*41.7085*		*15*		*15*				
Manganese (µg/L)	26									*50*		*50*			*100*
Mercury (µg/L)	<0.0002								*2*		*2*			*0.05*	*0.051*
Selenium (µg/L)	<5.0		*5*	*20*		*5*			*50*		*50*			*170*	*4,200*
Silver (µg/L)	0.74				*1.6378*			*1.5271*		*100*		*100*			
Zinc (µg/L)	4.00		*76.6230*	*76.6230*		*76.6230*	*76.6230*			*5,000*		*5,000*		*7,400*	*26,000*
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	4.0												*200/400*		
Ammonia - Total (mg/L) [5]	<0.10					*1.57*	*4.64*								
Total Hardness, as CaCO3 (mg/L)	59.0														
Chloride (mg/L) [9]	1.1					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L) [8]	<0.10								*45*		*10*			*10*	
Alkalinity - Total (mg/L)	60.0					*≥ 20*									
Total Dissolved Solids (mg/L)	53.0									*500*		*500*			
PCBs (µg/L)	0.0		*0.014*			*0.014*			*0.5*		*0.5*			*0.00017*	*0.00017*

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

NQ = Not quantified

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

LE = Laboratory error in method of detection, no value to report

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8. Criteria for total nitrate as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Poe-2 (NFFR at Pulga)	December '99	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	11:00														
In situ Parameters															
Water Temperature (°C)	4.50														
Dissolved Oxygen (mg/L)	10.20												*>7*		
Specific Conductance (µmhos/cm)	110									*900*			*150*		
pH (Standard Units)	7.60							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	1.3									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (µg/L)	<5.0								*50*		*10*				
Barium (µg/L)	13								*1,000*		*2,000*			*1,000*	
Cadmium (µg/L)	<2.0		*1.2225*	*1.6524*		*0.13979*	*0.86176*		*5*		*5*				
Chromium (µg/L) [7]	<5.0		*99.7249*	*836.6581*		*41.5217*	*868.7154*		*50*		*100*				
Copper (µg/L)	<5.0		*4.3547*	*6.0432*		*4.3547*	*6.0432*		*1,300*	*1,000*	*1,300*	*1,000*		*1,300*	
Iron (µg/L)	69					*1,000*				*300*		*300*			
Lead (µg/L)	<5.0		*1.0226*	*26.2424*		*1.0226*	*26.2424*		*15*		*15*				
Manganese (µg/L)	11									*50*		*50*			*100*
Mercury (µg/L)	<0.0002								*2*		*2*			*0.05*	*0.051*
Selenium (µg/L)	<5.0		*5*	*20*		*5*			*50*		*50*			*170*	*4,200*
Silver (µg/L)	<3.6				*0.8758*			*0.8166*		*100*		*100*			
Zinc (µg/L)	<1.3		*56.2896*	*56.2896*		*56.2896*	*56.2896*			*5,000*		*5,000*		*7,400*	*26,000*
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	2.0												*200/400*		
Ammonia - Total (mg/L) [5]	<0.50					*3.98*	*11.37*								
Total Hardness, as CaCO3 (mg/L)	41.0														
Chloride (mg/L) [9]	1.0					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L) [8]	<0.10								*45*		*10*			*10*	
Alkalinity - Total (mg/L)	60.0					*≥ 20*									
Total Dissolved Solids (mg/L)	LE									*500*		*500*			
PCBs (µg/L)	0.0		*0.014*			*0.014*			*0.5*		*0.5*			*0.00017*	*0.00017*

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL
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Shaded cells represent exceedances of the criteria
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9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
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Poe-2 (NFFR at Pulga)	March '00	Flag	California Toxics Rules Criteria (USEPA) [1] Freshwater Aquatic Life Protection			USEPA National Recommended [2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) [3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB [4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	10:15														
In situ Parameters															
Water Temperature (°C)	7.90														
Dissolved Oxygen (mg/L)	11.20												*>7*		
Specific Conductance (µmhos/cm)	83									*900*			*150*		
pH (Standard Units)	7.40							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	3.9									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (µg/L)	<3.2								*50*		*10*				
Barium (µg/L)	14								*1,000*		*2,000*			*1,000*	
Cadmium (µg/L)	<0.36		*1.1038*	*1.4269*		*0.12695*	*0.75503*		*5*		*5*				
Chromium (µg/L) [7]	<0.47		*89.6490*	*752.1246*		*37.3264*	*780.9429*		*50*		*100*				
Copper (µg/L)	<0.40		*3.8966*	*5.3462*		*3.8966*	*5.3462*		*1,300*	*1,000*	*1,300*	*1,000*		*1,300*	
Iron (µg/L)	150					*1,000*				*300*		*300*			
Lead (µg/L)	<1.3		*0.8666*	*22.2384*		*0.8666*	*22.2384*		*15*		*15*				
Manganese (µg/L)	7									*50*		*50*			*100*
Mercury (µg/L)	<0.0002								*2*		*2*			*0.05*	*0.051*
Selenium (µg/L)	<4.2		*5*	*20*		*5*			*50*		*50*			*170*	*4,200*
Silver (µg/L)	<0.36				*0.7002*			*0.6529*		*100*		*100*			
Zinc (µg/L)	<1.3		*50.4164*	*50.4164*		*50.4164*	*50.4164*			*5,000*		*5,000*		*7,400*	*26,000*
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	2.0												*200/400*		
Ammonia - Total (mg/L) [5]	<0.10					*4.73*	*15.34*								
Total Hardness, as CaCO3 (mg/L)	36.0														
Chloride (mg/L) [9]	<0.20					*230*	*860*			*250*		*350*			
Nitrate, as NO3 (mg/L) [8]	<0.10								*45*		*10*			*10*	
Alkalinity - Total (mg/L)	40.0					*≥ 20*									
Total Dissolved Solids (mg/L)	84.0									*500*		*500*			
PCBs (µg/L)	0.0		*0.014*			*0.014*			*0.5*		*0.5*			*0.00017*	*0.00017*

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10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Poe-3 (Above Poe Powerhouse)

	1999						2000
	March	June	July	August	September	December	March
Time	13:00	14:30	9:40	12:30	10:30	12:00	11:30
In situ Parameters							
Water Temperature (°C)	7.90	20.00	21.50	20.50	18.00	5.10	10.80
Dissolved Oxygen (DO), (mg/L)	11.80	8.40	9.50	8.40	8.50	12.00	10.70
DO Percent Saturation (%)	102	94	110	96	92	97	99
Specific Conductance (μmhos/cm)	88	107	114	113	130	113	94
pH	7.90	7.30	7.80	7.70	7.70	7.60	7.60
Turbidity (NTU)	6.70 [a]	1.1	0.9	0.8	1.5 [b]	1.5 [c]	2.8 [d]
Analytical Parameters							
Total Coliform (MPN/100 mL)	23	NQ [e]	500	22	30	8	2
Fecal Coliform (MPN/100 mL)	4	NQ [e]	13	4	4	<2	<2
Total Metals:							
Arsenic (μg/L)	<2.0	<5.0	<5.0	<5.0	<5.0	<5.0	<3.2
Barium (μg/L)	15	16	16	14	21	13	15
Cadmium (μg/L)	<0.50	<2.0	<2.0	<2.0	<2.0	<2.0	<0.36
Chromium (μg/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<0.47
Copper (μg/L)	2.8	<5.0	<5.0	<5.0	<5.0	<5.0	<0.40
Iron (μg/L)	230	96	49	27	310	18	93
Lead (μg/L)	<0.5	<5.0	<5.0	<5.0	<5.0	<5.0	<1.3
Manganese (μg/L)	12	7.8	10	9.3	21	8.2	<0.46
Mercury (μg/L)	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
Selenium (μg/L)	<4.0	<5.0	<5.0	<5.0	<5.0	<5.0	<4.2
Silver (μg/L)	<0.50	0.1	<3.6	<3.6	0.67	<3.6	<0.36
Zinc (μg/L)	4.6	2.0	<1.3	<1.3	<1.3	<1.3	<1.3
Ammonia - Total (mg/L)	<0.10	<0.50	<0.10	<0.10	<0.10	<0.50	<0.10
Total Hardness, as CaCO3 (mg/L)	38	42	45	46	58	42	37
Chloride (mg/L)	0.80	1.00	1.10	0.90	1.00	1.00	<0.20
Sulfate (mg/L)	2.20	4.00	1.00	1.70	2.00	2.00	2.00
Nitrate, as NO3 (mg/L)	<0.10	<1.0	<0.10	<0.10	<0.10	<0.10	<0.10
Alkalinity - Total (mg/L)	44	50	50	60	60	60	50
Total Dissolved Solids (mg/L)	68	66	56	62	80	69	87
Total Suspended Solids (mg/L)	7.0	<1.3	<1.0	<1.0	<1.0	<1.0	<1.0
Total Phosphorous (mg/L)	NS	<0.01	0.05	<1.0	<1.0	<0.01	<0.01
Orthophosphate (mg/L)	<0.50	<0.01	0.02	<1.0	<0.01	<0.01	<0.01
Total Kjeldahl Nitrogen (mg/L)	<0.20	<0.50	<0.20	<0.20	<0.20	<0.50	<0.20
Total Organic Nitrogen (mg/L)	<0.20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.20
Total Calcium (mg/L)	8.50	9.80	9.90	9.70	12.00	10.00	8.40
Total Magnesium (mg/L)	3.40	5.00	5.20	5.00	5.70	5.90	5.80
Total Potassium (mg/L)	0.64	1.20	1.90	1.10	1.10	1.00	1.00
Total Sodium (mg/L)	2.90	4.40	3.90	3.60	5.00	3.80	4.30
Total Boron (mg/L)	<0.006	<0.0001	<0.0005	<0.0001	<0.0001	<0.0001	<0.1
Silica (mg/L)	17.0	13.0	12.0	12.4	12.0	13.0	16.0
MBAS (mg/L)	<0.025	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
PCBs							
Aroclor 1016 (μg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Aroclor 1221 (μg/L)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Aroclor 1232 (μg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Aroclor 1242 (μg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Aroclor 1248 (μg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Aroclor 1254 (μg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Aroclor 1260 (μg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Sequoia Laboratory in Pleasant Hill analyzed samples from March 1999 for metals and nutrients, all other samples were analyzed by Chromalab in Pleasanton for metals and nutrients.

Monarch Lab in Chico analyzed coliform samples

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.

J values applicable to 2000 data only, this is when the lab started to report J flag values

<VALUE = less than the detection limit for 1999 data, less than the MDL for 2000 data

NS = Constituent not sampled for during monitoring program

NQ = Not quantified

LE = Laboratory error in method of detection, no value to report

[a] = raining during sampling event, lots of tributary runoff to main stem.

[b] = smoke from fire in project area

[c] = flows near minimum levels

[d] = Flows controlled, no spill

[e] = Laboratory error in method of detection, coliform present but unable to quantify due to laboratory error

Poe-3 (Above Poe Powerhouse)	March '99	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantanaous Max*	*CCC*	*CMC*	*Instantanaous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	13:00														
In situ Parameters															
Water Temperature (°C)	7.90														
Dissolved Oxygen (mg/L)	11.80												*>7*		
Specific Conductance (μmhos/cm)	88									*900*			*150*		
pH (Standard Units)	7.90							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	6.7									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (μg/L)	<2.0								*50*		*10*				
Barium (μg/L)	15								*1,000*		*2,000*			*1,000*	
Cadmium (μg/L)	<0.50		*1.1517*	*1.5166*		*0.13214*	*0.79769*		*5*		*5*				
Chromium (μg/L) [7]	<5.0		*93.7080*	*786.1779*		*39.0164*	*816.3009*		*50*		*100*				
Copper (μg/L)	2.8		*4.0809*	*5.6256*		*4.0809*	*5.6256*		*1,300*	*1,000*	*1,300*	*1,000*		*1,300*	
Iron (μg/L)	230					*1,000*				*300*		*300*			
Lead (μg/L)	<0.5		*0.9283*	*23.8229*		*0.9283*	*23.8229*		*15*		*15*				
Manganese (μg/L)	12									*50*		*50*			*100*
Mercury (μg/L)	<0.0002								*2*		*2*			*0.05*	*0.051*
Selenium (μg/L)	<4.0		*5*	*20*		*5*			*50*		*50*			*170*	*4,200*
Silver (μg/L)	<0.50				*0.7685*			*0.7165*		*100*		*100*			
Zinc (μg/L)	4.60		*52.7797*	*52.7797*		*52.7797*	*52.7797*			*5,000*		*5,000*		*7,400*	*26,000*
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	4.0												*200/400*		
Ammonia - Total (mg/L) [5]	<0.10					*2.80*	*6.77*								
Total Hardness, as CaCO3 (mg/L)	38.0														
Chloride (mg/L) [9]	0.8					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L) [8]	<0.10								*45*		*10*			*10*	
Alkalinity - Total (mg/L)	44.0					*≥ 20*									
Total Dissolved Solids (mg/L)	68.0									*500*		*500*			
PCBs (μg/L)	0.0		*0.014*			*0.014*			*0.5*		*0.5*			*0.00017*	*0.00017*

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

NQ = Not quantified

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

LE = Laboratory error in method of detection, no value to report

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. Criteria for CTR and USEPA chromium total recoverable expressed as chromium III
8. Criteria for total nitrate as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Poe-3 (Above Poe Powerhouse)	June '99	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	14:30														
In situ Parameters															
Water Temperature (°C)	20.00														
Dissolved Oxygen (mg/L)	8.40												>7		
Specific Conductance (µmhos/cm)	107									900			150		
pH (Standard Units)	7.30							6.5-9.0					6.5-8.5		
Turbidity (NTU)	1.1									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (µg/L)	<5.0								50		10				
Barium (µg/L)	16								1,000		2,000			1,000	
Cadmium (µg/L)	<2.0		1.2459	1.6979		0.14231	0.88313		5		5				
Chromium (µg/L) [7]	<5.0		101.7126	853.3343		42.3493	886.0305		50		100				
Copper (µg/L)	<5.0		4.4453	6.1819		4.4453	6.1819		1,300	1,000	1,300	1,000		1,300	
Iron (µg/L)	96					1,000				300		300			
Lead (µg/L)	<5.0		1.0545	27.0599		1.0545	27.0599		15		15				
Manganese (µg/L)	8									50		50			100
Mercury (µg/L)	<0.0005								2		2			0.05	0.051
Selenium (µg/L)	<5.0		5	20		5			50		50			170	4,200
Silver (µg/L)	0.10				0.9128			0.8511		100		100			
Zinc (µg/L)	2.00		57.4507	57.4507		57.4507	57.4507			5,000		5,000		7,400	26,000
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	NQ												200/400		
Ammonia - Total (mg/L) [5]	<0.50					3.57	17.51								
Total Hardness, as CaCO3 (mg/L)	42.0														
Chloride (mg/L) [9]	1.0					230	860			250		250			
Nitrate, as NO3 (mg/L) [8]	<1.0								45		10			10	
Alkalinity - Total (mg/L)	50.0					≥ 20									
Total Dissolved Solids (mg/L)	66.0									500		500			
PCBs (µg/L)	0.0		0.014			0.014			0.5		0.5			0.00017	0.00017

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

NQ = Not quantified

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

LE = Laboratory error in method of detection, no value to report

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. Criteria for CTR and USEPA chromium total recoverable expressed as chromium III
8. Criteria for total nitrate as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Poe-3 (Above Poe Powerhouse)	July '99	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	9:40														
In situ Parameters															
Water Temperature (°C)	21.50														
Dissolved Oxygen (mg/L)	9.50												*>7*		
Specific Conductance (µmhos/cm)	114									*900*			*150*		
pH (Standard Units)	7.80							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	0.9									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (µg/L)	<5.0								*50*		*10*				
Barium (µg/L)	16								*1,000*		*2,000*			*1,000*	
Cadmium (µg/L)	<2.0		*1.3152*	*1.8353*		*0.14977*	*0.94729*		*5*		*5*				
Chromium (µg/L) [7]	<5.0		*107.6254*	*902.9404*		*44.8111*	*937.5373*		*50*		*100*				
Copper (µg/L)	<5.0		*4.7152*	*6.5971*		*4.7152*	*6.5971*		*1,300*	*1,000*	*1,300*	*1,000*		*1,300*	
Iron (µg/L)	49					*1,000*				*300*		*300*			
Lead (µg/L)	<5.0		*1.1513*	*29.5440*		*1.1513*	*29.5440*		*15*		*15*				
Manganese (µg/L)	10.0									*50*		*50*			*100*
Mercury (µg/L)	<0.0005								*2*		*2*			*0.05*	*0.051*
Selenium (µg/L)	<5.0		*5*	*20*		*5*			*50*		*50*			*170*	*4,200*
Silver (µg/L)	<3.6				*1.0278*			*0.9584*		*100*		*100*			
Zinc (µg/L)	<1.3		*60.9093*	*60.9093*		*60.9093*	*60.9093*			*5,000*		*5,000*		*7,400*	*26,000*
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	13.0												*200/400*		
Ammonia - Total (mg/L) [5]	<0.10					*2.03*	*8.11*								
Total Hardness, as CaCO3 (mg/L)	45.0														
Chloride (mg/L) [9]	1.1					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L) [8]	<0.10								*45*		*10*			*10*	
Alkalinity - Total (mg/L)	50.0					*≥ 20*									
Total Dissolved Solids (mg/L)	56.0									*500*		*500*			
PCBs (µg/L)	0.0		*0.014*			*0.014*			*0.5*		*0.5*			*0.00017*	*0.00017*

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
NQ = Not quantified
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)
LE = Laboratory error in method of detection, no value to report

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
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8. Criteria for total nitrate as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 / 100 mL.

Poe-3 (Above Poe Powerhouse)	August '99	Flag	California Toxics Rules Criteria (USEPA) [1] Freshwater Aquatic Life Protection			USEPA National Recommended [2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) [3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB [4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	12:30														
In situ Parameters															
Water Temperature (°C)	20.50														
Dissolved Oxygen (mg/L)	8.40												>7		
Specific Conductance (µmhos/cm)	113									900			150		
pH (Standard Units)	7.70							6.5-9.0					6.5-8.5		
Turbidity (NTU)	0.8									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (µg/L)	<5.0								50		10				
Barium (µg/L)	14								1,000		2,000			1,000	
Cadmium (µg/L)	<2.0		1.3381	1.8814		0.15223	0.96870		5		5				
Chromium (µg/L) [7]	<5.0		109.5803	919.3412		45.6251	954.5665		50		100				
Copper (µg/L)	<5.0		4.8046	6.7352		4.8046	6.7352		1,300	1,000	1,300	1,000		1,300	
Iron (µg/L)	27					1,000				300		300			
Lead (µg/L)	<5.0		1.1840	30.3823		1.1840	30.3823		15		15				
Manganese (µg/L)	9									50		50			100
Mercury (µg/L)	<0.0002								2		2			0.05	0.051
Selenium (µg/L)	<5.0		5	20		5			50		50			170	4,200
Silver (µg/L)	<3.6				1.0674			0.9953		100		100			
Zinc (µg/L)	<1.3		62.0542	62.0542		62.0542	62.0542			5,000		5,000		7,400	26,000
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	4.0												200/400		
Ammonia - Total (mg/L) [5]	<0.10					2.43	9.64								
Total Hardness, as CaCO3 (mg/L)	46.0														
Chloride (mg/L) [9]	0.9					230	860			250		250			
Nitrate, as NO3 (mg/L) [8]	<0.10								45		10			10	
Alkalinity - Total (mg/L)	60.0					≥ 20									
Total Dissolved Solids (mg/L)	62.0									500		500			
PCBs (µg/L)	0.0		0.014			0.014			0.5		0.5			0.00017	0.00017

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

NQ = Not quantified

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

LE = Laboratory error in method of detection, no value to report

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. Criteria for CTR and USEPA chromium total recoverable expressed as chromium III
8. Criteria for total nitrate as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Poe-3 (Above Poe Powerhouse)	September '99	Flag	California Toxics Rules Criteria (USEPA) [1] Freshwater Aquatic Life Protection			USEPA National Recommended [2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) [3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB [4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	10:30														
In situ Parameters															
Water Temperature (°C)	18.00														
Dissolved Oxygen (mg/L)	8.50												>7		
Specific Conductance (μmhos/cm)	130									900			150		
pH (Standard Units)	7.70							6.5-9.0					6.5-8.5		
Turbidity (NTU)	1.5									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (μg/L)	<5.0								50		10				
Barium (μg/L)	21								1,000		2,000			1,000	
Cadmium (μg/L)	<2.0		1.6052	2.4436		0.18075	1.22611		5		5				
Chromium (μg/L) [7]	<5.0		132.4894	1111.5412		55.1636	1154.1308		50		100				
Copper (μg/L)	<5.0		5.8571	8.3792		5.8571	8.3792		1,300	1,000	1,300	1,000		1,300	
Iron (μg/L)	310					1,000				300		300			
Lead (μg/L)	<5.0		1.5903	40.8107		1.5903	40.8107		15		15				
Manganese (μg/L)	21									50		50			100
Mercury (μg/L)	<0.0002								2		2			0.05	0.051
Selenium (μg/L)	<5.0		5	20		5			50		50			170	4,200
Silver (μg/L)	0.67				1.5904			1.4828		100		100			
Zinc (μg/L)	<1.3		75.5212	75.5212		75.5212	75.5212			5,000		5,000		7,400	26,000
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	4.0												200/400		
Ammonia - Total (mg/L) [5]	<0.10					2.86	9.64								
Total Hardness, as CaCO3 (mg/L)	58.0														
Chloride (mg/L) [9]	1.0					230	860			250		250			
Nitrate, as NO3 (mg/L) [8]	<0.10								45		10			10	
Alkalinity - Total (mg/L)	60.0					≥ 20									
Total Dissolved Solids (mg/L)	80.0									500		500			
PCBs (μg/L)	0.0		0.014			0.014			0.5		0.5			0.00017	0.00017

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

NQ = Not quantified

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

LE = Laboratory error in method of detection, no value to report

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. Criteria for CTR and USEPA chromium total recoverable expressed as chromium III
8. Criteria for total nitrate as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 /100 mL.

Poe-3 (Above Poe Powerhouse)	December '99	Flag	California Toxics Rules Criteria (USEPA) [1] Freshwater Aquatic Life Protection			USEPA National Recommended [2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) [3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB [4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	12:00														
In situ Parameters															
Water Temperature (°C)	5.10														
Dissolved Oxygen (mg/L)	12.00												>7		
Specific Conductance (µmhos/cm)	113									900			150		
pH (Standard Units)	7.60							6.5-9.0					6.5-8.5		
Turbidity (NTU)	1.5									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (µg/L)	<5.0								50		10				
Barium (µg/L)	13								1,000		2,000			1,000	
Cadmium (µg/L)	<2.0		1.2459	1.6979		0.14231	0.88313		5		5				
Chromium (µg/L) [7]	<5.0		101.7126	853.3343		42.3493	886.0305		50		100				
Copper (µg/L)	<5.0		4.4453	6.1819		4.4453	6.1819		1,300	1,000	1,300	1,000		1,300	
Iron (µg/L)	18					1,000				300		300			
Lead (µg/L)	<5.0		1.0545	27.0599		1.0545	27.0599		15		15				
Manganese (µg/L)	8									50		50			100
Mercury (µg/L)	<0.0002								2		2			0.05	0.051
Selenium (µg/L)	<5.0		5	20		5			50		50			170	4,200
Silver (µg/L)	<3.6				0.9128			0.8511		100		100			
Zinc (µg/L)	<1.3		57.4507	57.4507		57.4507	57.4507			5,000		5,000		7,400	26,000
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	<2												200/400		
Ammonia - Total (mg/L) [5]	<0.50					3.98	11.37								
Total Hardness, as CaCO3 (mg/L)	42.0														
Chloride (mg/L) [9]	1.0					230	860			250		250			
Nitrate, as NO3 (mg/L) [8]	<0.10								45		10			10	
Alkalinity - Total (mg/L)	60.0					≥ 20									
Total Dissolved Solids (mg/L)	69.0									500		500			
PCBs (µg/L)	0.0		0.014			0.014			0.5		0.5			0.00017	0.00017

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
NQ = Not quantified
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)
LE = Laboratory error in method of detection, no value to report

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. Criteria for CTR and USEPA chromium total recoverable expressed as chromium III
8. Criteria for total nitrate as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 / 100 mL.

Poe-3 (Above Poe Powerhouse)	March '00	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	11:30														
In situ Parameters															
Water Temperature (°C)	10.80														
Dissolved Oxygen (mg/L)	10.70												*>7*		
Specific Conductance (μmhos/cm)	94									*900*			*150*		
pH (Standard Units)	7.60							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	2.8									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (μg/L)	<3.2								*50*		*10*				
Barium (μg/L)	15								*1,000*		*2,000*			*1,000*	
Cadmium (μg/L)	<0.36		*1.1278*	*1.4717*		*0.12955*	*0.77636*		*5*		*5*				
Chromium (μg/L) [7]	<0.47		*91.6834*	*769.1929*		*38.1735*	*798.6651*		*50*		*100*				
Copper (μg/L)	<0.40		*3.9890*	*5.4860*		*3.9890*	*5.4860*		*1,300*	*1,000*	*1,300*	*1,000*		*1,300*	
Iron (μg/L)	93					*1,000*				*300*		*300*			
Lead (μg/L)	<1.3		*0.8974*	*23.0277*		*0.8974*	*23.0277*		*15*		*15*				
Manganese (μg/L)	<0.46									*50*		*50*			*100*
Mercury (μg/L)	<0.0002								*2*		*2*			*0.05*	*0.051*
Selenium (μg/L)	<4.2		*5*	*20*		*5*			*50*		*50*			*170*	*4,200*
Silver (μg/L)	<0.36				*0.7340*			*0.6844*		*100*		*100*			
Zinc (μg/L)	<1.3		*51.6005*	*51.6005*		*51.6005*	*51.6005*			*5,000*		*5,000*		*7,400*	*26,000*
Additional Analytical Parameters															
Fecal Coliform (MPN/100mL) [10]	<2												*200/400*		
Ammonia - Total (mg/L) [5]	<0.10					*3.98*	*11.37*								
Total Hardness, as CaCO3 (mg/L)	37.0														
Chloride (mg/L) [9]	<0.20					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L) [8]	<0.10								*45*		*10*			*10*	
Alkalinity - Total (mg/L)	50.0					*≥ 20*									
Total Dissolved Solids (mg/L)	87.0									*500*		*500*			
PCBs (μg/L)	0.0		*0.014*			*0.014*			*0.5*		*0.5*			*0.00017*	*0.00017*

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

NQ = Not quantified

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

LE = Laboratory error in method of detection, no value to report

1. USEPA 40 CFR Part 131. Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium
10. Fecal Coliform limit is a monthly geometric mean of < 200 / 100 mL, and no more than 10% of the monthly observations above 400 / 100 mL.

2000-2001 Spoil Pile Water Quality Data

and

Comparison to Applicable Regulatory Criteria

372 3375

Spoil Pile Sampling - April 2000

	2000										
	Poe-S-1A		Poe-S2		Poe-S3		Poe-S4		RL	MDL
Time	11:30		10:30		10:20		10:00			
In situ Parameters										
Water Temperature (°C)	9.8		10.2		10.2		10.20		0.10	
Specific Conductance (µmhos/cm)	75.0		72.5		72.5		73.1		1.0	
pH	7.5		7.5		7.5		7.50		0.10	
Analytical Parameters										
Total Metals:										
Arsenic (mg/L)	<0.0032		<0.0032		<0.0032		<0.0032		0.00500	0.00320
Barium (mg/L)	0.02		0.02		0.01		0.02		0.00500	0.00039
Cadmium (mg/L)	0.001	J	<0.00036		<0.00036		<0.00036		0.00200	0.00036
Chromium (mg/L)	0.0008	J	<0.00047		<0.00047		<0.00047		0.00500	0.00047
Copper (mg/L)	0.0023	J	0.0026	J	0.0012	J	0.0012	J	0.00500	0.00040
Iron (mg/L)	1.2		0.35		0.32		0.35		0.10000	0.00280
Lead (mg/L)	<0.0013		<0.0013		<0.0013		<0.0013		0.00500	0.00130
Manganese (mg/L)	0.057		0.016		0.014		0.016		0.00500	0.00046
Mercury (mg/L)	<0.0002		<0.0002		<0.0002		<0.0002		0.00020	0.00020
Nickel (mg/L)	0.0023	J	0.0019	J	0.0015	J	0.0016	J	0.00500	0.00046
Selenium (mg/L)	<0.0042		<0.0042		<0.0042		<0.0042		0.00500	0.00420
Silver (mg/L)	<0.00036		0.00044	J	<0.00036		<0.00036		0.00500	0.00036
Zinc (mg/L)	<0.0013		<0.0013		<0.0013		<0.0013		0.01000	0.00130
Total Hardness, as CaCO3 (mg/L)	35.0		35.0		35.0		35.0			

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.

< = Constituent not detected above the MDL

Hardness value of 35 mg/L was used at each station for calculations that involved hardness, this value represents the lowest value measured in the vicinity of the spoil piles, based on 2002 data.

Poe-S-1A (culvert flow from Adit #2)	April-00	Flag	California Toxics Rules Criteria (USEPA) [1] Freshwater Aquatic Life Protection			USEPA National Recommended [2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) [3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB [4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	11:30														
In situ Parameters															
Water Temperature (°C)	9.8														
Specific Conductance (µmhos/cm)	75									*900*			*150*		
pH (Standard Units)	7.5							*6.5-9.0*					*6.5-8.5*		
Analytical Parameters															
Total Metals (units of milligrams per liter) [5]															
Arsenic (mg/L)	<0.0032								*0.050*		*0.010*				
Barium (mg/L)	0.02000								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	0.00100	*J*	*0.0011*	*0.0014*		*0.00012*	*0.00073*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00080	*J*	*0.0876*	*0.7350*		*0.0365*	*0.7631*		*0.050*		*0.100*				
Copper (mg/L)	0.00230	*J*	*0.0038*	*0.0052*		*0.0038*	*0.0052*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	1.20000					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	<0.0013		*0.0008*	*0.0215*		*0.0008*	*0.0215*		*0.015*		*0.015*				
Manganese (mg/L)	0.05700									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	<0.0002								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00230	*J*	*0.0215*	*0.1930*		*0.0215*	*0.1930*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.0042		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.00036				*0.0007*			*0.0006*		*0.100*					
Zinc (mg/L)	<0.0013		*0.0492*	*0.0492*		*0.0492*	*0.0492*			*5.000*				*7.4*	*26*
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	35.0														

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

< = Constituent was not detected above the MDL

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.

Poe-S2 (NFFR upstream of culvert inflow)	April-00	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	10:30														
In situ Parameters															
Water Temperature (°C)	10.2														
Specific Conductance (μmhos/cm)	73									*900*			*150*		
pH (Standard Units)	7.5							*6.5-9.0*					*6.5-8.5*		
Analytical Parameters															
Total Metals (units of milligrams per liter)[5]															
Arsenic (mg/L)	<0.0032								*0.050*		*0.010*				
Barium (mg/L)	0.02000								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.00036		*0.0011*	*0.0014*		*0.00012*	*0.00073*		*0.0050*		*0.0050*				
Chromium (mg/L)	<0.00047		*0.0876*	*0.7350*		*0.0365*	*0.7631*		*0.050*		*0.100*				
Copper (mg/L)	0.00260	J	*0.0038*	*0.0052*		*0.0038*	*0.0052*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.35000					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	<0.0013		*0.0008*	*0.0215*		*0.0008*	*0.0215*		*0.015*		*0.015*				
Manganese (mg/L)	0.01600									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	<0.0002								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00190	J	*0.0215*	*0.1930*		*0.0215*	*0.1930*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.0042		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	0.00044	J			*0.0007*			*0.0006*		*0.100*					
Zinc (mg/L)	<0.0013		*0.0492*	*0.0492*		*0.0492*	*0.0492*			*5.000*				*7.4*	*26*
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	35.0														

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

< = Constituent was not detected above the MDL

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131. Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.

Poe-S3 (NFFR immediately downstream of culvert inflow)	April-00	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	10:20														
In situ Parameters															
Water Temperature (°C)	10.2														
Specific Conductance (μmhos/cm)	73									*900*			*150*		
pH (Standard Units)	7.5							*6.5-9.0*					*6.5-8.5*		
Analytical Parameters															
Total Metals (units of milligrams per liter)[5]															
Arsenic (mg/L)	<0.0032								*0.050*		*0.010*				
Barium (mg/L)	0.01000								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.00036		*0.0011*	*0.0014*		*0.00012*	*0.00073*		*0.0050*		*0.0050*				
Chromium (mg/L)	<0.00047		*0.0876*	*0.7350*		*0.0365*	*0.7631*		*0.050*		*0.100*				
Copper (mg/L)	0.00120	J	*0.0038*	*0.0052*		*0.0038*	*0.0052*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.32000					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	<0.0013		*0.0008*	*0.0215*		*0.0008*	*0.0215*		*0.015*		*0.015*				
Manganese (mg/L)	0.01400									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	<0.0002								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00150	J	*0.0215*	*0.1930*		*0.0215*	*0.1930*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.0042		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.00036				*0.0007*			*0.0006*		*0.100*					
Zinc (mg/L)	<0.0013		*0.0492*	*0.0492*		*0.0492*	*0.0492*			*5.000*				*7.4*	*26*
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	35.0														

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

< = Constituent was not detected above the MDL

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.

Poe-S4 (NFFR above Poe Powerhouse, approximately 0.5 miles downstream of culvert inflow)	April-00	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	10:00														
In situ Parameters															
Water Temperature (°C)	10.2														
Specific Conductance (µmhos/cm)	73									*900*			*150*		
pH (Standard Units)	7.5							*6.5-9.0*					*6.5-8.5*		
Analytical Parameters															
Total Metals (units of milligrams per liter) [5]															
Arsenic (mg/L)	<0.0032								*0.050*		*0.010*				
Barium (mg/L)	0.02000								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.00036		*0.0011*	*0.0014*		*0.00012*	*0.00073*		*0.0050*		*0.0050*				
Chromium (mg/L)	<0.00047		*0.0876*	*0.7350*		*0.0365*	*0.7631*		*0.050*		*0.100*				
Copper (mg/L)	0.00120	J	*0.0038*	*0.0052*		*0.0038*	*0.0052*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.35000					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	<0.0013		*0.0008*	*0.0215*		*0.0008*	*0.0215*		*0.015*		*0.015*				
Manganese (mg/L)	0.01600									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	<0.0002								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00160	J	*0.0215*	*0.1930*		*0.0215*	*0.1930*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.0042		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.00036				*0.0007*			*0.0006*		*0.100*					
Zinc (mg/L)	<0.0013		*0.0492*	*0.0492*		*0.0492*	*0.0492*			*5.000*				*7.4*	*26*
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	35.0														

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentraion below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

< = Constituent was not detected above the MDL

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.

Spoil Pile Sampling - March 2001

	2001							
	Poe-S1A	Poe-S1B	Poe-S2	Poe-S3	Poe-S4	Poe-S5	RL	MDL
Time	11:00	10:45	10:00	10:25	11:25	11:35		
In situ Parameters								
Water Temperature (°C)	6.6	8.9	7.3	7.30	7.40	5.10	0.1	
Specific Conductance (µmhos/cm)	131	129	111	112	111	114	1.0	
pH	8.0	8.3	8.5	8.40	8.10	8.00	0.1	
Turbidity (NTU)	4.7	9.1	7.7	6.3	6.0	2.6	0.1	
Depth (M)								
Analytical Parameters								
Total Metals:								
Arsenic (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.00500	0.00300
Barium (mg/L)	0.015	0.017	0.012	0.012	0.012	0.014	0.00500	0.00030
Cadmium (mg/L)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.00200	0.00010
Chromium (mg/L)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.00500	0.00020
Copper (mg/L)	0.006	0.0052	<0.0003	<0.0003	<0.0003	<0.0003	0.00500	0.00030
Iron (mg/L)	0.14	0.38	0.23	0.2	0.18	0.11	0.10000	0.01510
Lead (mg/L)	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	0.00500	0.00160
Manganese (mg/L)	0.02	0.0054	0.024	0.025	0.022	0.022	0.00500	0.00090
Mercury (mg/L)	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	0.00020	0.00004
Nickel (mg/L)	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	<0.0019	0.00500	0.00190
Selenium (mg/L)	<0.0042	<0.0042	<0.0042	<0.0042	<0.0042	<0.0042	0.00500	0.00420
Silver (mg/L)	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.00500	0.00030
Zinc (mg/L)	0.0047 J	0.0063 J	<0.0032	<0.0032	<0.0032	<0.0032	0.01000	0.00320
Total Hardness, as CaCO3 (mg/L)	35.0	35.0	35.0	35.0	35.0	35.0		

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.

< = Constituent not detected above the MDL

Hardness value of 35 mg/L was used at each station for calculations that involved hardness, this value represents the lowest value measured in the vicinity of the spoil piles, based on 2002 data.

Poe S-1A (culvert flow from Adit #2)	March-01	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking Water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	11:00														
In situ Parameters															
Water Temperature (°C)	6.6														
Specific Conductance (μmhos/cm)	131									*900*			*150*		
pH (Standard Units)	8.0							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	4.7									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter)[5]															
Arsenic (mg/L)	<0.0030								*0.050*		*0.010*				
Barium (mg/L)	0.01500								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.0001		*0.0011*	*0.0014*		*0.00012*	*0.00073*		*0.0050*		*0.0050*				
Chromium (mg/L)	<0.0002		*0.0876*	*0.7350*		*0.0365*	*0.7631*		*0.050*		*0.100*				
Copper (mg/L)	0.00600		*0.0038*	*0.0052*		*0.0038*	*0.0052*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.14000					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	<0.0016		*0.0008*	*0.0215*		*0.0008*	*0.0215*		*0.015*		*0.015*				
Manganese (mg/L)	0.02000									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	<0.00004								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	<0.0019		*0.0215*	*0.1930*		*0.0215*	*0.1930*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.0042		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.0003				*0.0007*			*0.0006*		*0.100*					
Zinc (mg/L)	0.00470	J	*0.0492*	*0.0492*		*0.0492*	*0.0492*			*5.000*				*7.4*	*26*
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	35.0														

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

<= Constituent not detected above the MDL

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California (*California Toxics Rule*).
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.

[redacted]

Poe S-1B (surface flow into culvert)	March-01	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	10:45														
In situ Parameters															
Water Temperature (°C)	8.9														
Specific Conductance (µmhos/cm)	129									*900*			*150*		
pH (Standard Units)	8.3							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	9.1									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter)[5]															
Arsenic (mg/L)	<0.0030								*0.050*		*0.010*				
Barium (mg/L)	0.01700								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.0001		*0.0011*	*0.0014*		*0.00012*	*0.00073*		*0.0050*		*0.0050*				
Chromium (mg/L)	<0.0002		*0.0876*	*0.7350*		*0.0365*	*0.7631*		*0.050*		*0.100*				
Copper (mg/L)	0.00520		*0.0038*	*0.0052*		*0.0038*	*0.0052*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.38000					*1.00*				*0.10*		*0.30*			
Lead (mg/L)	<0.0016		*0.0008*	*0.0215*		*0.0008*	*0.0215*		*0.015*		*0.015*				
Manganese (mg/L)	0.00540									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	<0.00004								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	<0.0019		*0.0215*	*0.1930*		*0.0215*	*0.1930*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.0042		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.0003				*0.0007*			*0.0006*		*0.100*					
Zinc (mg/L)	0.00630	J	*0.0492*	*0.0492*		*0.0492*	*0.0492*			*5.000*				*7.4*	*26*
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	35.0														

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

<= Constituent not detected above the MDL

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.

Poe S-2 (NFFR upstream of culvert inflow)	March-01	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking Water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	10:00														
In situ Parameters															
Water Temperature (°C)	7.3														
Specific Conductance (μmhos/cm)	111.0									*900*			*150*		
pH (Standard Units)	8.5							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	7.7									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter)[5]															
Arsenic (mg/L)	<0.0030								*0.050*		*0.010*				
Barium (mg/L)	0.01200								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.0001		*0.0011*	*0.0014*		*0.00012*	*0.00073*		*0.0050*		*0.0050*				
Chromium (mg/L)	<0.0002		*0.0876*	*0.7350*		*0.0365*	*0.7631*		*0.050*		*0.100*				
Copper (mg/L)	<0.0003		*0.0038*	*0.0052*		*0.0038*	*0.0052*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.23000					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	<0.0016		*0.0008*	*0.0215*		*0.0008*	*0.0215*		*0.015*		*0.015*				
Manganese (mg/L)	0.02400									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	<0.00004								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	<0.0019		*0.0215*	*0.1930*		*0.0215*	*0.1930*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.0042		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.0003				*0.0007*			*0.0006*		*0.100*					
Zinc (mg/L)	<0.0032		*0.0492*	*0.0492*		*0.0492*	*0.0492*			*5.000*				*7.4*	*26*
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	35.0														

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL
and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
<= Constituent not detected above the MDL
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.

Poe S-3 (NFFR immediately downstream of culver inflow)	March-01	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	10:25														
In situ Parameters															
Water Temperature (°C)	7.3														
Specific Conductance (µmhos/cm)	112.0									*900*			*150*		
pH (Standard Units)	8.4							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	6.3									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [5]															
Arsenic (mg/L)	<0.0030								*0.050*		*0.010*				
Barium (mg/L)	0.01200								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.0001		*0.0011*	*0.0014*		*0.00012*	*0.00073*		*0.0050*		*0.0050*				
Chromium (mg/L)	<0.0002		*0.0876*	*0.7350*		*0.0365*	*0.7631*		*0.050*		*0.100*				
Copper (mg/L)	<0.0003		*0.0038*	*0.0052*		*0.0038*	*0.0052*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.20000					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	<0.0016		*0.0008*	*0.0215*		*0.0008*	*0.0215*		*0.015*		*0.015*				
Manganese (mg/L)	0.02500									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	<0.00004								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	<0.0019		*0.0215*	*0.1930*		*0.0215*	*0.1930*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.0042		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.0003				*0.0007*			*0.0006*		*0.100*					
Zinc (mg/L)	<0.0032		*0.0492*	*0.0492*		*0.0492*	*0.0492*			*5.000*				*7.4*	*26*
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	35.0														

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

<= Constituent not detected above the MDL

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.

Poe S-4 (NFFR above Poe Powerhouse, approximately 0.5 miles downstream of culvert inflow)	March-01	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	11:25														
In situ Parameters															
Water Temperature (°C)	7.4														
Specific Conductance (µmhos/cm)	111.0									*900*			*150*		
pH (Standard Units)	8.1							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	6.0									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter)[5]															
Arsenic (mg/L)	<0.0030								*0.050*		*0.010*				
Barium (mg/L)	0.01200								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.0001		*0.0011*	*0.0014*		*0.00012*	*0.00073*		*0.0050*		*0.0050*				
Chromium (mg/L)	<0.0002		*0.0876*	*0.7350*		*0.0365*	*0.7631*		*0.050*		*0.100*				
Copper (mg/L)	<0.0003		*0.0038*	*0.0052*		*0.0038*	*0.0052*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.18000					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	<0.0016		*0.0008*	*0.0215*		*0.0008*	*0.0215*		*0.015*		*0.015*				
Manganese (mg/L)	0.02200									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	<0.00004								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	<0.0019		*0.0215*	*0.1930*		*0.0215*	*0.1930*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.0042		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.0003				*0.0007*			*0.0006*		*0.100*					
Zinc (mg/L)	<0.0032		*0.0492*	*0.0492*		*0.0492*	*0.0492*			*5.000*				*7.4*	*26*
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	35.0														

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

<= Constituent not detected above the MDL

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.

Poe S-5 (Poe Powerhouse Tailrace outflow to NFFR)	March-01	Flag	California Toxics Rules Criteria (USEPA) [1] Freshwater Aquatic Life Protection			USEPA National Recommended [2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept of Health Services (DHS) [3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB [4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	11:35														
In situ Parameters															
Water Temperature (°C)	5.1														
Specific Conductance (μmhos/cm)	114.0									900			150		
pH (Standard Units)	8.0							6.5-9.0					6.5-8.5		
Turbidity (NTU)	2.6									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) [5]															
Arsenic (mg/L)	<0.0030								0.050		0.010				
Barium (mg/L)	0.01400								1.0		2.0			1.0	
Cadmium (mg/L)	<0.0001		0.0011	0.0014		0.00012	0.00073		0.0050		0.0050				
Chromium (mg/L)	<0.0002		0.0876	0.7350		0.0365	0.7631		0.050		0.100				
Copper (mg/L)	<0.0003		0.0038	0.0052		0.0038	0.0052		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	0.11000					1.00				0.30		0.30			
Lead (mg/L)	<0.0016		0.0008	0.0215		0.0008	0.0215		0.015		0.015				
Manganese (mg/L)	0.02200									0.050		0.050			0.1
Mercury (mg/L)	<0.00004								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	<0.0019		0.0215	0.1930		0.0215	0.1930		0.100					0.61	4.60
Selenium (mg/L)	<0.0042		0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	<0.0003				0.0007			0.0006		0.100					
Zinc (mg/L)	<0.0032		0.0492	0.0492		0.0492	0.0492			5.000				7.4	26
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	35.0														

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

<= Constituent not detected above the MDL

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.

2001-2002 Spoil Pile Water Quality Data

and

Comparison to Applicable Regulatory Criteria

Poe-Adit (Seepage flow from floor of Adit No. 2 tunnel exit, test condition)

	2001-2002			
	Dry Condition	Wet Condition		
	26-Nov-01	3-Jan-02	Report Limit	MDL
Time	NS	11:45		
In situ Parameters				
Water Temperature (°C)	NS	12.10	0.1	—
Specific Conductance (µmhos/cm)	NS	118	1.0	—
pH	NS	7.40	0.1	—
Turbidity (NTU)	NS	0.8	0.1	—
Analytical Parameters				
Total Metals:				
Arsenic (mg/L)	NS	ND	0.005	*0.003*
Barium (mg/L)	NS	0.009	0.005	*0.0003*
Cadmium (mg/L)	NS	ND	0.001	*7.4E-05*
Chromium (mg/L)	NS	ND	0.005	*0.0002*
Copper (mg/L)	NS	ND	0.005	*0.0003*
Iron (mg/L)	NS	ND	0.2	*0.0151*
Lead (mg/L)	NS	ND	0.001	*6.6E-05*
Manganese (mg/L)	NS	ND	0.005	*0.0009*
Mercury (mg/L)	NS	ND	0.0002	*0.00004*
Nickel (mg/L)	NS	ND	0.005	*0.0019*
Selenium (mg/L)	NS	ND	0.005	*0.0042*
Silver (mg/L)	NS	0.0004 J	0.005	*0.0003*
Zinc (mg/L)	NS	ND	0.01	*0.0032*
Dissolved Metals:				
Arsenic (mg/L)	NS	ND	0.005	*0.003*
Barium (mg/L)	NS	0.039	0.005	*0.0003*
Cadmium (mg/L)	NS	ND	0.001	*7.4E-05*
Chromium (mg/L)	NS	ND	0.005	*0.0002*
Copper (mg/L)	NS	ND	0.005	*0.0003*
Iron (mg/L)	NS	ND	0.2	*0.0151*
Lead (mg/L)	NS	ND	0.001	*6.6E-05*
Manganese (mg/L)	NS	ND	0.005	*0.0009*
Mercury (mg/L)	NS	ND	0.0002	*0.00004*
Nickel (mg/L)	NS	ND	0.005	*0.0019*
Selenium (mg/L)	NS	ND	0.005	*0.0042*
Silver (mg/L)	NS	ND	0.005	*0.0003*
Zinc (mg/L)	NS	0.007 J	0.01	*0.0032*
Total Hardness, as CaCO3 (mg/L)	NS	56.00	10.0	—
Total Chloride (mg/L)	NS	2.70	0.2	—
Total Sulfate (mg/L)	NS	3.20	0.2	—
Total Dissolved Solids (mg/L)	NS	140.00	1.0	—
Total				
Calcium (mg/L)	NS	15.00	0.2	*0.0152*
Magnesium (mg/L)	NS	4.30	0.2	*0.0255*
Potassium (mg/L)	NS	0.96 J	4.8	*0.0620*
Sodium (mg/L)	NS	2.60	1.0	*0.0500*
Dissolved				
Calcium (mg/L)	NS	15.00	0.2	*0.0152*
Magnesium (mg/L)	NS	4.40	0.2	*0.0255*
Potassium (mg/L)	NS	0.97 J	4.8	*0.0620*
Sodium (mg/L)	NS	2.80	1.0	*0.0500*

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based o a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.
NS = Constituent not sampled for during monitoring program
ND = analyte not detected above the MDL

Poe-Adit (Seepage flow from floor of Adit No. 2 tunnel exit, test condition)	Jan-02	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
Wet Conditions			*CCC*	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	11:45														
In situ Parameters															
Water Temperature (°C)	12.10														
Specific Conductance (mmhos/cm)	118									*900*			*150*		
pH (Standard Units)	7.40							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	0.8									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (mg/L)	ND								*0.050*		*0.010*				
Barium (mg/L)	0.00900								*1.0*		*2.0*				
Cadmium (mg/L)	ND		*0.0016*	*0.0023*		*0.00018*	*0.00118*		*0.0050*		*0.0050*				
Chromium (mg/L)	ND		*0.1287*	*1.0801*		*0.0536*	*1.1214*		*0.050*		*0.100*				
Copper (mg/L)	ND		*0.0057*	*0.0081*		*0.0057*	*0.0081*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	ND					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	ND		*0.0015*	*0.0390*		*0.0015*	*0.0390*		*0.015*		*0.015*				
Manganese (mg/L)	ND									*0.050*		*0.050*			
Mercury (mg/L)	ND								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	ND		*0.0319*	*0.2873*		*0.0319*	*0.2873*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	ND		*0.0050*	*0.0200*		*0.0050*			*0.050*		*0.050*				
Silver (mg/L)	0.00040	J			*0.0015*			*0.0014*		*0.100*					
Zinc (mg/L)	ND		*0.0733*	*0.0733*		*0.0733*	*0.0733*			*5.000*					
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	ND		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	ND		*0.0015*	*0.0023*		*0.00016*	*0.0011*								
Chromium (mg/L)	ND		*0.1107*	*0.3413*		*0.04610*	*0.3544*								
Copper (mg/L)	ND		*0.0055*	*0.0078*		*0.0055*	*0.0078*								
Lead (mg/L)	ND		*0.0013*	*0.0342*		*0.0013*	*0.0342*								
Mercury (mg/L)	ND					*0.00077*	*0.0014*								
Nickel (mg/L)	ND		*0.0318*	*0.2867*		*0.0318*	*0.2867*								
Silver (mg/L)	ND				*0.00127*			*0.00119*							
Zinc (mg/L)	0.00700	J	*0.0723*	*0.0717*		*0.0723*	*0.0717*								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	56.0														
Chloride (mg/L) [7]	2.7					*230*	*860*			*250*		*250*			
Sulfate (mg/L)	3.2									*250*	*500*	*250*			
Total Dissolved Solids (mg/L)	140.0									*500*		*500*			

Handwritten note beside the Iron–Nickel rows: "Not on other paper"

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-L1 (NFFR upstream of Adit No. 1, background conditions)

	2001-2002					
	Dry Condition		Wet Condition			
	26-Nov-01		3-Jan-02		Report Limit	*MDL*
Time	14:25		9:30			
In situ Parameters						
Water Temperature (°C)	7.20		6.50		0.1	—
Specific Conductance (μmhos/cm)	108		74		1.0	—
pH	7.70		7.60		0.1	—
Turbidity (NTU)	2.1		17.4		0.1	—
Analytical Parameters						
Total Metals:						
Arsenic (mg/L)	ND		ND		0.005	*0.003*
Barium (mg/L)	0.013		0.019		0.005	*0.0003*
Cadmium (mg/L)	ND		ND		0.001	*7.4E-05*
Chromium (mg/L)	0.0006	J	ND		0.005	*0.0002*
Copper (mg/L)	0.0012	J	0.0084		0.005	*0.0003*
Iron (mg/L)	0.094		0.82		0.2	*0.0151*
Lead (mg/L)	ND		0.00027	J	0.001	*6.6E-05*
Manganese (mg/L)	0.0079		0.055		0.005	*0.0009*
Mercury (mg/L)	ND		ND		0.0002	*0.00004*
Nickel (mg/L)	0.0023	J	0.0069		0.005	*0.0019*
Selenium (mg/L)	ND		ND		0.005	*0.0042*
Silver (mg/L)	ND		0.0003	J	0.005	*0.0003*
Zinc (mg/L)	ND		0.02		0.01	*0.0032*
Dissolved Metals:						
Arsenic (mg/L)	ND		ND		0.005	*0.003*
Barium (mg/L)	0.04		0.04		0.005	*0.0003*
Cadmium (mg/L)	ND		ND		0.001	*7.4E-05*
Chromium (mg/L)	0.00042	J	ND		0.005	*0.0002*
Copper (mg/L)	ND		ND		0.005	*0.0003*
Iron (mg/L)	0.096	J	0.06	J	0.2	*0.0151*
Lead (mg/L)	ND		ND		0.001	*6.6E-05*
Manganese (mg/L)	0.0074		0.025		0.005	*0.0009*
Mercury (mg/L)	ND		ND		0.0002	*0.00004*
Nickel (mg/L)	0.0022	J	ND		0.005	*0.0019*
Selenium (mg/L)	ND		ND		0.005	*0.0042*
Silver (mg/L)	ND		0.0004	J	0.005	*0.0003*
Zinc (mg/L)	ND		0.013		0.01	*0.0032*
Total Hardness, as $CaCO_3$ (mg/L)	47.00		37.00		10.0	—
Total Chloride (mg/L)	2.90		2.50		0.2	—
Total Sulfate (mg/L)	3.90		2.70		0.2	—
Total Dissolved Solids (mg/L)	52.00		85.00		1.0	—
Total						
Calcium (mg/L)	8.80		7.50		0.2	*0.0152*
Magnesium (mg/L)	6.00		4.30		0.2	*0.0255*
Potassium (mg/L)	1.00	J	0.87	J	4.8	*0.0620*
Sodium (mg/L)	3.70		7.20		1.0	*0.0500*
Dissolved						
Calcium (mg/L)	9.10		6.70		0.2	*0.0152*
Magnesium (mg/L)	6.20		4.00		0.2	*0.0255*
Potassium (mg/L)	1.10	J	0.72	J	4.8	*0.0620*
Sodium (mg/L)	5.10		2.60		1.0	*0.0500*

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based o: a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.
NS = Constituent not sampled for during monitoring program
ND = analyte not detected above the MDL

Not on other sheet

Poe-L1 (NFFR upstream of Adit No. 1, background conditions)	Nov-01	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
Dry Conditions			*CCC*	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	14:25														
In situ Parameters															
Water Temperature (°C)	7.20														
Specific Conductance (µmhos/cm)	108									*900*			*150*		
pH (Standard Units)	7.70							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	2.1									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (mg/L)	ND								*0.050*		*0.010*				
Barium (mg/L)	0.01300								*1.0*		*2.0*				
Cadmium (mg/L)	ND		*0.0014*	*0.0019*		*0.00015*	*0.00099*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00060	J	*0.1115*	*0.9357*		*0.0464*	*0.9715*		*0.050*		*0.100*				
Copper (mg/L)	0.00120	J	*0.0049*	*0.0069*		*0.0049*	*0.0069*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.09400					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	ND		*0.0012*	*0.0312*		*0.0012*	*0.0312*		*0.015*		*0.015*				
Manganese (mg/L)	0.00790									*0.050*		*0.050*			
Mercury (mg/L)	ND								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00230	J	*0.0275*	*0.2477*		*0.0275*	*0.2477*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	ND		*0.0050*	*0.0200*		*0.0050*			*0.050*		*0.050*				
Silver (mg/L)	ND				*0.0011*			*0.0010*		*0.100*					
Zinc (mg/L)	ND		*0.0632*	*0.0632*		*0.0632*	*0.0632*			*5.000*					
Dissolved Metals (units of milligrams per liter) [5]															
Arsenic (mg/L)	ND		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	ND		*0.0013*	*0.0019*		*0.00015*	*0.0010*								
Chromium (mg/L)	0.00042		*0.0959*	*0.2957*		*0.0399*	*0.3070*								
Copper (mg/L)	ND		*0.0047*	*0.0066*		*0.0047*	*0.0066*								
Lead (mg/L)	ND		*0.0011*	*0.0281*		*0.0011*	*0.0281*								
Mercury (mg/L)	ND					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00220	J	*0.0275*	*0.2472*		*0.0275*	*0.2472*								
Silver (mg/L)	ND				*0.00094*			*0.00088*							
Zinc (mg/L)	ND		*0.0623*	*0.0618*		*0.0623*	*0.0618*								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	47.0														
Chloride (mg/L) [7]	2.9					*230*	*860*			*250*		*250*			
Sulfate (mg/L)	3.9									*250*	*500*	*250*			
Total Dissolved Solids (mg/L)	52.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)
1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-L1 (NFFR upstream of Adit No. 1, background conditions)	Jan-02	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
Wet Conditions			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	9:30														
In situ Parameters															
Water Temperature (°C)	6.50														
Specific Conductance (mmhos/cm)	74									900			150		
pH (Standard Units)	7.60							6.5-9.0					6.5-8.5		
Turbidity (NTU)	17.4									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (mg/L)	ND								0.050		0.010				
Barium (mg/L)	0.01900								1.0		2.0				
Cadmium (mg/L)	ND		0.0011	0.0015		0.00013	0.00078		0.0050		0.0050				
Chromium (mg/L)	ND		0.0917	0.7692		0.0382	0.7987		0.050		0.100				
Copper (mg/L)	0.00840		0.0040	0.0055		0.0040	0.0055		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	0.82000					1.00				0.30		0.30			
Lead (mg/L)	0.00027	J	0.0009	0.0230		0.0009	0.0230		0.015		0.015				
Manganese (mg/L)	0.05500									0.050		0.050			
Mercury (mg/L)	ND								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00690		0.0225	0.2023		0.0225	0.2023		0.100					0.61	4.60
Selenium (mg/L)	ND		0.0050	0.0200		0.0050			0.050		0.050				
Silver (mg/L)	0.00030	J			0.0007			0.0007		0.100					
Zinc (mg/L)	0.02000		0.0516	0.0516		0.0516	0.0516			5.000					
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	ND		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	ND		0.0011	0.0015		0.00012	0.0008								
Chromium (mg/L)	ND		0.0788	0.2431		0.03283	0.2524								
Copper (mg/L)	ND		0.0038	0.0053		0.0038	0.0053								
Lead (mg/L)	ND		0.0008	0.0216		0.0008	0.0216								
Mercury (mg/L)	ND					0.00077	0.0014								
Nickel (mg/L)	ND		0.0224	0.2019		0.0224	0.2019								
Silver (mg/L)	0.00040	J			0.00062			0.00058							
Zinc (mg/L)	0.01300		0.0509	0.0505		0.0509	0.0505								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	37.0														
Chloride (mg/L) [7]	2.5					230	860			250		250			
Sulfate (mg/L)	2.7									250	500	250			
Total Dissolved Solids (mg/L)	85.0									500		500			

total value

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California (*California Toxics Rule*).
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-L2 (NFFR upstream of Adit No. 2, test condition)

	2001-2002					
	Dry Condition		Wet Condition			
	26-Nov-01		3-Jan-02		Report Limit	MDL
Time	12:15		12:15			
In situ Parameters						
Water Temperature (°C)	8.40		6.70		0.1	---
Specific Conductance (µmhos/cm)	105		73		1.0	---
pH	7.70		7.50		0.1	---
Turbidity (NTU)	2.5		17.6		0.1	---
Analytical Parameters						
Total Metals:						
Arsenic (mg/L)	ND		ND		0.005	*0.003*
Barium (mg/L)	0.013		0.018		0.005	*0.0003*
Cadmium (mg/L)	ND		ND		0.001	*7.4E-05*
Chromium (mg/L)	0.00043	J	ND		0.005	*0.0002*
Copper (mg/L)	0.0011	J	0.0054		0.005	*0.0003*
Iron (mg/L)	0.095	J	0.86		0.2	*0.0151*
Lead (mg/L)	ND		0.00025	J	0.001	*6.6E-05*
Manganese (mg/L)	0.0079		0.055		0.005	*0.0009*
Mercury (mg/L)	ND		ND		0.0002	*0.00004*
Nickel (mg/L)	0.0022		0.007		0.005	*0.0019*
Selenium (mg/L)	ND		ND		0.005	*0.0042*
Silver (mg/L)	ND		ND		0.005	*0.0003*
Zinc (mg/L)	ND		0.008	J	0.01	*0.0032*
Dissolved Metals:						
Arsenic (mg/L)	ND		ND		0.005	*0.003*
Barium (mg/L)	0.042		0.04		0.005	*0.0003*
Cadmium (mg/L)	ND		ND		0.001	*7.4E-05*
Chromium (mg/L)	0.00052	J	ND		0.005	*0.0002*
Copper (mg/L)	0.0005	J	ND		0.005	*0.0003*
Iron (mg/L)	0.046	J	0.024	J	0.2	*0.0151*
Lead (mg/L)	ND		ND		0.001	*6.6E-05*
Manganese (mg/L)	0.0048	J	ND		0.005	*0.0009*
Mercury (mg/L)	ND		ND		0.0002	*0.00004*
Nickel (mg/L)	ND		ND		0.005	*0.0019*
Selenium (mg/L)	ND		ND		0.005	*0.0042*
Silver (mg/L)	ND		ND		0.005	*0.0003*
Zinc (mg/L)	0.0053	J	0.008	J	0.01	*0.0032*
Total Hardness, as CaCO3 (mg/L)	47.00		38.00		10.0	---
Total Chloride (mg/L)	3.00		2.70		0.2	---
Total Sulfate (mg/L)	3.60		2.70		0.2	---
Total Dissolved Solids (mg/L)	53.00		97.00		1.0	---
Total						
Calcium (mg/L)	8.70		7.90		0.2	*0.0152*
Magnesium (mg/L)	6.20		4.50		0.2	*0.0255*
Potassium (mg/L)	1.10	J	0.89	J	4.8	*0.0620*
Sodium (mg/L)	3.50		7.60		1.0	*0.0500*
Dissolved						
Calcium (mg/L)	8.70		6.70		0.2	*0.0152*
Magnesium (mg/L)	6.20		3.90		0.2	*0.0255*
Potassium (mg/L)	1.10	J	0.68	J	4.8	*0.0620*
Sodium (mg/L)	4.20		2.60		1.0	*0.0500*

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based o a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.

NS = Constituent not sampled for during monitoring program

ND = analyte not detected above the MDL

Poe-L2 (NFFR upstream of Adit No. 2, test condition)	Nov-01	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
Dry Conditons			*CCC*	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	12:15														
In situ Parameters															
Water Temperature (°C)	8.40														
Specific Conductance (μmhos/cm)	105									*900*			*150*		
pH (Standard Units)	7.70							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	2.5									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (mg/L)	ND								*0.050*		*0.010*				
Barium (mg/L)	0.01300								*1.0*		*2.0*				
Cadmium (mg/L)	ND		*0.0014*	*0.0019*		*0.00015*	*0.00099*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00043	J	*0.1115*	*0.9357*		*0.0464*	*0.9715*		*0.050*		*0.100*				
Copper (mg/L)	0.00110	J	*0.0049*	*0.0069*		*0.0049*	*0.0069*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.09500	J				*1.00*				*0.30*		*0.30*			
Lead (mg/L)	ND		*0.0012*	*0.0312*		*0.0012*	*0.0312*		*0.015*		*0.015*				
Manganese (mg/L)	0.00790									*0.050*		*0.050*			
Mercury (mg/L)	ND								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00220	J	*0.0275*	*0.2477*		*0.0275*	*0.2477*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	ND		*0.0050*	*0.0200*		*0.0050*			*0.050*		*0.050*				
Silver (mg/L)	ND				*0.0011*			*0.0010*		*0.100*					
Zinc (mg/L)	ND		*0.0632*	*0.0632*		*0.0632*	*0.0632*			*5.000*					
Dissolved Metals (units of milligrams per liter) [5]															
Arsenic (mg/L)	ND		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	ND		*0.0013*	*0.0019*		*0.00015*	*0.0010*								
Chromium (mg/L)	0.00052	J	*0.0959*	*0.2957*		*0.0399*	*0.3070*								
Copper (mg/L)	0.00050	J	*0.0047*	*0.0066*		*0.0047*	*0.0066*								
Lead (mg/L)	ND		*0.0011*	*0.0281*		*0.0011*	*0.0281*								
Mercury (mg/L)	ND					*0.00077*	*0.0014*								
Nickel (mg/L)	ND		*0.0275*	*0.2472*		*0.0275*	*0.2472*								
Silver (mg/L)	ND				*0.00094*			*0.00038*							
Zinc (mg/L)	0.00530	J	*0.0623*	*0.0618*		*0.0623*	*0.0618*								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	47.0														
Chloride (mg/L) [7]	3.0					*230*	*860*			*250*		*250*			
Sulfate (mg/L)	3.6									*250*	*500*	*250*			
Total Dissolved Solids (mg/L)	53.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-L2 (NFFR upstream of Adit No. 2, test condition)	Jan-02	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
Wet Conditions			*CCC*	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	12:15														
In situ Parameters															
Water Temperature (°C)	6.70														
Specific Conductance (mmhos/cm)	73									*900*			*150*		
pH (Standard Units)	7.50							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	17.6									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (mg/L)	ND								*0.050*		*0.010*				
Barium (mg/L)	0.01800								*1.0*		*2.0*				
Cadmium (mg/L)	ND		*0.0012*	*0.0015*		*0.00013*	*0.00080*		*0.0050*		*0.0050*				
Chromium (mg/L)	ND		*0.0937*	*0.7862*		*0.0390*	*0.8163*		*0.050*		*0.100*				
Copper (mg/L)	0.00540		*0.0041*	*0.0056*		*0.0041*	*0.0056*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.86000					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	0.00025	J	*0.0009*	*0.0238*		*0.0009*	*0.0238*		*0.015*		*0.015*				
Manganese (mg/L)	0.05500									*0.050*		*0.050*			
Mercury (mg/L)	ND								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00700		*0.0230*	*0.2069*		*0.0230*	*0.2069*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	ND		*0.0050*	*0.0200*		*0.0050*			*0.050*		*0.050*				
Silver (mg/L)	ND				*0.0008*			*0.0007*		*0.100*					
Zinc (mg/L)	0.00800	J	*0.0528*	*0.0528*		*0.0528*	*0.0528*			*5.000*					
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	ND		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	ND		*0.0011*	*0.0015*		*0.00013*	*0.0008*								
Chromium (mg/L)	ND		*0.0806*	*0.2484*		*0.03355*	*0.2580*								
Copper (mg/L)	ND		*0.0039*	*0.0054*		*0.0039*	*0.0054*								
Lead (mg/L)	ND		*0.0009*	*0.0222*		*0.0009*	*0.0222*								
Mercury (mg/L)	ND					*0.00077*	*0.0014*								
Nickel (mg/L)	ND		*0.0229*	*0.2065*		*0.0229*	*0.2065*								
Silver (mg/L)	ND				*0.00065*			*0.00061*							
Zinc (mg/L)	0.00800	J	*0.0520*	*0.0516*		*0.0520*	*0.0516*								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	38.0														
Chloride (mg/L) [7]	2.7					*230*	*860*			*250*		*250*			
Sulfate (mg/L)	2.7									*250*	*500*	*250*			
Total Dissolved Solids (mg/L)	97.0									*500*		*500*			

total value

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-L3 (NFFR downstream of Adit No. 2, test condition)

	2001-2002					
	Dry Condition		Wet Condition			
	26-Nov-01		3-Jan-02		Report Limit	MDL
Time	11:50		11:00			
In situ Parameters						
Water Temperature (°C)	8.40		6.80		0.1	—
Specific Conductance (µmhos/cm)	106		76		1.0	—
pH	7.70		7.50		0.1	—
Turbidity (NTU)	2.5		17.6		0.1	—
Analytical Parameters						
Total Metals:						
Arsenic (mg/L)	ND		ND		0.005	0.003
Barium (mg/L)	0.013		0.015		0.005	0.0003
Cadmium (mg/L)	ND		ND		0.001	7.4E-05
Chromium (mg/L)	0.0006	J	ND		0.005	0.0002
Copper (mg/L)	0.0015	J	0.0052		0.005	0.0003
Iron (mg/L)	0.085	J	0.27		0.2	0.0151
Lead (mg/L)	ND		0.00026	J	0.001	6.6E-05
Manganese (mg/L)	0.0089		0.048		0.005	0.0009
Mercury (mg/L)	ND		ND		0.0002	0.00004
Nickel (mg/L)	0.0023	J	0.005		0.005	0.0019
Selenium (mg/L)	ND		ND		0.005	0.0042
Silver (mg/L)	ND		0.0003	J	0.005	0.0003
Zinc (mg/L)	ND		0.017		0.01	0.0032
Dissolved Metals:						
Arsenic (mg/L)	ND		ND		0.005	0.003
Barium (mg/L)	0.041		0.041		0.005	0.0003
Cadmium (mg/L)	ND		ND		0.001	7.4E-05
Chromium (mg/L)	0.0004	J	ND		0.005	0.0002
Copper (mg/L)	0.0004	J	ND		0.005	0.0003
Iron (mg/L)	0.31		0.03	J	0.2	0.0151
Lead (mg/L)	ND		ND		0.001	6.6E-05
Manganese (mg/L)	0.0019	J	ND		0.005	0.0009
Mercury (mg/L)	ND		ND		0.0002	0.00004
Nickel (mg/L)	ND		ND		0.005	0.0019
Selenium (mg/L)	ND		ND		0.005	0.0042
Silver (mg/L)	ND		0.0003	J	0.005	0.0003
Zinc (mg/L)	0.005	J	0.008	J	0.01	0.0032
Total Hardness, as CaCO3 (mg/L)	47.00		38.00		10.0	—
Total Chloride (mg/L)	2.90		2.60		0.2	—
Total Sulfate (mg/L)	3.60		2.80		0.2	—
Total Dissolved Solids (mg/L)	63.00		120.00		1.0	—
Total						
Calcium (mg/L)	8.80		7.80		0.2	0.0152
Magnesium (mg/L)	6.20		4.60		0.2	0.0255
Potassium (mg/L)	1.10	J	0.75	J	4.8	0.0620
Sodium (mg/L)	3.40		7.30		1.0	0.0500
Dissolved						
Calcium (mg/L)	8.70		6.90		0.2	0.0152
Magnesium (mg/L)	6.10		4.30		0.2	0.0255
Potassium (mg/L)	1.00	J	0.69	J	4.8	0.0620
Sodium (mg/L)	3.90		2.60		1.0	0.0500

— not on other sheet

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based o a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.

NS = Constituent not sampled for during monitoring program

ND = analyte not detected above the MDL

Poe-L3 (NFFR downstream of Adit No. 2, test condition)	Nov-01	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
Dry Conditons			*CCC*	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	11:50														
In situ Parameters															
Water Temperature (°C)	8.40														
Specific Conductance (µmhos/cm)	106									*900*			*150*		
pH (Standard Units)	7.70							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	2.5									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (mg/L)	ND								*0.050*		*0.010*				
Barium (mg/L)	0.01300								*1.0*		*2.0*				
Cadmium (mg/L)	ND		*0.0014*	*0.0019*		*0.00015*	*0.00099*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00060	J	*0.1115*	*0.9357*		*0.0464*	*0.9715*		*0.050*		*0.100*				
Copper (mg/L)	0.00150	J	*0.0049*	*0.0069*		*0.0049*	*0.0069*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.08500	J				*1.00*				*0.30*		*0.30*			
Lead (mg/L)	ND		*0.0012*	*0.0312*		*0.0012*	*0.0312*		*0.015*		*0.015*				
Manganese (mg/L)	0.00890									*0.050*		*0.050*			
Mercury (mg/L)	ND								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00230	J	*0.0275*	*0.2477*		*0.0275*	*0.2477*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	ND		*0.0050*	*0.0200*		*0.0050*			*0.050*		*0.050*				
Silver (mg/L)	ND				*0.0011*			*0.0010*		*0.100*					
Zinc (mg/L)	ND		*0.0632*	*0.0632*		*0.0632*	*0.0632*			*5.000*					
Dissolved Metals (units of milligrams per liter) [5]															
Arsenic (mg/L)	ND		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	ND		*0.0013*	*0.0019*		*0.00015*	*0.0010*								
Chromium (mg/L)	0.00040	J	*0.0959*	*0.2957*		*0.0399*	*0.3070*								
Copper (mg/L)	0.00040	J	*0.0047*	*0.0066*		*0.0047*	*0.0066*								
Lead (mg/L)	ND		*0.0011*	*0.0281*		*0.0011*	*0.0281*								
Mercury (mg/L)	ND					*0.00077*	*0.0014*								
Nickel (mg/L)	ND		*0.0275*	*0.2472*		*0.0275*	*0.2472*								
Silver (mg/L)	ND				*0.00094*			*0.00088*							
Zinc (mg/L)	0.00500	J	*0.0623*	*0.0618*		*0.0623*	*0.0618*								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	47.0														
Chloride (mg/L) [7]	2.9					*230*	*860*			*250*		*250*			
Sulfate (mg/L)	3.6									*250*	*500*	*250*			
Total Dissolved Solids (mg/L)	63.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-L3 (NFFR downstream of Adit No. 2, test condition)	Jan-02	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	Other waters
Wet Conditions			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org consump)
Time	11:00														
In situ Parameters															
Water Temperature (°C)	6.80														
Specific Conductance (mmhos/cm)	76									900			150		
pH (Standard Units)	7.50							6.5-9.0					6.5-8.5		
Turbidity (NTU)	17.6									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (mg/L)	ND								0.050		0.010				
Barium (mg/L)	0.01500								1.0		2.0				
Cadmium (mg/L)	ND		0.0012	0.0015		0.00013	0.00080		0.0050		0.0050				
Chromium (mg/L)	ND		0.0937	0.7862		0.0390	0.8163		0.050		0.100				
Copper (mg/L)	0.00520		0.0041	0.0056		0.0041	0.0056		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	0.27000					1.00				0.30		0.30			
Lead (mg/L)	0.00026	J	0.0009	0.0238		0.0009	0.0238		0.015		0.015				
Manganese (mg/L)	0.04800									0.050		0.050			
Mercury (mg/L)	ND								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00500		0.0230	0.2069		0.0230	0.2069		0.100					0.61	4.60
Selenium (mg/L)	ND		0.0050	0.0200		0.0050			0.050		0.050				
Silver (mg/L)	0.00030	J			0.0008			0.0007		0.100					
Zinc (mg/L)	0.01700		0.0528	0.0528		0.0528	0.0528			5.000					
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	ND		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	ND		0.0011	0.0015		0.00013	0.0008								
Chromium (mg/L)	ND		0.0806	0.2484		0.03355	0.2580								
Copper (mg/L)	ND		0.0039	0.0054		0.0039	0.0054								
Lead (mg/L)	ND		0.0009	0.0222		0.0009	0.0222								
Mercury (mg/L)	ND					0.00077	0.0014								
Nickel (mg/L)	ND		0.0229	0.2065		0.0229	0.2065								
Silver (mg/L)	0.00030	J			0.00065			0.00061							
Zinc (mg/L)	0.00800	J	0.0520	0.0516		0.0520	0.0516								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	38.0														
Chloride (mg/L) [7]	2.6					230	860			250		250			
Sulfate (mg/L)	2.8									250	500	250			
Total Dissolved Solids (mg/L)	120.0									500		500			

total value

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
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Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
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1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
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3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-L4 (Adit No. 2 leakage culvert below railroad grade, test condition)

	2001-2002					
	Dry Condition		Wet Condition			
	26-Nov-01		3-Jan-02		Report Limit	MDL
Time	11:30		12:00			
In situ Parameters						
Water Temperature (°C)	7.40		9.50		0.1	—
Specific Conductance (µmhos/cm)	112		112		1.0	—
pH	7.60		7.60		0.1	—
Turbidity (NTU)	3.2		9.2		0.1	—
Analytical Parameters						
Total Metals:						
Arsenic (mg/L)	ND		ND		0.005	*0.003*
Barium (mg/L)	0.015		0.016		0.005	*0.0003*
Cadmium (mg/L)	ND		ND		0.001	*7.4E-05*
Chromium (mg/L)	0.00055	J	ND		0.005	*0.0002*
Copper (mg/L)	0.002	J	ND		0.005	*0.0003*
Iron (mg/L)	0.14	J	0.43		0.2	*0.0151*
Lead (mg/L)	ND		0.0001	J	0.001	*6.6E-05*
Manganese (mg/L)	0.019		0.028		0.005	*0.0009*
Mercury (mg/L)	ND		ND		0.0002	*0.00004*
Nickel (mg/L)	0.0023	J	ND		0.005	*0.0019*
Selenium (mg/L)	ND		ND		0.005	*0.0042*
Silver (mg/L)	ND		ND		0.005	*0.0003*
Zinc (mg/L)	ND		0.008	J	0.01	*0.0032*
Dissolved Metals:						
Arsenic (mg/L)	ND		ND		0.005	*0.003*
Barium (mg/L)	0.043		0.036		0.005	*0.0003*
Cadmium (mg/L)	ND		ND		0.001	*7.4E-05*
Chromium (mg/L)	0.00041	J	ND		0.005	*0.0002*
Copper (mg/L)	ND		ND		0.005	*0.0003*
Iron (mg/L)	0.055	J	ND		0.2	*0.0151*
Lead (mg/L)	ND		ND		0.001	*6.6E-05*
Manganese (mg/L)	0.0021	J	ND		0.005	*0.0009*
Mercury (mg/L)	ND		ND		0.0002	*0.00004*
Nickel (mg/L)	ND		ND		0.005	*0.0019*
Selenium (mg/L)	ND		ND		0.005	*0.0042*
Silver (mg/L)	ND		ND		0.005	*0.0003*
Zinc (mg/L)	0.0058	J	0.007	J	0.01	*0.0032*
Total Hardness, as CaCO3 (mg/L)	46.00		55.00		10.0	—
Total Chloride (mg/L)	3.20		2.50		0.2	—
Total Sulfate (mg/L)	5.20		6.30		0.2	—
Total Dissolved Solids (mg/L)	60.00		170.00		1.0	—
Total						
Calcium (mg/L)	11.00		13.00		0.2	*0.0152*
Magnesium (mg/L)	4.80		5.80		0.2	*0.0255*
Potassium (mg/L)	1.10	J	1.10	J	4.8	*0.0620*
Sodium (mg/L)	4.30		7.10		1.0	*0.0500*
Dissolved						
Calcium (mg/L)	11.00		12.00		0.2	*0.0152*
Magnesium (mg/L)	4.80		5.60		0.2	*0.0255*
Potassium (mg/L)	1.10	J	0.96	J	4.8	*0.0620*
Sodium (mg/L)	4.80		2.50		1.0	*0.0500*

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based o a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.

NS = Constituent not sampled for during monitoring program

ND = analyte not detected above the MDL

Poe-L4 (Adit No. 2 leakage culvert below railroad grade, test condition)	Nov-01	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
Dry Conditons			*CCC*	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	11:30														
In situ Parameters															
Water Temperature (°C)	7.40														
Specific Conductance (µmhos/cm)	112									*900*			*150*		
pH (Standard Units)	7.60							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	3.2									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (mg/L)	ND								*0.050*		*0.010*				
Barium (mg/L)	0.01500								*1.0*		*2.0*				
Cadmium (mg/L)	ND		*0.0013*	*0.0019*		*0.00015*	*0.00097*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00055	J	*0.1096*	*0.9193*		*0.0456*	*0.9546*		*0.050*		*0.100*				
Copper (mg/L)	0.00200	J	*0.0048*	*0.0067*		*0.0048*	*0.0067*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.14000	J				*1.00*				*0.30*		*0.30*			
Lead (mg/L)	ND		*0.0012*	*0.0304*		*0.0012*	*0.0304*		*0.015*		*0.015*				
Manganese (mg/L)	0.01900									*0.050*		*0.050*			
Mercury (mg/L)	ND								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00230	J	*0.0270*	*0.2432*		*0.0270*	*0.2432*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	ND		*0.0050*	*0.0200*		*0.0050*			*0.050*		*0.050*				
Silver (mg/L)	ND				*0.0011*			*0.0010*		*0.100*					
Zinc (mg/L)	ND		*0.0621*	*0.0621*		*0.0621*	*0.0621*			*5.000*					
Dissolved Metals (units of milligrams per liter) [5]															
Arsenic (mg/L)	ND		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	ND		*0.0013*	*0.0018*		*0.00014*	*0.0009*								
Chromium (mg/L)	0.00041	J	*0.0942*	*0.2905*		*0.0392*	*0.3016*								
Copper (mg/L)	ND		*0.0046*	*0.0065*		*0.0046*	*0.0065*								
Lead (mg/L)	ND		*0.0011*	*0.0275*		*0.0011*	*0.0275*								
Mercury (mg/L)	ND					*0.00077*	*0.0014*								
Nickel (mg/L)	ND		*0.0270*	*0.2427*		*0.0270*	*0.2427*								
Silver (mg/L)	ND				*0.00091*			*0.00085*							
Zinc (mg/L)	0.00580	J	*0.0612*	*0.0607*		*0.0612*	*0.0607*								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	46.0														
Chloride (mg/L) [7]	3.2					*230*	*860*			*250*		*250*			
Sulfate (mg/L)	5.2									*250*	*500*	*250*			
Total Dissolved Solids (mg/L)	60.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-L4 (Adit No. 2 leakage culvert below railroad grade, test condition)	Jan-02	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	Other waters
Wet Conditions			*CCC*	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	12:00														
In situ Parameters															
Water Temperature (°C)	9.50														
Specific Conductance (mmhos/cm)	112									*900*			*150*		
pH (Standard Units)	7.60							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	9.2									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (mg/L)	ND								*0.050*		*0.010*				
Barium (mg/L)	0.01600								*1.0*		*2.0*				
Cadmium (mg/L)	ND		*0.0015*	*0.0023*		*0.00017*	*0.00116*		*0.0050*		*0.0050*				
Chromium (mg/L)	ND		*0.1269*	*1.0642*		*0.0528*	*1.1050*		*0.050*		*0.100*				
Copper (mg/L)	ND		*0.0056*	*0.0080*		*0.0056*	*0.0080*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.43000					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	0.00010	J	*0.0015*	*0.0381*		*0.0015*	*0.0381*		*0.015*		*0.015*				
Manganese (mg/L)	0.02800									*0.050*		*0.050*			
Mercury (mg/L)	ND								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	ND		*0.0315*	*0.2829*		*0.0315*	*0.2829*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	ND		*0.0050*	*0.0200*		*0.0050*			*0.050*		*0.050*				
Silver (mg/L)	ND				*0.0015*			*0.0014*		*0.100*					
Zinc (mg/L)	0.00800	J	*0.0722*	*0.0722*		*0.0722*	*0.0722*			*5.000*					
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	ND		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	ND		*0.0014*	*0.0022*		*0.00016*	*0.0011*								
Chromium (mg/L)	ND		*0.1091*	*0.3363*		*0.04542*	*0.3492*								
Copper (mg/L)	ND		*0.0054*	*0.0077*		*0.0054*	*0.0077*								
Lead (mg/L)	ND		*0.0013*	*0.0335*		*0.0013*	*0.0335*								
Mercury (mg/L)	ND					*0.00077*	*0.0014*								
Nickel (mg/L)	ND		*0.0314*	*0.2824*		*0.0314*	*0.2824*								
Silver (mg/L)	ND				*0.00123*			*0.00115*							
Zinc (mg/L)	0.00700	J	*0.0712*	*0.0706*		*0.0712*	*0.0706*								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	55.0														
Chloride (mg/L) [7]	2.5					*230*	*860*			*250*		*250*			
Sulfate (mg/L)	6.3									*250*	*500*	*250*			
Total Dissolved Solids (mg/L)	170.0									*500*		*500*			

Not on other paper

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
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3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-L5 (Adit No. 2 leakage culvert at inflow to NFFR, test condition)

	2001-2002					
	Dry Condition		Wet Condition			
	26-Nov-01		3-Jan-02		Report Limit	MDL
Time	12:30		12:30			
In situ Parameters						
Water Temperature (°C)	7.60		9.90		0.1	---
Specific Conductance (µmhos/cm)	117		129		1.0	---
pH	7.60		7.60		0.1	---
Turbidity (NTU)	2.8		6.5		0.1	---
Analytical Parameters						
Total Metals:						
Arsenic (mg/L)	ND		ND		0.005	*0.003*
Barium (mg/L)	0.014		0.015		0.005	*0.0003*
Cadmium (mg/L)	ND		ND		0.001	*7.4E-05*
Chromium (mg/L)	0.00055	J	ND		0.005	*0.0002*
Copper (mg/L)	0.0017	J	0.0084		0.005	*0.0003*
Iron (mg/L)	0.16	J	0.28		0.2	*0.0151*
Lead (mg/L)	ND		0.000076	J	0.001	*6.6E-05*
Manganese (mg/L)	0.016		0.026		0.005	*0.0009*
Mercury (mg/L)	ND		ND		0.0002	*0.00004*
Nickel (mg/L)	0.002	J	ND		0.005	*0.0019*
Selenium (mg/L)	ND		ND		0.005	*0.0042*
Silver (mg/L)	ND		0.0003	J	0.005	*0.0003*
Zinc (mg/L)	0.0041	J	0.021		0.01	*0.0032*
Dissolved Metals:						
Arsenic (mg/L)	ND		ND		0.005	*0.003*
Barium (mg/L)	0.042		0.04		0.005	*0.0003*
Cadmium (mg/L)	ND		ND		0.001	*7.4E-05*
Chromium (mg/L)	0.00048	J	ND		0.005	*0.0002*
Copper (mg/L)	ND		ND		0.005	*0.0003*
Iron (mg/L)	0.056	J	ND		0.2	*0.0151*
Lead (mg/L)	ND		ND		0.001	*6.6E-05*
Manganese (mg/L)	0.0028	J	ND		0.005	*0.0009*
Mercury (mg/L)	ND		ND		0.0002	*0.00004*
Nickel (mg/L)	ND		ND		0.005	*0.0019*
Selenium (mg/L)	ND		ND		0.005	*0.0042*
Silver (mg/L)	ND		ND		0.005	*0.0003*
Zinc (mg/L)	0.0061	J	0.006	J	0.01	*0.0032*
Total Hardness, as CaCO3 (mg/L)	50.00		62.00		10.0	---
Total Chloride (mg/L)	3.20		2.70		0.2	---
Total Sulfate (mg/L)	6.20		9.20		0.2	---
Total Dissolved Solids (mg/L)	82.00		120.00		1.0	---
Total						
Calcium (mg/L)	11.00		14.00		0.2	*0.0152*
Magnesium (mg/L)	5.30		6.70		0.2	*0.0255*
Potassium (mg/L)	1.10	J	1.10	J	4.8	*0.0620*
Sodium (mg/L)	4.30		7.40		1.0	*0.0500*
Dissolved						
Calcium (mg/L)	11.00		13.00		0.2	*0.0152*
Magnesium (mg/L)	5.40		6.60		0.2	*0.0255*
Potassium (mg/L)	1.10	J	1.00	J	4.8	*0.0620*
Sodium (mg/L)	4.80		2.70		1.0	*0.0500*

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based o a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.

NS = Constituent not sampled for during monitoring program

ND = analyte not detected above the MDL

Poe-L5 (Adit No. 2 leakage culvert at inflow to NFFR, test condition)	Nov-01	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
Dry Conditons			*CCC*	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	12:30														
In situ Parameters															
Water Temperature (°C)	7.60														
Specific Conductance (µmhos/cm)	117									*900*			*150*		
pH (Standard Units)	7.60							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	2.8									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (mg/L)	ND								*0.050*		*0.010*				
Barium (mg/L)	0.01400								*1.0*		*2.0*				
Cadmium (mg/L)	ND		*0.0014*	*0.0021*		*0.00016*	*0.00105*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00055	J	*0.1173*	*0.9843*		*0.0488*	*1.0220*		*0.050*		*0.100*				
Copper (mg/L)	0.00170	J	*0.0052*	*0.0073*		*0.0052*	*0.0073*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.16000	J				*1.00*				*0.30*		*0.30*			
Lead (mg/L)	ND		*0.0013*	*0.0338*		*0.0013*	*0.0338*		*0.015*		*0.015*				
Manganese (mg/L)	0.01600									*0.050*		*0.050*			
Mercury (mg/L)	ND								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00200	J	*0.0290*	*0.2610*		*0.0290*	*0.2610*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	ND		*0.0050*	*0.0200*		*0.0050*			*0.050*		*0.050*				
Silver (mg/L)	ND				*0.0012*			*0.0011*		*0.100*					
Zinc (mg/L)	0.00410	J	*0.0666*	*0.0666*		*0.0666*	*0.0666*			*5.000*					
Dissolved Metals (units of milligrams per liter) [5]															
Arsenic (mg/L)	ND		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	ND		*0.0013*	*0.0020*		*0.00015*	*0.0010*								
Chromium (mg/L)	0.00048	J	*0.1009*	*0.3110*		*0.0420*	*0.3230*								
Copper (mg/L)	ND		*0.0050*	*0.0070*		*0.0050*	*0.0070*								
Lead (mg/L)	ND		*0.0012*	*0.0301*		*0.0012*	*0.0301*								
Mercury (mg/L)	ND					*0.00077*	*0.0014*								
Nickel (mg/L)	ND		*0.0289*	*0.2605*		*0.0289*	*0.2605*								
Silver (mg/L)	ND				*0.00105*			*0.00098*							
Zinc (mg/L)	0.00610	J	*0.0657*	*0.0651*		*0.0657*	*0.0651*								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	50.0														
Chloride (mg/L) [7]	3.2					*230*	*860*			*250*		*250*			
Sulfate (mg/L)	6.2									*250*	*500*	*250*			
Total Dissolved Solids (mg/L)	82.0									*500*		*500*			

total value

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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5. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
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7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-L5 (Adit No. 2 leakage culvert at inflow to NFFR, test condition)	Jan-02	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
Wet Conditions			*CCC*	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*	-	*(water + organism consump)*	*(aquatic org. consump)*
Time	12:30														
In situ Parameters															
Water Temperature (°C)	9.90														
Specific Conductance (mmhos/cm)	129									*900*			*150*		
pH (Standard Units)	7.60							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	6.5									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (mg/L)	ND								*0.050*		*0.010*				
Barium (mg/L)	0.01500								*1.0*		*2.0*				
Cadmium (mg/L)	ND		*0.0017*	*0.0026*		*0.00019*	*0.00131*		*0.0050*		*0.0050*				
Chromium (mg/L)	ND		*0.1399*	*1.1739*		*0.0583*	*1.2189*		*0.050*		*0.100*				
Copper (mg/L)	0.00840		*0.0062*	*0.0089*		*0.0062*	*0.0089*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.28000					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	0.00008	J	*0.0017*	*0.0444*		*0.0017*	*0.0444*		*0.015*		*0.015*				
Manganese (mg/L)	0.02600									*0.050*		*0.050*			
Mercury (mg/L)	ND								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	ND		*0.0348*	*0.3131*		*0.0348*	*0.3131*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	ND		*0.0050*	*0.0200*		*0.0050*			*0.050*		*0.050*				
Silver (mg/L)	0.00030	J			*0.0018*			*0.0017*		*0.100*					
Zinc (mg/L)	0.02100		*0.0799*	*0.0799*		*0.0799*	*0.0799*			*5.000*					
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	ND		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	ND		*0.0016*	*0.0025*		*0.00018*	*0.0013*								
Chromium (mg/L)	ND		*0.1203*	*0.3710*		*0.05010*	*0.3852*								
Copper (mg/L)	ND		*0.0060*	*0.0086*		*0.0060*	*0.0086*								
Lead (mg/L)	ND		*0.0015*	*0.0382*		*0.0015*	*0.0382*								
Mercury (mg/L)	ND					*0.00077*	*0.0014*								
Nickel (mg/L)	ND		*0.0347*	*0.3125*		*0.0347*	*0.3125*								
Silver (mg/L)	ND				*0.00152*			*0.00141*							
Zinc (mg/L)	0.00600	J	*0.0788*	*0.0782*		*0.0788*	*0.0782*								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	62.0														
Chloride (mg/L) [7]	2.7					*230*	*860*			*250*		*250*			
Sulfate (mg/L)	9.2									*250*	*500*	*250*			
Total Dissolved Solids (mg/L)	120.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

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Shaded cells represent exceedances of the criteria

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2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-L6 (Poe Powerhouse Tailrace, background condition)

	2001-2002					
	Dry Condition		Wet Condition			
	26-Nov-01		3-Jan-02		Report Limit	*MDL*
Time	13:15		13:15			
In situ Parameters						
Water Temperature (°C)	7.10		6.20		0.1	—
Specific Conductance (μmhos/cm)	108		74		1.0	—
pH	7.60		7.80		0.1	—
Turbidity (NTU)	4.2		17.1		0.1	—
Analytical Parameters						
Total Metals:						
Arsenic (mg/L)	ND		ND		0.005	*0.003*
Barium (mg/L)	0.016		0.019		0.005	*0.0003*
Cadmium (mg/L)	ND		ND		0.001	*7.4E-05*
Chromium (mg/L)	0.00055	J	ND		0.005	*0.0002*
Copper (mg/L)	0.0016	J	0.0084		0.005	*0.0003*
Iron (mg/L)	0.17	J	1.00		0.2	*0.0151*
Lead (mg/L)	ND		0.0002	J	0.001	*6.6E-05*
Manganese (mg/L)	0.026		0.057		0.005	*0.0009*
Mercury (mg/L)	ND		ND		0.0002	*0.00004*
Nickel (mg/L)	0.0022	J	0.007		0.005	*0.0019*
Selenium (mg/L)	ND		ND		0.005	*0.0042*
Silver (mg/L)	ND		ND		0.005	*0.0003*
Zinc (mg/L)	ND		0.026		0.01	*0.0032*
Dissolved Metals:						
Arsenic (mg/L)	ND		ND		0.005	*0.003*
Barium (mg/L)	0.042		0.039		0.005	*0.0003*
Cadmium (mg/L)	ND		ND		0.001	*7.4E-05*
Chromium (mg/L)	0.00022	J	ND		0.005	*0.0002*
Copper (mg/L)	ND		ND		0.005	*0.0003*
Iron (mg/L)	0.048	J	0.03	J	0.2	*0.0151*
Lead (mg/L)	ND		ND		0.001	*6.6E-05*
Manganese (mg/L)	0.0023	J	ND		0.005	*0.0009*
Mercury (mg/L)	ND		ND		0.0002	*0.00004*
Nickel (mg/L)	ND		ND		0.005	*0.0019*
Selenium (mg/L)	ND		ND		0.005	*0.0042*
Silver (mg/L)	ND		0.0004	J	0.005	*0.0003*
Zinc (mg/L)	0.0065		0.008	J	0.01	*0.0032*
Total Hardness, as CaCO3 (mg/L)	47.00		36.00		10.0	—
Total Chloride (mg/L)	3.20		2.60		0.2	—
Total Sulfate (mg/L)	4.60		2.80		0.2	—
Total Dissolved Solids (mg/L)	59.00		92.00		1.0	—
Total						
Calcium (mg/L)	11.00		7.80		0.2	*0.0152*
Magnesium (mg/L)	4.80		4.00		0.2	*0.0255*
Potassium (mg/L)	1.10	J	0.84	J	4.8	*0.0620*
Sodium (mg/L)	4.70		7.20		1.0	*0.0500*
Dissolved						
Calcium (mg/L)	10.00		6.90		0.2	*0.0152*
Magnesium (mg/L)	4.70		3.70		0.2	*0.0255*
Potassium (mg/L)	1.00	J	0.72	J	4.8	*0.0620*
Sodium (mg/L)	4.80		2.70		1.0	*0.0500*

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.

NS = Constituent not sampled for during monitoring program

ND = analyte not detected above the MDL

Poe-L6 (Poe Powerhouse Tailrace, background condition)	Nov-01	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
Dry Conditons			*CCC*	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	13:15														
In situ Parameters															
Water Temperature (°C)	7.10														
Specific Conductance (µmhos/cm)	108									*900*			*150*		
pH (Standard Units)	7.60							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	4.2									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter)[6]															
Arsenic (mg/L)	ND								*0.050*		*0.010*				
Barium (mg/L)	0.01600								*1.0*		*2.0*				
Cadmium (mg/L)	ND		*0.0014*	*0.0019*		*0.00015*	*0.00099*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00055	J	*0.1115*	*0.9357*		*0.0464*	*0.9715*		*0.050*		*0.100*				
Copper (mg/L)	0.00160	J	*0.0049*	*0.0069*		*0.0049*	*0.0069*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.17000	J				*1.00*				*0.30*		*0.30*			
Lead (mg/L)	ND		*0.0012*	*0.0312*		*0.0012*	*0.0312*		*0.015*		*0.015*				
Manganese (mg/L)	0.02600									*0.050*		*0.050*			
Mercury (mg/L)	ND								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00220	J	*0.0275*	*0.2477*		*0.0275*	*0.2477*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	ND		*0.0050*	*0.0200*		*0.0050*			*0.050*		*0.050*				
Silver (mg/L)	ND				*0.0011*			*0.0010*		*0.100*					
Zinc (mg/L)	ND		*0.0632*	*0.0632*		*0.0632*	*0.0632*			*5.000*					
Dissolved Metals (units of milligrams per liter)[5]															
Arsenic (mg/L)	ND		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	ND		*0.0013*	*0.0019*		*0.00015*	*0.0010*								
Chromium (mg/L)	0.00022	J	*0.0959*	*0.2957*		*0.0399*	*0.3070*								
Copper (mg/L)	ND		*0.0047*	*0.0066*		*0.0047*	*0.0066*								
Lead (mg/L)	ND		*0.0011*	*0.0281*		*0.0011*	*0.0281*								
Mercury (mg/L)	ND					*0.00077*	*0.0014*								
Nickel (mg/L)	ND		*0.0275*	*0.2472*		*0.0275*	*0.2472*								
Silver (mg/L)	ND				*0.00094*			*0.00088*							
Zinc (mg/L)	0.00650		*0.0623*	*0.0618*		*0.0623*	*0.0618*								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	47.0														
Chloride (mg/L)[7]	3.2					*230*	*860*			*250*		*250*			
Sulfate (mg/L)	4.6									*250*	*500*	*250*			
Total Dissolved Solids (mg/L)	59.0									*500*		*500*			

total value

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-L6 (Poe Powerhouse Tailrace, background condition)	Jan-02	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
Wet Conditions			*CCC*	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	13:15														
In situ Parameters															
Water Temperature (°C)	6.20														
Specific Conductance (mmhos/cm)	74									*900*			*150*		
pH (Standard Units)	7.80							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	17.1									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (mg/L)	ND								*0.050*		*0.010*				
Barium (mg/L)	0.01900								*1.0*		*2.0*				
Cadmium (mg/L)	ND		*0.0011*	*0.0014*		*0.00013*	*0.00076*		*0.0050*		*0.0050*				
Chromium (mg/L)	ND		*0.0896*	*0.7521*		*0.0373*	*0.7809*		*0.050*		*0.100*				
Copper (mg/L)	0.00840		*0.0039*	*0.0053*		*0.0039*	*0.0053*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	1.00000					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	0.00020	J	*0.0009*	*0.0222*		*0.0009*	*0.0222*		*0.015*		*0.015*				
Manganese (mg/L)	0.05700									*0.050*		*0.050*			
Mercury (mg/L)	ND								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00700		*0.0220*	*0.1977*		*0.0220*	*0.1977*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	ND		*0.0050*	*0.0200*		*0.0050*			*0.050*		*0.050*				
Silver (mg/L)	ND				*0.0007*			*0.0007*		*0.100*					
Zinc (mg/L)	0.02600		*0.0504*	*0.0504*		*0.0504*	*0.0504*			*5.000*					
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	ND		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	ND		*0.0011*	*0.0014*		*0.00012*	*0.0007*								
Chromium (mg/L)	ND		*0.0771*	*0.2377*		*0.03210*	*0.2468*								
Copper (mg/L)	ND		*0.0037*	*0.0051*		*0.0037*	*0.0051*								
Lead (mg/L)	ND		*0.0008*	*0.0209*		*0.0008*	*0.0209*								
Mercury (mg/L)	ND					*0.00077*	*0.0014*								
Nickel (mg/L)	ND		*0.0219*	*0.1973*		*0.0219*	*0.1973*								
Silver (mg/L)	0.00040	J			*0.00060*			*0.00055*							
Zinc (mg/L)	0.00800	J	*0.0497*	*0.0493*		*0.0497*	*0.0493*								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	36.0														
Chloride (mg/L) [7]	2.6					*230*	*860*			*250*		*250*			
Sulfate (mg/L)	2.8									*250*	*500*	*250*			
Total Dissolved Solids (mg/L)	92.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
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5. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-T1 (Tributary stream flowing into NFFR upstream of Adit No. 1, background condition)

	2001-2002					
	Dry Condition	Wet Condition				
	26-Nov-01	3-Jan-02		Report Limit		*MDL*
Time	NS	9:20				
In situ Parameters						
Water Temperature (°C)	NS	10.30		0.1		---
Specific Conductance (µmhos/cm)	NS	154		1.0		---
pH	NS	7.30		0.1		---
Turbidity (NTU)	NS	3.3		0.1		---
Analytical Parameters						
Total Metals:						
Arsenic (mg/L)	NS	ND		0.005		*0.003*
Barium (mg/L)	NS	0.015		0.005		*0.0003*
Cadmium (mg/L)	NS	ND		0.001		*7.4E-05*
Chromium (mg/L)	NS	ND		0.005		*0.0002*
Copper (mg/L)	NS	ND		0.005		*0.0003*
Iron (mg/L)	NS	0.25		0.2		*0.0151*
Lead (mg/L)	NS	ND		0.001		*6.6E-05*
Manganese (mg/L)	NS	0.0053		0.005		*0.0009*
Mercury (mg/L)	NS	ND		0.0002		*0.00004*
Nickel (mg/L)	NS	0.019		0.005		*0.0019*
Selenium (mg/L)	NS	ND		0.005		*0.0042*
Silver (mg/L)	NS	0.0003	J	0.005		*0.0003*
Zinc (mg/L)	NS	0.003	J	0.01		*0.0032*
Dissolved Metals:						
Arsenic (mg/L)	NS	ND		0.005		*0.003*
Barium (mg/L)	NS	0.043		0.005		*0.0003*
Cadmium (mg/L)	NS	ND		0.001		*7.4E-05*
Chromium (mg/L)	NS	ND		0.005		*0.0002*
Copper (mg/L)	NS	ND		0.005		*0.0003*
Iron (mg/L)	NS	ND		0.2		*0.0151*
Lead (mg/L)	NS	ND		0.001		*6.6E-05*
Manganese (mg/L)	NS	ND		0.005		*0.0009*
Mercury (mg/L)	NS	ND		0.0002		*0.00004*
Nickel (mg/L)	NS	0.013		0.005		*0.0019*
Selenium (mg/L)	NS	ND		0.005		*0.0042*
Silver (mg/L)	NS	0.0003	J	0.005		*0.0003*
Zinc (mg/L)	NS	0.007	J	0.01		*0.0032*
Total Hardness, as $CaCO_3$ (mg/L)	NS	87.00		10.0		---
Total Chloride (mg/L)	NS	3.70		0.2		---
Total Sulfate (mg/L)	NS	2.00		0.2		---
Total Dissolved Solids (mg/L)	NS	130.00		1.0		---
Total						
Calcium (mg/L)	NS	4.40		0.2		*0.0152*
Magnesium (mg/L)	NS	19.00		0.2		*0.0255*
Potassium (mg/L)	NS	0.50		4.8		*0.0620*
Sodium (mg/L)	NS	0.90		1.0		*0.0500*
Dissolved						
Calcium (mg/L)	NS	4.20		0.2		*0.0152*
Magnesium (mg/L)	NS	18.00		0.2		*0.0255*
Potassium (mg/L)	NS	0.47	J	4.8		*0.0620*
Sodium (mg/L)	NS	1.00		1.0		*0.0500*

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based o a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.

NS = Constituent not sampled for during monitoring program

ND = analyte not detected above the MDL

Poe-T1 (Tributary stream flowing into NFFR upstream of Adit No. 1, background condition)	Jan-02	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
Wet Conditions			*CCC*	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	9:20														
In situ Parameters															
Water Temperature (°C)	10.30														
Specific Conductance (mmhos/cm)	154									*900*			*150*		
pH (Standard Units)	7.30							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	3.3									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [6]															
Arsenic (mg/L)	ND								*0.050*		*0.010*				
Barium (mg/L)	0.01500								*1.0*		*2.0*				
Cadmium (mg/L)	ND		*0.0022*	*0.0039*		*0.00024*	*0.00185*		*0.0050*		*0.0050*				
Chromium (mg/L)	ND		*0.1847*	*1.5493*		*0.0769*	*1.6087*		*0.050*		*0.100*				
Copper (mg/L)	ND		*0.0083*	*0.0123*		*0.0083*	*0.0123*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.25000					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	ND		*0.0027*	*0.0684*		*0.0027*	*0.0684*		*0.015*		*0.015*				
Manganese (mg/L)	0.00530									*0.050*		*0.050*			
Mercury (mg/L)	ND								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.01900		*0.0464*	*0.4170*		*0.0464*	*0.4170*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	ND		*0.0050*	*0.0200*		*0.0050*			*0.050*		*0.050*				
Silver (mg/L)	0.00030	J			*0.0032*			*0.0030*		*0.100*					
Zinc (mg/L)	0.00300	J	*0.1065*	*0.1065*		*0.1065*	*0.1065*			*5.000*					
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	ND		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	ND		*0.0020*	*0.0037*		*0.00022*	*0.0018*								
Chromium (mg/L)	ND		*0.1588*	*0.4896*		*0.06613*	*0.5083*								
Copper (mg/L)	ND		*0.0080*	*0.0118*		*0.0080*	*0.0118*								
Lead (mg/L)	ND		*0.0022*	*0.0555*		*0.0022*	*0.0555*								
Mercury (mg/L)	ND					*0.00077*	*0.0014*								
Nickel (mg/L)	0.01300		*0.0462*	*0.4162*		*0.0462*	*0.4162*								
Silver (mg/L)	0.00030	J			*0.00272*			*0.00253*							
Zinc (mg/L)	0.00700	J	*0.1050*	*0.1041*		*0.1050*	*0.1041*								
Additional Analytical Parameters															
Total Hardness, as CaCO3 (mg/L)	87.0														
Chloride (mg/L) [7]	3.7					*230*	*860*			*250*		*250*			
Sulfate (mg/L)	2.0									*250*	*500*	*250*			
Total Dissolved Solids (mg/L)	130.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL
and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)
1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*]
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
6. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
7. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Not on other sheet

2003 Water Quality Data

and

Comparison to Applicable Regulatory Criteria

Poe-1A (NFFR at Poe Reservoir entrance)

	2003							
	March		May		August		October	
Time	14:13		8:00		8:05		8:30	
In situ Parameters								
Water Temperature (°C)	7.9		11.0		19.2		14.30	
Dissolved Oxygen (mg/L)	11.0		11.2		9.8		9.40	
DO percent saturation (%)	97		107		111		96	
Specific Conductance (µmhos/cm)	73		83		114		106	
pH	7.8		7.9		7.7		8.70	
Turbidity (NTU)	5.0		1.7		<2		1.1	
Depth (M)								
Analytical Parameters								
Total Metals:								
Aluminum (mg/L)	0.060		0.188		0.043		0.018	J
Arsenic (mg/L)	0.00069		0.00044		0.00116		0.00121	
Barium (mg/L)	0.0138		0.015		0.0107		0.013	
Cadmium (mg/L)	<0.00001	DNQ	<0.000002		0.000005		<0.000002	
Chromium (mg/L)	0.00057		0.00108		0.00061		0.00008	J
Copper (mg/L)	0.00114		0.00108		0.00051		0.00029	
Iron (mg/L)	NS		NS		0.0723		0.0799	
Lead (mg/L)	0.000073		0.000037		0.000036		<0.000002	
Manganese (mg/L)	0.0204		0.0178		0.0394		0.035	
Mercury (mg/L)	2.83E-06		2.66E-06		3.80E-07		4.34E-07	
Nickel (mg/L)	0.00199		0.00127		0.00041		0.00017	
Selenium (mg/L)	<0.0003	DNQ	<0.0001		0.0002		0.00025	J
Silver (mg/L)	<0.000008		<0.000008		<0.000008		<0.000008	
Zinc (mg/L)	0.00064		<0.00002		0.00034		0.0001	
Dissolved Metals:								
Arsenic (mg/L)	0.00066		0.00047		0.00109		0.00112	
Cadmium (mg/L)	<0.00001	DNQ	<0.000002		<0.000002		0.000003	J
Copper (mg/L)	0.00071		0.00072		0.00043		0.00018	
Iron (mg/L)	0.025		0.041		0.0021	J	0.0046	J
Lead (mg/L)	0.000014		<0.000002		0.000002		<0.000002	
Mercury (mg/L)	2.09E-06		1.55E-06		<0.20E-06		3.04E-07	
Nickel (mg/L)	0.00144		0.00102		0.00021		0.00008	
Silver (mg/L)	<0.000008		<0.000008		<0.000008		<0.000008	
Zinc (mg/L)	0.00127		<0.00002		0.00046		<0.00002	
Ammonia - Total (mg/L)	0.066	J	<0.05		<0.05		<0.05	
Total Hardness, as CaCO3 (mg/L)	33.7		38.2		52.5		47.6	
Chloride (mg/L)	0.70		0.76		1.02		1.17	
Nitrate, as NO3 (mg/L) + Nitrite (mg/L)	0.0656		0.0522		0.0741		0.0603	
Sulfate (mg/L)	1.96		2.04		1.62		1.57	
Alkalinity - Total (mg/L)	34.6		42.2		55.3		58.2	
Total Dissolved Solids (mg/L)	60		56		77		66	
Total Suspended Solids (mg/L)	4.2		1.9		2.2		1.4	
Total Phosphorous (mg/L)	<0.03		<0.03		<0.03		0.0176	J
Orthophosphate (mg/L)	0.0114		0.0118		0.0117		0.0145	
Chlorophyll-a (µg/L)	0.78		3.94		1.48		0.217	
Calcium (mg/L)	8.11		8.89		10.00		10.10	
Magnesium (mg/L)	3.17		3.45		3.73		4.96	
Potassium (mg/L)	0.58		0.64		0.81		1.37	
Sodium (mg/L)	2.50		2.76		4.35		4.77	

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.
DNQ = Detected above MDL and below RL, but not quantified (Marine Pollution Studies Laboratory).
Result reported as less than the RL for this flag.
NS = Constituent not sampled for during monitoring program
Non-detectable results without a flag (DNQ) are reported as less than the MDL.

Poe-1A (NFFR at Poe Reservoir entrance)	March	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	14:13														
In situ Parameters															
Water Temperature (°C)	7.9														
Dissolved Oxygen (mg/L)	11.0												*>7*		
Specific Conductance (µmhos/cm)	73									*900*			*150*		
pH (Standard Units)	7.8							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	5.0									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [7]															
Aluminum (mg/L)	0.06000					*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	0.00069								*0.050*		*0.010*				
Barium (mg/L)	0.01380								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.00001	DNQ	*0.0010*	*0.0013*		*0.00012*	*0.00071*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00057		*0.0349*	*0.7125*		*0.0354*	*0.7398*		*0.050*		*0.100*				
Copper (mg/L)	0.00114		*0.0037*	*0.0050*		*0.0037*	*0.0050*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	NS					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	0.00007		*0.0008*	*0.0204*		*0.0008*	*0.0204*		*0.015*		*0.015*				
Manganese (mg/L)	0.02040									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	2.83E-06								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00199		*0.0208*	*0.1869*		*0.0208*	*0.1869*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.0003	DNQ	*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.000008				*0.0006*			*0.0006*		*0.100*					
Zinc (mg/L)	0.00064		*0.0477*	*0.0477*		*0.0477*	*0.0477*			*5.000*				*7.4*	*26*
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00066		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	<0.00001	DNQ	*0.0010*	*0.0013*		*0.00012*	*0.0007*								
Copper (mg/L)	0.00071		*0.0035*	*0.0048*		*0.0035*	*0.0048*								
Lead (mg/L)	0.00001		*0.0008*	*0.0194*		*0.0008*	*0.0194*								
Mercury (mg/L)	2.09E-06					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00144		*0.0207*	*0.1866*		*0.0207*	*0.1866*								
Silver (mg/L)	<0.000008				*0.00053*			*0.00050*							
Zinc (mg/L)	0.00127		*0.0470*	*0.0466*		*0.0470*	*0.0466*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) [5]	0.066	J				*3.18*	*8.11*								
Total Hardness, as CaCO3 (mg/L)	33.7														
Chloride (mg/L) [9]	0.7					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] [8]	0.1								*10*		*10*			*10*	
Sulfate (mg/L)	2.0									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	34.6					*≥ 20*									
Total Dissolved Solids (mg/L)	60.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-1A (NFFR at Poe Reservoir entrance)	May	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	8:00														
In situ Parameters															
Water Temperature (°C)	11.0														
Dissolved Oxygen (mg/L)	11.2												*>7*		
Specific Conductance (mmhos/cm)	83									*900*			*150*		
pH (Standard Units)	7.9							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	1.7									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.18800					*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	0.00044								*0.050*		*0.010*				
Barium (mg/L)	0.01500								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.000002		*0.0012*	*0.0015*		*0.00013*	*0.00080*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00108		*0.0941*	*0.7896*		*0.0392*	*0.8198*		*0.050*		*0.100*				
Copper (mg/L)	0.00108		*0.0041*	*0.0057*		*0.0041*	*0.0057*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	NS					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	0.00004		*0.0009*	*0.0240*		*0.0009*	*0.0240*		*0.015*		*0.015*				
Manganese (mg/L)	0.01780									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	2.66E-06								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00127		*0.0231*	*0.2079*		*0.0231*	*0.2079*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.0001		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.3*
Silver (mg/L)	<0.000008				*0.0008*			*0.0007*		*0.100*					
Zinc (mg/L)	<0.00002		*0.0530*	*0.0530*		*0.0530*	*0.0530*			*5.000*				*7.4*	*36*
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00047		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	<0.000002		*0.0011*	*0.0015*		*0.00013*	*0.0008*								
Copper (mg/L)	0.00072		*0.0039*	*0.0054*		*0.0039*	*0.0054*								
Lead (mg/L)	<0.000002		*0.0009*	*0.0223*		*0.0009*	*0.0223*								
Mercury (mg/L)	1.55E-06					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00102		*0.0230*	*0.2074*		*0.0230*	*0.2074*								
Silver (mg/L)	<0.000008				*0.00066*			*0.00061*							
Zinc (mg/L)	<0.00002		*0.0523*	*0.0518*		*0.0523*	*0.0518*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					*2.80*	*6.77*								
Total Hardness, as CaCO3 (mg/L)	38.2														
Chloride (mg/L) 9	0.8					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								*10*		*10*			*10*	
Sulfate (mg/L)	2.0									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	42.2					*≥ 20*									
Total Dissolved Solids (mg/L)	56.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
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Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)
1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
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8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-1A (NFFR at Poe Reservoir entrance)	August	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	8:05														
In situ Parameters															
Water Temperature (°C)	19.24														
Dissolved Oxygen (mg/L)	9.77												>7		
Specific Conductance (mmhos/cm)	113.5									900			150		
pH (Standard Units)	7.70							6.5-9.0					6.5-8.5		
Turbidity (NTU)	<2									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.04330					0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	0.00116								0.050		0.010				
Barium (mg/L)	0.01070								1.0		2.0			1.0	
Cadmium (mg/L)	0.00001		0.0015	0.0022		0.00017	0.00111		0.0050		0.0050				
Chromium (mg/L)	0.00061		0.1221	1.0244		0.0508	1.0637		0.050		0.100				
Copper (mg/L)	0.00051		0.0054	0.0076		0.0054	0.0076		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	0.07230					1.00				0.30		0.30			
Lead (mg/L)	0.00004		0.0014	0.0359		0.0014	0.0359		0.015		0.015				
Manganese (mg/L)	0.03940									0.050		0.050			0.1
Mercury (mg/L)	3.80E-07								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00041		0.0302	0.2720		0.0302	0.2720		0.100					0.61	4.60
Selenium (mg/L)	0.00020		0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	<0.000008				0.0013			0.0012		0.100					
Zinc (mg/L)	0.00034		0.0694	0.0694		0.0694	0.0694			5.000				7.4	26
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00109		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	<0.000002		0.0014	0.0021		0.00016	0.0011								
Copper (mg/L)	0.00043		0.0052	0.0073		0.0052	0.0073								
Lead (mg/L)	0.00000		0.0012	0.0318		0.0012	0.0318								
Mercury (mg/L)	<0.20E-06					0.00077	0.0014								
Nickel (mg/L)	0.00021		0.0302	0.2715		0.0302	0.2715								
Silver (mg/L)	<0.000008				0.00114			0.00106							
Zinc (mg/L)	0.00046		0.0684	0.0679		0.0684	0.0679								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					2.64	9.64								
Total Hardness, as CaCO3 (mg/L)	52.5														
Chloride (mg/L) 9	1.0					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								10		10			10	
Sulfate (mg/L)	1.6									250	500	250			
Alkalinity - Total (mg/L)	55.3					≥20									
Total Dissolved Solids (mg/L)	77.0									500		500			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-1A (NFFR at Poe Reservoir entrance)	October	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	8:30														
In situ Parameters															
Water Temperature (°C)	14.30														
Dissolved Oxygen (mg/L)	9.40												>7		
Specific Conductance (mmhos/cm)	106									*900*			*150*		
pH (Standard Units)	8.70							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	1.1									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.01840	J				*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	0.00121								*0.050*		*0.010*				
Barium (mg/L)	0.01300								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.000002		*0.0014*	*0.0020*		*0.00016*	*0.00100*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00008	J	*0.1127*	*0.9454*		*0.0469*	*0.9817*		*0.050*		*0.100*				
Copper (mg/L)	0.00029		*0.0049*	*0.0070*		*0.0049*	*0.0070*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.07990					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	<0.000002		*0.0012*	*0.0317*		*0.0012*	*0.0317*		*0.015*		*0.015*				
Manganese (mg/L)	0.03500									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	4.34E-07								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00017		*0.0278*	*0.2504*		*0.0278*	*0.2504*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	0.00025	J	*0.0050*	*0.0200*		*0.0050*			*0.050*		*0.050*			*0.170*	*4.2*
Silver (mg/L)	<0.000008				*0.0011*			*0.0011*		*0.100*					
Zinc (mg/L)	0.00010		*0.0639*	*0.0639*		*0.0639*	*0.0639*			*5.000*				*7.4*	*26*
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00112		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	0.00000	J	*0.0013*	*0.0019*		*0.00015*	*0.0010*								
Copper (mg/L)	0.00018		*0.0047*	*0.0067*		*0.0047*	*0.0067*								
Lead (mg/L)	<0.000002		*0.0011*	*0.0285*		*0.0011*	*0.0285*								
Mercury (mg/L)	3.04E-07					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00008		*0.0278*	*0.2499*		*0.0278*	*0.2499*								
Silver (mg/L)	<0.000008				*0.00096*			*0.00090*							
Zinc (mg/L)	<0.00002		*0.0630*	*0.0625*		*0.0630*	*0.0625*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					*0.78*	*1.47*								
Total Hardness, as CaCO3 (mg/L)	47.6														
Chloride (mg/L) 9	1.2					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								*10*		*10*			*10*	
Sulfate (mg/L)	1.6									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	58.2					*≥20*									
Total Dissolved Solids (mg/L)	66.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL
and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-2A (NFFR at NF-23 gage station)

	2003							
	March		May		August		October	
Time	12:36		9:30		9:42		9:30	
In situ Parameters								
Water Temperature (°C)	9.5		11.1		18.4		14.00	
Dissolved Oxygen (mg/L)	10.5		11.3		8.4		10.10	
DO percent saturation (%)	97		107		93		102	
Specific Conductance (µmhos/cm)	74		80		112		106	
pH	8.3		8.0		8.0		8.20	
Turbidity (NTU)	2.2		0.8		<2		1.9	
Depth (M)								
Analytical Parameters								
Total Metals:								
Aluminum (mg/L)	0.033		0.111		0.0294	J	<0.010	
Arsenic (mg/L)	0.00057		0.00045		0.00107		0.0011	
Barium (mg/L)	0.0117		0.014		0.0119		0.011	
Cadmium (mg/L)	<0.00001	DNQ	<0.000002		<0.000002		<0.000002	
Chromium (mg/L)	0.00050		0.00106		0.00058		0.00009	
Copper (mg/L)	0.00079		0.00087		0.0005		0.00033	
Iron (mg/L)	NS		NS		0.0476		0.0478	
Lead (mg/L)	0.000043		0.000020		0.000020		0.000007	J
Manganese (mg/L)	0.00984		0.013		0.0224		0.0233	
Mercury (mg/L)	2.01E-06		2.56E-06		4.8E-07		4.09E-07	
Nickel (mg/L)	0.00181		0.00143		0.00071		0.00039	
Selenium (mg/L)	<0.0003	DNQ	<0.0001		0.00019		0.00034	
Silver (mg/L)	<0.000008		<0.000008		<0.000008		<0.000008	
Zinc (mg/L)	0.00040		<0.00002		0.00019		<0.00002	
Dissolved Metals:								
Arsenic (mg/L)	0.00050		0.00034		0.00106		0.00096	
Cadmium (mg/L)	<0.000002		<0.000002		<0.000002		<0.000002	
Copper (mg/L)	0.00058		0.00062		0.00038		0.00022	
Iron (mg/L)	0.020		0.031		<0.002		0.0033	J
Lead (mg/L)	0.000010		<0.00001	DNQ	<0.000002		<0.000002	
Mercury (mg/L)	0.0000019		1.85E-06		<0.20E-06		2.68E-07	
Nickel (mg/L)	0.00156		0.00118		0.00046		0.00021	
Silver (mg/L)	<0.000008		<0.000008		<0.000008		<0.000008	
Zinc (mg/L)	0.00019		<0.00002		0.00004		<0.00002	
Ammonia - Total (mg/L)	0.06	J	<0.05		<0.05		<0.05	
Total Hardness, as CaCO3 (mg/L)	33.70		36.30		52.00		46.60	
Chloride (mg/L)	0.65		0.72		0.97		1.01	
Nitrate, as NO3 (mg/L) + Nitrite (mg/L)	0.0562		0.0600		0.0731		0.0737	
Sulfate (mg/L)	1.94		1.93		1.65		1.56	
Alkalinity - Total (mg/L)	23.6		41.6		55.8		49.9	
Total Dissolved Solids (mg/L)	57		57		72		67	
Total Suspended Solids (mg/L)	1.2		1.7		1.2		1.2	
Total Phosphorous (mg/L)	<0.03		<0.03		<0.03		0.0202	J
Orthophosphate (mg/L)	0.0116		0.0112		0.0126		0.0159	
Chlorophyll-a (µg/L)	0.22		8.72		0.95		0.185	
Calcium (mg/L)	7.27		8.40		9.83		9.68	
Magnesium (mg/L)	3.67		3.61		5.43		5.06	
Potassium (mg/L)	0.57		0.65		1.74		1.34	
Sodium (mg/L)	2.25		2.60		4.53		4.58	

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based or statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.
DNQ = Detected above MDL and below RL, but not quantified (Marine Pollution Studies Laboratory).
Result reported as less than the RL for this flag.
NS = Constituent not sampled for during monitoring program
Non-detectable results without a flag (DNQ) are reported as less than the MDL.

Poe-2A (NFFR at NF-23 gage station)	March	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org consump)
Time	12:36														
In situ Parameters															
Water Temperature (°C)	9.50														
Dissolved Oxygen (mg/L)	10.50												>7		
Specific Conductance (µmhos/cm)	74									900			150		
pH (Standard Units)	8.30							6.5-9.0					6.5-8.5		
Turbidity (NTU)	2.2									5					
Analytical Parameters															
Total Metals (units of milligrams per liter)[7]															
Aluminum (mg/L)	0.03300					0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	0.00057								0.050		0.010				
Barium (mg/L)	0.01170								1.0		2.0			1.0	
Cadmium (mg/L)	<0.00001	DNQ	0.0010	0.0013		0.00012	0.00071		0.0050		0.0050				
Chromium (mg/L)	0.00050		0.0849	0.7125		0.0354	0.7398		0.050		0.100				
Copper (mg/L)	0.00079		0.0037	0.0050		0.0037	0.0050		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	NS					1.00				0.30		0.30			
Lead (mg/L)	0.00004		0.0008	0.0204		0.0008	0.0204		0.015		0.015				
Manganese (mg/L)	0.00984									0.050		0.050			0.1
Mercury (mg/L)	2.01E-06								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00181		0.0208	0.1869		0.0208	0.1869		0.100					0.61	4.60
Selenium (mg/L)	<0.0003	DNQ	0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	<0.000008				0.0006			0.0006		0.100					
Zinc (mg/L)	0.00040		0.0477	0.0477		0.0477	0.0477			5.000				7.4	26
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00050		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	<0.000002		0.0010	0.0013		0.00012	0.0007								
Copper (mg/L)	0.00058		0.0035	0.0048		0.0035	0.0048								
Lead (mg/L)	0.00001		0.0008	0.0194		0.0008	0.0194								
Mercury (mg/L)	1.90E-06					0.00077	0.0014								
Nickel (mg/L)	0.00156		0.0207	0.1866		0.0207	0.1866								
Silver (mg/L)	<0.000008				0.00053			0.00050							
Zinc (mg/L)	0.00019		0.0470	0.0466		0.0470	0.0466								
Additional Analytical Parameters															
Ammonia - Total (mg/L)[5]	0.055	J				1.52	3.15								
Total Hardness, as CaCO3 (mg/L)	33.7														
Chloride (mg/L)[9]	0.7					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)][8]	0.1								10		10			10	
Sulfate (mg/L)	1.9									250	500	250			
Alkalinity - Total (mg/L)	23.6					≥ 20									
Total Dissolved Solids (mg/L)	57.0									500		500			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California (*California Toxics Rule*).
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-2A (NFFR at NF-23 gage station)	May	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org consump)
Time	9:30														
In situ Parameters															
Water Temperature (°C)	11.11														
Dissolved Oxygen (mg/L)	11.28												>7		
Specific Conductance (mmhos/cm)	80									900			150		
pH (Standard Units)	8.00							6.5-9.0					6.5-8.5		
Turbidity (NTU)	0.8									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.11100					0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	0.00045								0.050		0.010				
Barium (mg/L)	0.01400								1.0		2.0			1.0	
Cadmium (mg/L)	<0.000002		0.0011	0.0014		0.00013	0.00076		0.0050		0.0050				
Chromium (mg/L)	0.00106		0.0903	0.7573		0.0376	0.7863		0.050		0.100				
Copper (mg/L)	0.00087		0.0039	0.0054		0.0039	0.0054		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	NS					1.00				0.30		0.30			
Lead (mg/L)	0.00002		0.0009	0.0225		0.0009	0.0225		0.015		0.015				
Manganese (mg/L)	0.01300									0.050		0.050			0.1
Mercury (mg/L)	2.56E-06								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00143		0.0221	0.1991		0.0221	0.1991		0.100					0.61	4.60
Selenium (mg/L)	<0.0001		0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	<0.000008				0.0007			0.0007		0.100					
Zinc (mg/L)	<0.00002		0.0508	0.0508		0.0508	0.0508			5.000				7.4	26
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00034		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	<0.000002		0.0011	0.0014		0.00012	0.0008								
Copper (mg/L)	0.00062		0.0038	0.0052		0.0038	0.0052								
Lead (mg/L)	<0.00001	DNQ	0.0008	0.0211		0.0008	0.0211								
Mercury (mg/L)	1.85E-06					0.00077	0.0014								
Nickel (mg/L)	0.00118		0.0221	0.1987		0.0221	0.1987								
Silver (mg/L)	<0.000008				0.00060			0.00056							
Zinc (mg/L)	<0.00002		0.0501	0.0497		0.0501	0.0497								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					2.43	5.62								
Total Hardness, as CaCO3 (mg/L)	36.3														
Chloride (mg/L) 9	0.7					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								10		10			10	
Sulfate (mg/L)	1.9									250	500	250			
Alkalinity - Total (mg/L)	41.6					≥ 20									
Total Dissolved Solids (mg/L)	57.0									500		500			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-2A (NFFR at NF-23 gage station)	August	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	9:42														
In situ Parameters															
Water Temperature (°C)	18.42														
Dissolved Oxygen (mg/L)	8.37												>7		
Specific Conductance (mmhos/cm)	111.6									900			150		
pH (Standard Units)	8.02							6.5-9.0					6.5-8.5		
Turbidity (NTU)	<2									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.02940					0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	0.00107								0.050		0.010				
Barium (mg/L)	0.01190								1.0		2.0			1.0	
Cadmium (mg/L)	<0.000002		0.0015	0.0022		0.00017	0.00110		0.0050		0.0050				
Chromium (mg/L)	0.00058		0.1212	1.0164		0.0504	1.0554		0.050		0.100				
Copper (mg/L)	0.00050		0.0053	0.0076		0.0053	0.0076		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	0.04760					1.00				0.30		0.30			
Lead (mg/L)	0.00002		0.0014	0.0355		0.0014	0.0355		0.015		0.015				
Manganese (mg/L)	0.02240									0.050		0.050			0.1
Mercury (mg/L)	4.80E-07								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00071		0.0300	0.2698		0.0300	0.2698		0.100					0.61	4.60
Selenium (mg/L)	0.00019		0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	<0.000008				0.0013			0.0012		0.100					
Zinc (mg/L)	0.00019		0.0688	0.0688		0.0688	0.0688			5.000				7.4	26
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00106		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	<0.000002		0.0014	0.0021		0.00016	0.0011								
Copper (mg/L)	0.00038		0.0051	0.0073		0.0051	0.0073								
Lead (mg/L)	<0.000002		0.0012	0.0315		0.0012	0.0315								
Mercury (mg/L)	<0.20E-06					0.00077	0.0014								
Nickel (mg/L)	0.00046		0.0299	0.2693		0.0299	0.2693								
Silver (mg/L)	<0.000008				0.00112			0.00104							
Zinc (mg/L)	0.00004		0.0679	0.0673		0.0679	0.0673								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					1.84	5.41								
Total Hardness, as CaCO3 (mg/L)	52.0														
Chloride (mg/L) 9	1.0					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								10		10			10	
Sulfate (mg/L)	1.7									250	500	250			
Alkalinity - Total (mg/L)	55.8					≥20									
Total Dissolved Solids (mg/L)	72.0									500		500			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California (California Toxics Rule).
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-2A (NFFR at NF-23 gage station)	October	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	9:30														
In situ Parameters															
Water Temperature (°C)	14.00														
Dissolved Oxygen (mg/L)	10.10												*>7*		
Specific Conductance (mmhos/cm)	106									*900*			*150*		
pH (Standard Units)	8.20							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	1.9									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	<0.010					*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	0.00110								*0.050*		*0.010*				
Barium (mg/L)	0.01100								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.000002		*0.0014*	*0.0019*		*0.00015*	*0.00098*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00009		*0.1107*	*0.9292*		*0.0461*	*0.9648*		*0.050*		*0.100*				
Copper (mg/L)	0.00033		*0.0049*	*0.0068*		*0.0049*	*0.0068*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.04780					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	0.00001	J	*0.0012*	*0.0309*		*0.0012*	*0.0309*		*0.015*		*0.015*				
Manganese (mg/L)	0.02330									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	4.09E-07								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00039		*0.0273*	*0.2459*		*0.0273*	*0.2459*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	0.00034		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.000008				*0.0011*			*0.0010*		*0.100*					
Zinc (mg/L)	<0.00002		*0.0627*	*0.0627*		*0.0627*	*0.0627*			*5.000*				*7.4*	*26*
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00096		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	<0.000002		*0.0013*	*0.0019*		*0.00014*	*0.0010*								
Copper (mg/L)	0.00022		*0.0047*	*0.0065*		*0.0047*	*0.0065*								
Lead (mg/L)	<0.000002		*0.0011*	*0.0279*		*0.0011*	*0.0279*								
Mercury (mg/L)	2.68E-07					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00021		*0.0273*	*0.2454*		*0.0273*	*0.2454*								
Silver (mg/L)	<0.000008				*0.00093*			*0.00087*							
Zinc (mg/L)	<0.00002		*0.0619*	*0.0614*		*0.0619*	*0.0614*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					*1.79*	*3.83*								
Total Hardness, as CaCO3 (mg/L)	46.6														
Chloride (mg/L) 9	1.0					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								*10*		*10*			*10*	
Sulfate (mg/L)	1.6									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	49.9					*≥20*									
Total Dissolved Solids (mg/L)	67.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-3 (NFFR above Poe Powerhouse)

	2003							
	March		May		August		October	
Time	9:15		12:15		12:30		13:30	
In situ Parameters								
Water Temperature (°C)	8.9		12.5		21.1		14.80	
Dissolved Oxygen (mg/L)	9.9		10.8		9.0		10.50	
DO percent saturation (%)	88		105		104		107	
Specific Conductance (μmhos/cm)	73		85		118		106	
pH	7.8		8.2		8.3		8.20	
Turbidity (NTU)	2.2		0.9		<2		0.8	
Depth (M)								
Analytical Parameters								
Total Metals:								
Aluminum (mg/L)	0.021		0.116		0.026	J	<0.010	
Arsenic (mg/L)	0.00055		0.00046		0.00098		0.00101	
Barium (mg/L)	0.0122		0.014		0.013		0.012	
Cadmium (mg/L)	<0.00001	DNQ	<0.000002		<0.000002		<0.000002	
Chromium (mg/L)	0.00064		0.00111		0.00103		0.00011	
Copper (mg/L)	0.00077		0.0008		0.00052		0.00032	
Iron (mg/L)	NS		NS		0.0352		0.0213	
Lead (mg/L)	0.000047		0.000021		0.000011		<0.000002	
Manganese (mg/L)	0.00726		0.00857		0.00987		0.00552	
Mercury (mg/L)	2.61E-06		2.37E-06		4.7E-07		3.86E-07	
Nickel (mg/L)	0.00161		0.00139		0.00076		0.00047	
Selenium (mg/L)	<0.0003	DNQ	<0.0001		<0.0001		0.00015	J
Silver (mg/L)	<0.000008		<0.000008		<0.000008		<0.000008	
Zinc (mg/L)	0.00038		0.00016		0.00011		<0.00002	
Dissolved Metals:								
Arsenic (mg/L)	0.00049		0.00028		0.00102		0.00101	
Cadmium (mg/L)	<0.00001	DNQ	<0.000002		<0.000002		<0.000002	
Copper (mg/L)	0.0006		0.00059		0.0005		0.00029	
Iron (mg/L)	0.022		0.014		0.002	J	0.0035	J
Lead (mg/L)	0.000014		<0.000002		<0.000002		<0.000002	
Mercury (mg/L)	1.79E-06		1.56E-06		<2.0E-7		3.87E-07	
Nickel (mg/L)	0.00132		0.0012		0.00066		0.00042	
Silver (mg/L)	0.000012		<0.000008		<0.000008		<0.000008	
Zinc (mg/L)	0.00022		<0.00002		0.00111		<0.00002	
Ammonia - Total (mg/L)	<0.05		<0.05		<0.05		<0.05	
Total Hardness, as $CaCO_3$ (mg/L)	32.7		38.2		56.2		46.6	
Chloride (mg/L)	0.64		0.77		0.96		1.06	
Nitrate, as NO_3 (mg/L) + Nitrite (mg/L)	0.0622		0.0695		0.0757		0.0690	
Sulfate (mg/L)	1.98		1.99		1.75		1.70	
Alkalinity - Total (mg/L)	29.9		40.9		60.7		52.6	
Total Dissolved Solids (mg/L)	50		59		74		60	
Total Suspended Solids (mg/L)	1.4		<1.0		1.2		<1.0	
Total Phosphorous (mg/L)	<0.03		<0.03		<0.03		0.0272	J
Orthophosphate (mg/L)	0.0104		0.0097	J	0.0118		0.0155	
Chlorophyll-a (μg/L)	0.38		2.19		0.30		0.089	
Calcium (mg/L)	7.51		8.59		10.20		9.53	
Magnesium (mg/L)	3.45		4.02		5.59		5.31	
Potassium (mg/L)	0.58		0.67		1.41		1.41	
Sodium (mg/L)	2.22		2.62		4.38		4.56	

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based on statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.

DNQ = Detected above MDL and below RL, but not quantified (Marine Pollution Studies Laboratory).
Result reported as less than the RL for this flag.

NS = Constituent not sampled for during monitoring program

Non-detectable results without a flag (DNQ) are reported as less than the MDL.

Poe-3 (NFFR above Poe Powerhouse)	March	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	9:15														
In situ Parameters															
Water Temperature (°C)	8.90														
Dissolved Oxygen (mg/L)	9.90												>7		
Specific Conductance (µmhos/cm)	73									900			150		
pH (Standard Units)	7.80							6.5-9.0					6.5-8.5		
Turbidity (NTU)	2.2									5					
Analytical Parameters															
Total Metals (units of milligrams per liter)[7]															
Aluminum (mg/L)	0.02100					0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	0.00055								0.050		0.010				
Barium (mg/L)	0.01220								1.0		2.0			1.0	
Cadmium (mg/L)	<0.00001	DNQ	0.0010	0.0013		0.00012	0.00068		0.0050		0.0050				
Chromium (mg/L)	0.00064		0.0829	0.6952		0.0345	0.7218		0.050		0.100				
Copper (mg/L)	0.00077		0.0036	0.0049		0.0036	0.0049		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	NS					1.00				0.30		0.30			
Lead (mg/L)	0.00005		0.0008	0.0197		0.0008	0.0197		0.015		0.015				
Manganese (mg/L)	0.00726									0.050		0.050			0.1
Mercury (mg/L)	2.61E-06								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00161		0.0203	0.1822		0.0203	0.1822		0.100					0.61	4.60
Selenium (mg/L)	<0.0003	DNQ	0.0050	0.0200		0.0050			0.050					0.170	4.3
Silver (mg/L)	<0.000008				0.0006			0.0006		0.100					
Zinc (mg/L)	0.00038		0.0465	0.0465		0.0465	0.0465			5.000				7.4	26
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00049		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	<0.00001	DNQ	0.0010	0.0013		0.00011	0.0007								
Copper (mg/L)	0.00060		0.0034	0.0047		0.0034	0.0047								
Lead (mg/L)	0.00001		0.0007	0.0188		0.0007	0.0188								
Mercury (mg/L)	1.79E-06					0.00077	0.0014								
Nickel (mg/L)	0.00132		0.0202	0.1819		0.0202	0.1819								
Silver (mg/L)	0.00001				0.00050			0.00047							
Zinc (mg/L)	0.00022		0.0458	0.0454		0.0458	0.0454								
Additional Analytical Parameters															
Ammonia - Total (mg/L)[5]	<0.05					3.18	8.11								
Total Hardness, as CaCO3 (mg/L)	32.7														
Chloride (mg/L)[9]	0.6					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)][8]	0.1								10		10			10	
Sulfate (mg/L)	2.0									250	500	250			
Alkalinity - Total (mg/L)	29.9					≥ 20									
Total Dissolved Solids (mg/L)	50.0									500		500			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-3 (NFFR above Poe Powerhouse)	May	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consume)*	*(aquatic org consume)*
Time	12:15														
In situ Parameters															
Water Temperature (°C)	12.48														
Dissolved Oxygen (mg/L)	10.80												*>7*		
Specific Conductance (mmhos/cm)	85									*900*			*150*		
pH (Standard Units)	8.20							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	0.9									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.11600					*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	0.00046								*0.050*		*0.010*			*1.0*	
Barium (mg/L)	0.01400								*1.0*		*2.0*				
Cadmium (mg/L)	<0.000002		*0.0012*	*0.0015*		*0.00013*	*0.00080*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00111		*0.0941*	*0.7896*		*0.0392*	*0.8198*		*0.050*		*0.100*			*1.3*	
Copper (mg/L)	0.00080		*0.0041*	*0.0057*		*0.0041*	*0.0057*		*1.3*	*1.0*	*1.3*	*1.0*			
Iron (mg/L)	NS					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	0.00002		*0.0009*	*0.0240*		*0.0009*	*0.0240*		*0.015*		*0.015*				*0.1*
Manganese (mg/L)	0.00857									*0.050*		*0.050*		*0.000050*	*0.000051*
Mercury (mg/L)	2.37E-06								*0.0020*		*0.0020*			*0.61*	*4.60*
Nickel (mg/L)	0.00139		*0.0231*	*0.2079*		*0.0231*	*0.2079*		*0.100*					*0.170*	*4.2*
Selenium (mg/L)	<0.0001		*0.0050*	*0.0200*		*0.0050*			*0.050*						
Silver (mg/L)	<0.000008				*0.0008*			*0.0007*		*0.100*				*7.4*	*26*
Zinc (mg/L)	0.00016		*0.0530*	*0.0530*		*0.0530*	*0.0530*			*5.000*					
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00028		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	<0.000002		*0.0011*	*0.0015*		*0.00013*	*0.0008*								
Copper (mg/L)	0.00059		*0.0039*	*0.0054*		*0.0039*	*0.0054*								
Lead (mg/L)	<0.000002		*0.0009*	*0.0223*		*0.0009*	*0.0223*								
Mercury (mg/L)	1.56E-06					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00120		*0.0230*	*0.2074*		*0.0230*	*0.2074*								
Silver (mg/L)	<0.000008				*0.00066*			*0.00061*							
Zinc (mg/L)	<0.00002		*0.0523*	*0.0518*		*0.0523*	*0.0518*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					*1.79*	*3.83*								
Total Hardness, as CaCO3 (mg/L)	38.2														
Chloride (mg/L) 9	0.8					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								*10*		*10*			*10*	
Sulfate (mg/L)	2.0									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	40.9					*≥20*									
Total Dissolved Solids (mg/L)	59.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL
and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)
1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-3 (NFFR above Poe Powerhouse)	August	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	12:30														
In situ Parameters															
Water Temperature (°C)	21.12														
Dissolved Oxygen (mg/L)	9.00												>7		
Specific Conductance (mmhos/cm)	118.4									900			150		
pH (Standard Units)	8.27							6.5-9.0					6.5-8.5		
Turbidity (NTU)	<2									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.02600					0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	0.00098								0.050		0.010				
Barium (mg/L)	0.01300								1.0		2.0			1.0	
Cadmium (mg/L)	<0.000002		0.0016	0.0024		0.00018	0.00119		0.0050		0.0050				
Chromium (mg/L)	0.00103		0.1291	1.0832		0.0538	1.1247		0.050		0.100				
Copper (mg/L)	0.00052		0.0057	0.0081		0.0057	0.0081		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	0.03520					1.00				0.30		0.30			
Lead (mg/L)	0.00001		0.0015	0.0392		0.0015	0.0392		0.015		0.015				
Manganese (mg/L)	0.00987									0.050		0.050			0.1
Mercury (mg/L)	4.70E-07								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00076		0.0320	0.2881		0.0320	0.2881		0.100					0.61	4.60
Selenium (mg/L)	<0.0001		0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	<0.000008				0.0015			0.0014		0.100					
Zinc (mg/L)	0.00011		0.0735	0.0735		0.0735	0.0735			5.000				7.4	26
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00102		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	<0.000002		0.0015	0.0023		0.00016	0.0011								
Copper (mg/L)	0.00050		0.0055	0.0078		0.0055	0.0078								
Lead (mg/L)	<0.000002		0.0013	0.0343		0.0013	0.0343								
Mercury (mg/L)	<2.0E-7					0.00077	0.0014								
Nickel (mg/L)	0.00066		0.0319	0.2876		0.0319	0.2876								
Silver (mg/L)	<0.000008				0.00128			0.00119							
Zinc (mg/L)	0.00111		0.0725	0.0719		0.0725	0.0719								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					1.05	3.34								
Total Hardness, as CaCO3 (mg/L)	56.2														
Chloride (mg/L) 9	1.0					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								10		10			10	
Sulfate (mg/L)	1.8									250	500	250			
Alkalinity - Total (mg/L)	60.7					≥ 20									
Total Dissolved Solids (mg/L)	74.0									500		500			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
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3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-3 (NFFR above Poe Powerhouse)	October	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	13:30														
In situ Parameters															
Water Temperature (°C)	14.80														
Dissolved Oxygen (mg/L)	10.50												>7		
Specific Conductance (mmhos/cm)	106									900			150		
pH (Standard Units)	8.20							6.5-9.0					6.5-8.5		
Turbidity (NTU)	0.8									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	<0.010					0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	0.00101								0.050		0.010				
Barium (mg/L)	0.01200								1.0		2.0			1.0	
Cadmium (mg/L)	<0.000002		0.0014	0.0019		0.00015	0.00098		0.0050		0.0050				
Chromium (mg/L)	0.00011		0.1107	0.9292		0.0461	0.9648		0.050		0.100				
Copper (mg/L)	0.00032		0.0049	0.0068		0.0049	0.0068		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	0.02130					1.00				0.30		0.30			
Lead (mg/L)	<0.000002		0.0012	0.0309		0.0012	0.0309		0.015		0.015				
Manganese (mg/L)	0.00552									0.050		0.050			0.1
Mercury (mg/L)	3.86E-07								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00047		0.0273	0.2459		0.0273	0.2459		0.100					0.61	4.60
Selenium (mg/L)	0.00015	J	0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	<0.000008				0.0011			0.0010		0.100					
Zinc (mg/L)	<0.00002		0.0627	0.0627		0.0627	0.0627			5.000				7.4	26
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00101		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	<0.000002		0.0013	0.0019		0.00014	0.0010								
Copper (mg/L)	0.00029		0.0047	0.0065		0.0047	0.0065								
Lead (mg/L)	<0.000002		0.0011	0.0279		0.0011	0.0279								
Mercury (mg/L)	3.87E-07					0.00077	0.0014								
Nickel (mg/L)	0.00042		0.0273	0.2454		0.0273	0.2454								
Silver (mg/L)	<0.000008				0.00093			0.00087							
Zinc (mg/L)	<0.00002		0.0619	0.0614		0.0619	0.0614								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					1.76	3.83								
Total Hardness, as CaCO3 (mg/L)	46.6														
Chloride (mg/L) 9	1.1					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								10		10			10	
Sulfate (mg/L)	1.7									250	500	250			
Alkalinity - Total (mg/L)	52.6					≥ 20									
Total Dissolved Solids (mg/L)	60.0									500		500			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

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Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
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Poe-5 (NFFR below Poe Dam)

	2003			
	March	May	August	October
Time	13:37	8:30	8:45	9:00
In situ Parameters				
Water Temperature (°C)	9.5	11.1	19.3	14.4
Dissolved Oxygen (mg/L)	10.3	12.0	7.9	7.2
DO percent saturation (%)	95	115	89	74
Specific Conductance (µmhos/cm)	75	80	113	107
pH	7.8	7.9	8.1	8.10
Turbidity (NTU)	2.7	1.2	<2	1.8
Depth (M)				
Analytical Parameters				
Total Metals:				
Aluminum (mg/L)	0.101	0.108	0.0214 J	0.0109 J
Arsenic (mg/L)	0.00059	0.00046	0.00102	0.00108
Barium (mg/L)	0.0127	0.014	0.0154	0.014
Cadmium (mg/L)	0.000009	<0.000002	<0.000002	<0.000002
Chromium (mg/L)	0.00045	0.00097	0.00056	0.00026
Copper (mg/L)	0.00093	0.00101	0.00064	0.00034
Iron (mg/L)	NS	NS	0.0337	0.0389
Lead (mg/L)	0.000048	0.00004	0.000012	<0.000002
Manganese (mg/L)	0.0099	0.0155	0.0166	0.0188
Mercury (mg/L)	2.48E-06	2.44E-06	4.8E-07	5.38E-07
Nickel (mg/L)	0.00149	0.00129	0.00074	0.00038
Selenium (mg/L)	<0.0001	<0.00001	0.00023	0.00027 J
Silver (mg/L)	0.000021	<0.000008	<0.000008	<0.000008
Zinc (mg/L)	0.00039	0.00018	0.00016	<0.00002
Dissolved Metals:				
Arsenic (mg/L)	0.0006	0.00037	0.00098	0.00101
Cadmium (mg/L)	<0.00001 DNQ	<0.000002	<0.000002	<0.000002
Copper (mg/L)	0.00075	0.0007	0.00056	0.00033
Iron (mg/L)	0.019	0.037	<0.002	0.0032 J
Lead (mg/L)	0.000011	<0.000002	<0.000002	<0.000002
Mercury (mg/L)	1.74E-06	1.81E-06	3.1E-07	5.4E-07
Nickel (mg/L)	0.00122	0.00093	0.00065	0.00027
Silver (mg/L)	<0.000008	<0.000008	<0.000008	<0.000008
Zinc (mg/L)	0.0002	<0.00002	0.00003	<0.00002
Ammonia - Total (mg/L)	<0.05	<0.05	<0.05	<0.05
Total Hardness, as CaCO3 (mg/L)	31.7	36.3	51.4	45.2
Chloride (mg/L)	0.67	0.75	0.98	1.03
Nitrate, as NO3 (mg/L) + Nitrite (mg/L)	0.0790	0.0644	0.1100	0.0750
Sulfate (mg/L)	2.01	1.95	1.64	1.57
Alkalinity - Total (mg/L)	36.5	40.1	54.5	50.2
Total Dissolved Solids (mg/L)	53	59	72	62
Total Suspended Solids (mg/L)	1.40	2.00	<1.0	<1.0
Total Phosphorous (mg/L)	<0.03	<0.03	<0.03	0.0171 J
Orthophosphate (mg/L)	0.0125	0.0106	0.0153	0.0174
Chlorophyll-a (µg/L)	0.210	4.860	0.812	0.122
Calcium (mg/L)	7.76	8.60	10.20	9.83
Magnesium (mg/L)	3.16	3.27	3.65	4.87
Potassium (mg/L)	0.69	0.66	1.40	1.41
Sodium (mg/L)	2.50	2.67	4.38	4.71

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based on statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.

DNQ = Detected above MDL and below RL, but not quantified (Marine Pollution Studies Laboratory). Result reported as less than the RL for this flag.

NS = Constituent not sampled for during monitoring program

Non-detectable results without a flag (DNQ) are reported as less than the MDL.

Poe-5 (NFFR below Poe Dam)	March	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	13:37														
In situ Parameters															
Water Temperature (°C)	9.50														
Dissolved Oxygen (mg/L)	10.30												>7		
Specific Conductance (µmhos/cm)	75									900			150		
pH (Standard Units)	7.80							6.5-9.0					6.5-8.5		
Turbidity (NTU)	2.7									5					
Analytical Parameters															
Total Metals (units of milligrams per liter)[7]															
Aluminum (mg/L)	0.10100					0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	0.00059								0.050		0.010				
Barium (mg/L)	0.01270								1.0		2.0			1.0	
Cadmium (mg/L)	0.00001		0.0010	0.0012		0.00012	0.00066		0.0050		0.0050				
Chromium (mg/L)	0.00045		0.0808	0.6777		0.0336	0.7037		0.050		0.100				
Copper (mg/L)	0.00093		0.0035	0.0047		0.0035	0.0047		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	NS					1.00				0.30		0.30			
Lead (mg/L)	0.00005		0.0007	0.0189		0.0007	0.0189		0.015		0.015				
Manganese (mg/L)	0.00990									0.050		0.050			0.1
Mercury (mg/L)	2.48E-06								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00149		0.0197	0.1775		0.0197	0.1775		0.100					0.61	4.60
Selenium (mg/L)	<0.0001		0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	0.00002				0.0006			0.0005		0.100					
Zinc (mg/L)	0.00039		0.0453	0.0453		0.0453	0.0453			5.000				7.4	26
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00060		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	<0.00001	DNQ	0.0010	0.0012		0.00011	0.0007								
Copper (mg/L)	0.00075		0.0034	0.0046		0.0034	0.0046								
Lead (mg/L)	0.00001		0.0007	0.0181		0.0007	0.0181								
Mercury (mg/L)	1.74E-06					0.00077	0.0014								
Nickel (mg/L)	0.00122		0.0197	0.1772		0.0197	0.1772								
Silver (mg/L)	<0.000008				0.00048			0.00045							
Zinc (mg/L)	0.00020		0.0446	0.0443		0.0446	0.0443								
Additional Analytical Parameters															
Ammonia - Total (mg/L)[5]	<0.05					3.18	8.11								
Total Hardness, as CaCO3 (mg/L)	31.7														
Chloride (mg/L)[9]	0.7					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)][8]	0.1								10		10			10	
Sulfate (mg/L)	2.0									250	500	250			
Alkalinity - Total (mg/L)	36.5					≥ 20									
Total Dissolved Solids (mg/L)	53.0									500		500			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
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1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California (*California Toxics Rule*).
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3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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Poe-5 (NFFR below Poe Dam)	May	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	8:30														
In situ Parameters															
Water Temperature (°C)	11.14														
Dissolved Oxygen (mg/L)	12.00												*>7*		
Specific Conductance (mmhos/cm)	80									*900*			*150*		
pH (Standard Units)	7.90							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	1.2									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.10800					*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	0.00046								*0.050*		*0.010*				
Barium (mg/L)	0.01400								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.000002		*0.0011*	*0.0014*		*0.00013*	*0.00076*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00097		*0.0903*	*0.7573*		*0.0376*	*0.7863*		*0.050*		*0.100*				
Copper (mg/L)	0.00101		*0.0039*	*0.0054*		*0.0039*	*0.0054*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	NS					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	0.00004		*0.0009*	*0.0225*		*0.0009*	*0.0225*		*0.015*		*0.015*				
Manganese (mg/L)	0.01550									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	2.44E-06								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00129		*0.0221*	*0.1991*		*0.0221*	*0.1991*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.00001		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.000008				*0.0007*			*0.0007*		*0.100*					
Zinc (mg/L)	0.00018		*0.0508*	*0.0508*		*0.0508*	*0.0508*			*5.000*				*7.4*	*26*
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00037		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	<0.000002		*0.0011*	*0.0014*		*0.00012*	*0.0008*								
Copper (mg/L)	0.00070		*0.0038*	*0.0052*		*0.0038*	*0.0052*								
Lead (mg/L)	<0.000002		*0.0008*	*0.0211*		*0.0008*	*0.0211*								
Mercury (mg/L)	1.81E-06					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00093		*0.0221*	*0.1987*		*0.0221*	*0.1987*								
Silver (mg/L)	<0.000008				*0.00060*			*0.00056*							
Zinc (mg/L)	<0.00002		*0.0501*	*0.0497*		*0.0501*	*0.0497*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					*2.80*	*6.77*								
Total Hardness, as CaCO3 (mg/L)	36.3														
Chloride (mg/L) 9	0.8					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								*10*		*10*			*10*	
Sulfate (mg/L)	2.0									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	40.1					*≥20*									
Total Dissolved Solids (mg/L)	59.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL
and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-5 (NFFR below Poe Dam)	August	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	8:45														
In situ Parameters															
Water Temperature (°C)	19.26														
Dissolved Oxygen (mg/L)	7.88												*>7*		
Specific Conductance (mmhos/cm)	113									*900*			*150*		
pH (Standard Units)	8.11							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	<2									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.02140					*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	0.00102								*0.050*		*0.010*				
Barium (mg/L)	0.01540								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.000002		*0.0015*	*0.0021*		*0.00017*	*0.00108*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00056		*0.1200*	*1.0068*		*0.0500*	*1.0454*		*0.050*		*0.100*				
Copper (mg/L)	0.00064		*0.0053*	*0.0075*		*0.0053*	*0.0075*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.03370					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	0.00001		*0.0014*	*0.0350*		*0.0014*	*0.0350*		*0.015*		*0.015*				
Manganese (mg/L)	0.01660									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	4.80E-07								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00074		*0.0297*	*0.2672*		*0.0297*	*0.2672*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	0.00023		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.3*
Silver (mg/L)	<0.000008				*0.0013*			*0.0012*		*0.100*					
Zinc (mg/L)	0.00016		*0.0682*	*0.0682*		*0.0682*	*0.0682*			*5.000*				*7.4*	*26*
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00098		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	<0.000002		*0.0014*	*0.0021*		*0.00015*	*0.0011*								
Copper (mg/L)	0.00056		*0.0051*	*0.0072*		*0.0051*	*0.0072*								
Lead (mg/L)	<0.000002		*0.0012*	*0.0311*		*0.0012*	*0.0311*								
Mercury (mg/L)	3.10E-07					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00065		*0.0296*	*0.2666*		*0.0296*	*0.2666*								
Silver (mg/L)	<0.000008				*0.00110*			*0.00102*							
Zinc (mg/L)	0.00003		*0.0672*	*0.0667*		*0.0672*	*0.0667*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					*1.52*	*4.55*								
Total Hardness, as CaCO3 (mg/L)	51.4														
Chloride (mg/L) 9	1.0					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								*10*		*10*			*10*	
Sulfate (mg/L)	1.6									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	54.5					*≥20*									
Total Dissolved Solids (mg/L)	72.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-5 (NFFR below Poe Dam)	October	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	9:00														
In situ Parameters															
Water Temperature (°C)	14.40														
Dissolved Oxygen (mg/L)	7.20												*>7*		
Specific Conductance (mmhos/cm)	107									*900*			*150*		
pH (Standard Units)	8.10							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	1.8									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.01090	J				*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	0.00108								*0.050*		*0.010*				
Barium (mg/L)	0.01400								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.000002		*0.0013*	*0.0018*		*0.00015*	*0.00095*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00026		*0.1080*	*0.9062*		*0.0450*	*0.9409*		*0.050*		*0.100*				
Copper (mg/L)	0.00034		*0.0047*	*0.0066*		*0.0047*	*0.0066*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.03890					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	<0.000002		*0.0012*	*0.0297*		*0.0012*	*0.0297*		*0.015*		*0.015*				
Manganese (mg/L)	0.01880									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	5.38E-07								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00038		*0.0266*	*0.2397*		*0.0266*	*0.2397*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	0.00027	J	*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.000008				*0.0010*			*0.0010*		*0.100*					
Zinc (mg/L)	<0.00002		*0.0611*	*0.0611*		*0.0611*	*0.0611*			*5.000*				*7.4*	*26*
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00101		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	<0.000002		*0.0012*	*0.0018*		*0.00014*	*0.0009*								
Copper (mg/L)	0.00033		*0.0045*	*0.0064*		*0.0045*	*0.0064*								
Lead (mg/L)	<0.000002		*0.0010*	*0.0269*		*0.0010*	*0.0269*								
Mercury (mg/L)	5.40E-07					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00027		*0.0266*	*0.2392*		*0.0266*	*0.2392*								
Silver (mg/L)	<0.000008				*0.00088*			*0.00082*							
Zinc (mg/L)	<0.00002		*0.0603*	*0.0598*		*0.0603*	*0.0598*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					*2.10*	*4.64*								
Total Hardness, as CaCO3 (mg/L)	45.2														
Chloride (mg/L) 9	1.0					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								*10*		*10*			*10*	
Sulfate (mg/L)	1.6									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	50.2					*≥20*									
Total Dissolved Solids (mg/L)	62.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-7 (NFFR upstream of Big Bend Dam)

	2003			
	March	May	August	October
Time	10:30	11:30	11:45	12:30
In situ Parameters				
Water Temperature (°C)	8.7	11.4	20.0	15.00
Dissolved Oxygen (mg/L)	11.1	12.5	8.6	10.60
DO percent saturation (%)	98	118	97	108
Specific Conductance (µmhos/cm)	71	81	113.1	106
pH	7.8	8.1	8.4	7.70
Turbidity (NTU)	3.6	1.8	<2	2.1
Depth (M)				
Analytical Parameters				
Total Metals:				
Aluminum (mg/L)	0.320	0.143	0.028 J	<0.010
Arsenic (mg/L)	0.00068	0.00042	0.00125	0.00115
Barium (mg/L)	0.0133	0.014	0.0116	0.011
Cadmium (mg/L)	<0.00001 DNQ	<0.000002	0.00001	<0.000002
Chromium (mg/L)	0.00058	0.00107	0.00054	0.0001
Copper (mg/L)	0.00118	0.00096	0.00052	0.0003
Iron (mg/L)	NS	NS	0.0511	0.135
Lead (mg/L)	0.000103	0.000029	0.000043	<0.000002
Manganese (mg/L)	0.023	0.0152	0.0222	0.0276
Mercury (mg/L)	2.51E-06	2.46E-06	2.1E-07	3.9E-07
Nickel (mg/L)	0.00201	0.0013	0.0004	0.00019
Selenium (mg/L)	<0.0001	<0.00001	0.0002	0.00016 J
Silver (mg/L)	<0.000008	<0.000008	<0.000008	<0.000008
Zinc (mg/L)	0.00076	<0.00002	0.00038	0.0003
Dissolved Metals:				
Arsenic (mg/L)	0.00059	0.00038	0.00112	0.00105
Cadmium (mg/L)	<0.00001 DNQ	<0.000002	<0.000002	<0.000002
Copper (mg/L)	0.00065	0.00065	0.00042	0.00026
Iron (mg/L)	0.018	0.021	<0.002	0.0041 J
Lead (mg/L)	0.00001	0.000009	<0.000002	<0.000002
Mercury (mg/L)	1.81E-06	1.91E-06	<2.0E-7	2.71E-07
Nickel (mg/L)	0.00131	0.001	0.00027	0.00013
Silver (mg/L)	<0.000008	<0.000008	<0.000008	<0.000008
Zinc (mg/L)	0.00025	<0.00002	0.00011	<0.00002
Ammonia - Total (mg/L)	<0.05	<0.05	<0.05	<0.05
Total Hardness, as CaCO3 (mg/L)	30.7	37.2	53.0	46.6
Chloride (mg/L)	0.67	0.77	1.05	1.05
Nitrate, as NO3 (mg/L) + Nitrite (mg/L)	0.0593	0.0767	0.0782	0.0633
Sulfate (mg/L)	1.93	1.96	1.66	1.60
Alkalinity - Total (mg/L)	31.2	40.7	55.0	52.1
Total Dissolved Solids (mg/L)	55	62	72	63
Total Suspended Solids (mg/L)	12.3	<1.0	1.3	1.1
Total Phosphorous (mg/L)	<0.03	<0.03	<0.03	0.0266 J
Orthophosphate (mg/L)	0.0113	0.0106	0.0124	0.0166
Chlorophyll-a (µg/L)	0.320	4.580	0.691	0.096
Calcium (mg/L)	7.72	8.57	10.20	9.95
Magnesium (mg/L)	3.00	3.41	3.74	4.86
Potassium (mg/L)	0.57	0.64	0.82	1.33
Sodium (mg/L)	2.36	2.67	4.37	4.68

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based on statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.

DNQ = Detected above MDL and below RL, but not quantified (Marine Pollution Studies Laboratory). Result reported as less than the RL for this flag.

NS = Constituent not sampled for during monitoring program

Non-detectable results without a flag (DNQ) are reported as less than the MDL.

Poe-7 (NFFR upstream of Big Bend Dam)	March	Flag	California Toxics Rules Criteria (USEPA) [1] Freshwater Aquatic Life Protection			USEPA National Recommended [2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) [3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB [4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	10:30														
In situ Parameters															
Water Temperature (°C)	8.70														
Dissolved Oxygen (mg/L)	11.10												*>7*		
Specific Conductance (µmhos/cm)	71									*900*			*150*		
pH (Standard Units)	7.80							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	3.6									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [7]															
Aluminum (mg/L)	0.32000					*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	0.00068								*0.050*		*0.010*				
Barium (mg/L)	0.01330								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.00001	DNQ	*0.0010*	*0.0012*		*0.00011*	*0.00064*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00058		*0.0787*	*0.6602*		*0.0328*	*0.6854*		*0.050*		*0.100*				
Copper (mg/L)	0.00118		*0.0034*	*0.0046*		*0.0034*	*0.0046*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	NS					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	0.00010		*0.0007*	*0.0182*		*0.0007*	*0.0182*		*0.015*		*0.015*				
Manganese (mg/L)	0.02300									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	2.51E-06								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00201		*0.0192*	*0.1728*		*0.0192*	*0.1728*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.0001		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.000008				*0.0005*			*0.0005*		*0.100*					
Zinc (mg/L)	0.00076		*0.0441*	*0.0441*		*0.0441*	*0.0441*			*5.000*				*7.4*	*26*
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00059		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	<0.00001	DNQ	*0.0009*	*0.0012*		*0.00011*	*0.0006*								
Copper (mg/L)	0.00065		*0.0033*	*0.0044*		*0.0033*	*0.0044*								
Lead (mg/L)	0.00001		*0.0007*	*0.0175*		*0.0007*	*0.0175*								
Mercury (mg/L)	1.81E-06					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00131		*0.0192*	*0.1724*		*0.0192*	*0.1724*								
Silver (mg/L)	<0.000008				*0.00045*			*0.00042*							
Zinc (mg/L)	0.00025		*0.0434*	*0.0431*		*0.0434*	*0.0431*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) [5]	<0.05					*3.18*	*8.11*								
Total Hardness, as CaCO3 (mg/L)	30.7														
Chloride (mg/L) [9]	0.7					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), {Nitrite (mg/L)} [8]	0.1								*10*		*10*			*10*	
Sulfate (mg/L)	1.9									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	31.2					*≥ 20*									
Total Dissolved Solids (mg/L)	55.0									*500*		*500*			

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Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

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8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Poe-7 (NFFR upstream of Big Bend Dam)	May	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average)	
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		Sources of Drinking water (water + organism consump)	Other waters (aquatic org. consump)
Time	11:30														
In situ Parameters															
Water Temperature (°C)	11.41														
Dissolved Oxygen (mg/L)	12.54												>7		
Specific Conductance (mmhos/cm)	81									900			150		
pH (Standard Units)	8.10							6.5-9.0					6.5-8.5		
Turbidity (NTU)	1.8									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.14300					0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	0.00042								0.050		0.010				
Barium (mg/L)	0.01400								1.0		2.0			1.0	
Cadmium (mg/L)	<0.000002		0.0011	0.0015		0.00013	0.00078		0.0050		0.0050				
Chromium (mg/L)	0.00107		0.0921	0.7726		0.0383	0.8022		0.050		0.100				
Copper (mg/L)	0.00096		0.0040	0.0055		0.0040	0.0055		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	NS					1.00				0.30		0.30			
Lead (mg/L)	0.00003		0.0009	0.0232		0.0009	0.0232		0.015		0.015				
Manganese (mg/L)	0.01520									0.050		0.050			0.1
Mercury (mg/L)	2.46E-06								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00130		0.0226	0.2032		0.0226	0.2032		0.100					0.61	4.60
Selenium (mg/L)	<0.00001		0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	<0.000008				0.0007			0.0007		0.100					
Zinc (mg/L)	<0.00002		0.0518	0.0518		0.0518	0.0518			5.000				7.4	26
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00038		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	<0.000002		0.0011	0.0015		0.00012	0.0008								
Copper (mg/L)	0.00065		0.0038	0.0053		0.0038	0.0053								
Lead (mg/L)	0.00001		0.0008	0.0217		0.0008	0.0217								
Mercury (mg/L)	1.91E-06					0.00077	0.0014								
Nickel (mg/L)	0.00100		0.0225	0.2028		0.0225	0.2028								
Silver (mg/L)	<0.000008				0.00063			0.00059							
Zinc (mg/L)	<0.00002		0.0511	0.0507		0.0511	0.0507								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					2.10	4.64								
Total Hardness, as CaCO3 (mg/L)	37.2														
Chloride (mg/L) 9	0.8					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								10		10			10	
Sulfate (mg/L)	2.0									250	500	250			
Alkalinity - Total (mg/L)	40.7					≥20									
Total Dissolved Solids (mg/L)	62.0									500		500			

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Poe-7 (NFFR upstream of Big Bend Dam)	August	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	11:45														
In situ Parameters															
Water Temperature (°C)	20.00														
Dissolved Oxygen (mg/L)	8.60												*>7*		
Specific Conductance (mmhos/cm)	113.1									*900*			*150*		
pH (Standard Units)	8.40							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	<2									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.02820					*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	0.00125								*0.050*		*0.010*				
Barium (mg/L)	0.01160								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	0.00001		*0.0015*	*0.0022*		*0.00017*	*0.00112*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00054		*0.1231*	*1.0324*		*0.0512*	*1.0720*		*0.050*		*0.100*				
Copper (mg/L)	0.00052		*0.0054*	*0.0077*		*0.0054*	*0.0077*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.05110					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	0.00004		*0.0014*	*0.0364*		*0.0014*	*0.0364*		*0.015*		*0.015*				
Manganese (mg/L)	0.02220									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	2.10E-07								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00040		*0.0305*	*0.2742*		*0.0305*	*0.2742*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	0.00020		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.000008				*0.0014*			*0.0013*		*0.100*					
Zinc (mg/L)	0.00038		*0.0700*	*0.0700*		*0.0700*	*0.0700*			*5.000*				*7.4*	*26*
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00112		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	<0.000002		*0.0014*	*0.0021*		*0.00016*	*0.0011*								
Copper (mg/L)	0.00042		*0.0052*	*0.0074*		*0.0052*	*0.0074*								
Lead (mg/L)	<0.000002		*0.0013*	*0.0321*		*0.0013*	*0.0321*								
Mercury (mg/L)	<2.0E-7					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00027		*0.0304*	*0.2737*		*0.0304*	*0.2737*								
Silver (mg/L)	<0.000008				*0.00116*			*0.00108*							
Zinc (mg/L)	0.00011		*0.0690*	*0.0684*		*0.0690*	*0.0684*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					*0.91*	*2.59*								
Total Hardness, as CaCO3 (mg/L)	53.0														
Chloride (mg/L) 9	1.1					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								*10*		*10*			*10*	
Sulfate (mg/L)	1.7									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	55.0					*≥20*									
Total Dissolved Solids (mg/L)	72.0									*500*		*500*			

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			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	12:30														
In situ Parameters															
Water Temperature (°C)	15.00														
Dissolved Oxygen (mg/L)	10.60												>7		
Specific Conductance (mmhos/cm)	106									900			150		
pH (Standard Units)	7.70							6.5-9.0					6.5-8.5		
Turbidity (NTU)	2.1									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	<0.010					0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	0.00115								0.050		0.010				
Barium (mg/L)	0.01100								1.0		2.0			1.0	
Cadmium (mg/L)	<0.000002		0.0014	0.0019		0.00015	0.00098		0.0050		0.0050				
Chromium (mg/L)	0.00010		0.1107	0.9292		0.0461	0.9648		0.050		0.100				
Copper (mg/L)	0.00030		0.0049	0.0068		0.0049	0.0068		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	0.13500					1.00				0.30		0.30			
Lead (mg/L)	<0.000002		0.0012	0.0309		0.0012	0.0309		0.015		0.015				
Manganese (mg/L)	0.02760									0.050		0.050			0.1
Mercury (mg/L)	3.90E-07								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00019		0.0273	0.2459		0.0273	0.2459		0.100					0.61	4.60
Selenium (mg/L)	0.00016	J	0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	<0.000008				0.0011			0.0010		0.100					
Zinc (mg/L)	0.00030		0.0627	0.0627		0.0627	0.0627			5.000				7.4	26
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00105		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	<0.000002		0.0013	0.0019		0.00014	0.0010								
Copper (mg/L)	0.00026		0.0047	0.0065		0.0047	0.0065								
Lead (mg/L)	<0.000002		0.0011	0.0279		0.0011	0.0279								
Mercury (mg/L)	2.71E-07					0.00077	0.0014								
Nickel (mg/L)	0.00013		0.0273	0.2454		0.0273	0.2454								
Silver (mg/L)	<0.000008				0.00093			0.00087							
Zinc (mg/L)	<0.00002		0.0619	0.0614		0.0619	0.0614								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					3.47	9.64								
Total Hardness, as CaCO3 (mg/L)	46.6														
Chloride (mg/L) 9	1.1					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								10		10			10	
Sulfate (mg/L)	1.6									250	500	250			
Alkalinity - Total (mg/L)	52.1					≥ 20									
Total Dissolved Solids (mg/L)	63.0									500		500			

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Flea Valley Creek (near mouth Poe Project)

	2003							
	March		May		August		October	
Time	12:00		10:10		10:20		9:45	
In situ Parameters								
Water Temperature (°C)	10.3		10.7		13.8		11.80	
Dissolved Oxygen (mg/L)	9.7		12.3		9.2		10.70	
DO percent saturation (%)	90		116		93		104	
Specific Conductance (µmhos/cm)	134		132		157		156	
pH	8.3		8.2		8.3		7.90	
Turbidity (NTU)	1.6		0.3		<1		1.2	
Depth (M)								
Analytical Parameters								
Total Metals:								
Aluminum (mg/L)	0.064		0.129		0.121		0.0122	J
Arsenic (mg/L)	0.00036		0.00012		0.00048		0.00041	
Barium (mg/L)	0.0192		0.017		0.026		0.025	
Cadmium (mg/L)	<0.00001	DNQ	<0.000002		0.000002		<0.000002	
Chromium (mg/L)	0.00093		0.00168		0.0016		0.00033	
Copper (mg/L)	0.0004		0.00036		0.00068		0.00032	
Iron (mg/L)	NS		NS		0.074		0.011	
Lead (mg/L)	0.000015		<0.000002		0.000047		0.000025	J
Manganese (mg/L)	0.00085		0.00097		0.00246		0.00156	
Mercury (mg/L)	1.62E-06		1.59E-06		7.2E-07		2.35E-07	
Nickel (mg/L)	0.00151		0.00172		0.00213		0.00148	
Selenium (mg/L)	<0.0003	DNQ	<0.00001		0.00031		0.00023	J
Silver (mg/L)	<0.000008		<0.000008		<0.000008		<0.000008	
Zinc (mg/L)	0.00024		<0.00002		0.00043		0.00003	J
Dissolved Metals:								
Arsenic (mg/L)	0.00035		<0.00010		0.00049		0.00043	
Cadmium (mg/L)	<0.00001	DNQ	<0.000002		<0.000002		0.000003	J
Copper (mg/L)	0.00029		0.00021		0.0003		0.00016	
Iron (mg/L)	0.019		<0.0050		<0.002		<0.0020	
Lead (mg/L)	<0.00001	DNQ	<0.000002		<0.000002		<0.000002	
Mercury (mg/L)	1.29E-06		1.70E-06		<2.0E-7		2.95E-07	
Nickel (mg/L)	0.00128		0.00145		0.00105		0.0008	
Silver (mg/L)	<0.000008		<0.000008		<0.000008		<0.000008	
Zinc (mg/L)	0.00016		<0.00002		0.00011		<0.00002	
Ammonia - Total (mg/L)	<0.05		<0.05		<0.05		<0.05	
Total Hardness, as CaCO3 (mg/L)	61.9		61.7		78.5		72.4	
Chloride (mg/L)	1.12		1.18		1.16		1.18	
Nitrate, as NO3 (mg/L) + Nitrite (mg/L)	0.0359		0.0616		0.0794		0.0840	
Sulfate (mg/L)	3.74		3.27		4.92		5.43	
Alkalinity - Total (mg/L)	66.6		69.1		76.5		74.9	
Total Dissolved Solids (mg/L)	101		95		107		101	
Total Suspended Solids (mg/L)	1.3		1.1		27.5		3.1	
Total Phosphorous (mg/L)	0.03	J	<0.03		0.041	J	0.0539	
Orthophosphate (mg/L)	0.0329		0.0298		0.0409		0.0494	
Chlorophyll-a (µg/L)	0.090		1.920		1.078		0.028	
Calcium (mg/L)	11.61		10.40		13.00		13.20	
Magnesium (mg/L)	8.65		8.72		8.58		9.07	
Potassium (mg/L)	1.51		1.34		2.31		2.21	
Sodium (mg/L)	3.54		3.35		4.60		4.83	

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.
DNQ = Detected above MDL and below RL, but not quantified (Marine Pollution Studies Laboratory).
Result reported as less than the RL for this flag.
NS = Constituent not sampled for during monitoring program
Non-detectable results without a flag (DNQ) are reported as less than the MDL.

Flea Valley Creek (near mouth Poe Project)	March	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org consump)
Time	12:00														
In situ Parameters															
Water Temperature (°C)	10.30														
Dissolved Oxygen (mg/L)	9.70												>7		
Specific Conductance (μmhos/cm)	134									900			150		
pH (Standard Units)	8.30							6.5-9.0					6.5-8.5		
Turbidity (NTU)	1.6									5					
Analytical Parameters															
Total Metals (units of milligrams per liter)[7]															
Aluminum (mg/L)	0.06400					0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	0.00036								0.050		0.010				
Barium (mg/L)	0.01920								1.0		2.0			1.0	
Cadmium (mg/L)	<0.00001	DNQ	0.0017	0.0026		0.00019	0.00131		0.0050		0.0050				
Chromium (mg/L)	0.00093		0.1397	1.1724		0.0582	1.2173		0.050		0.100				
Copper (mg/L)	0.00040		0.0062	0.0089		0.0062	0.0089		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	NS					1.00				0.30		0.30			
Lead (mg/L)	0.00002		0.0017	0.0443		0.0017	0.0443		0.015		0.015				
Manganese (mg/L)	0.00085									0.050		0.050			0.1
Mercury (mg/L)	1.62E-06								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00151		0.0348	0.3127		0.0348	0.3127		0.100					0.61	4.60
Selenium (mg/L)	<0.0003	DNQ	0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	<0.000008				0.0018			0.0017		0.100					
Zinc (mg/L)	0.00024		0.0798	0.0798		0.0798	0.0798			5.000				7.4	26
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00035		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	<0.00001	DNQ	0.0016	0.0025		0.00018	0.0013								
Copper (mg/L)	0.00029		0.0059	0.0086		0.0059	0.0086								
Lead (mg/L)	<0.00001	DNQ	0.0015	0.0382		0.0015	0.0382								
Mercury (mg/L)	1.29E-06					0.00077	0.0014								
Nickel (mg/L)	0.00128		0.0347	0.3121		0.0347	0.3121								
Silver (mg/L)	<0.000008				0.00151			0.00141							
Zinc (mg/L)	0.00016		0.0787	0.0780		0.0787	0.0780								
Additional Analytical Parameters															
Ammonia - Total (mg/L)[5]	<0.05					1.52	3.15								
Total Hardness, as CaCO3 (mg/L)	61.9														
Chloride (mg/L)[9]	1.1					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)][8]	0.04								10		10			10	
Sulfate (mg/L)	3.7									250	500	250			
Alkalinity - Total (mg/L)	66.6					≥ 20									
Total Dissolved Solids (mg/L)	101.0									500		500			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California (*California Toxics Rule*).
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Flea Valley Creek (near mouth Poe Project)	May	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	10:10														
In situ Parameters															
Water Temperature (°C)	10.65														
Dissolved Oxygen (mg/L)	12.26												*>7*		
Specific Conductance (mmhos/cm)	132									*900*			*150*		
pH (Standard Units)	8.23							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	0.3									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.12900					*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	0.00012								*0.050*		*0.010*				
Barium (mg/L)	0.01700								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.000002		*0.0017*	*0.0026*		*0.00019*	*0.00131*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00168		*0.1394*	*1.1693*		*0.0580*	*1.2141*		*0.050*		*0.100*				
Copper (mg/L)	0.00036		*0.0062*	*0.0089*		*0.0062*	*0.0089*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	NS					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	<0.000002		*0.0017*	*0.0442*		*0.0017*	*0.0442*		*0.015*		*0.015*				
Manganese (mg/L)	0.00097									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	1.59E-06								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00172		*0.0347*	*0.3118*		*0.0347*	*0.3118*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.00001		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.000008				*0.0018*			*0.0016*		*0.100*					
Zinc (mg/L)	<0.00002		*0.0796*	*0.0796*		*0.0796*	*0.0796*			*5.000*				*7.4*	*26*
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	<0.00010		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	<0.000002		*0.0016*	*0.0025*		*0.00018*	*0.0013*								
Copper (mg/L)	0.00021		*0.0059*	*0.0085*		*0.0059*	*0.0085*								
Lead (mg/L)	<0.000002		*0.0015*	*0.0380*		*0.0015*	*0.0380*								
Mercury (mg/L)	1.70E-06					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00145		*0.0346*	*0.3112*		*0.0346*	*0.3112*								
Silver (mg/L)	<0.000008				*0.00150*			*0.00140*							
Zinc (mg/L)	<0.00002		*0.0785*	*0.0778*		*0.0785*	*0.0778*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					*1.71*	*3.61*								
Total Hardness, as CaCO3 (mg/L)	61.7														
Chloride (mg/L) 9	1.2					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.06								*10*		*10*			*10*	
Sulfate (mg/L)	3.3									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	69.1					*≥20*									
Total Dissolved Solids (mg/L)	95.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California (California Toxics Rule).
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Flea Valley Creek (near mouth Poe Project)	August	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	10:20														
In situ Parameters															
Water Temperature (°C)	13.84														
Dissolved Oxygen (mg/L)	9.19												>7		
Specific Conductance (mmhos/cm)	157									*900*			*150*		
pH (Standard Units)	8.26							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	<1									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.12100					*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	0.00048								*0.050*		*0.010*				
Barium (mg/L)	0.02600								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	0.00000		*0.0020*	*0.0034*		*0.00023*	*0.00167*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00160		*0.1698*	*1.4242*		*0.0707*	*1.4788*		*0.050*		*0.100*				
Copper (mg/L)	0.00068		*0.0076*	*0.0111*		*0.0076*	*0.0111*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.07400					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	0.00005		*0.0023*	*0.0600*		*0.0023*	*0.0600*		*0.015*		*0.015*				
Manganese (mg/L)	0.00246									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	7.20E-07								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00213		*0.0425*	*0.3823*		*0.0425*	*0.3823*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	0.00031		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.000008				*0.0027*			*0.0025*		*0.100*					
Zinc (mg/L)	0.00043		*0.0976*	*0.0976*		*0.0976*	*0.0976*			*5.000*				*7.4*	*26*
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00049		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	<0.000002		*0.0019*	*0.0033*		*0.00021*	*0.0016*								
Copper (mg/L)	0.00030		*0.0073*	*0.0107*		*0.0073*	*0.0107*								
Lead (mg/L)	<0.000002		*0.0019*	*0.0496*		*0.0019*	*0.0496*								
Mercury (mg/L)	<2.0E-7					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00105		*0.0424*	*0.3815*		*0.0424*	*0.3815*								
Silver (mg/L)	<0.000008				*0.00228*			*0.00212*							
Zinc (mg/L)	0.00011		*0.0962*	*0.0955*		*0.0962*	*0.0955*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					*1.63*	*3.40*								
Total Hardness, as CaCO3 (mg/L)	78.5														
Chloride (mg/L) 9	1.2					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.08								*10*		*10*			*10*	
Sulfate (mg/L)	4.9									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	76.5					*≥ 20*									
Total Dissolved Solids (mg/L)	107.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

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Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
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7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Flea Valley Creek (near mouth Poe Project)	October	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	9:45														
In situ Parameters															
Water Temperature (°C)	11.80														
Dissolved Oxygen (mg/L)	10.70												>7		
Specific Conductance (mmhos/cm)	156									900			150		
pH (Standard Units)	7.90							6.5-9.0					6.5-8.5		
Turbidity (NTU)	1.2									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.01220	J				0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	0.00041								0.050		0.010				
Barium (mg/L)	0.02500								1.0		2.0			1.0	
Cadmium (mg/L)	<0.000002		0.0019	0.0031		0.00021	0.00154		0.0050		0.0050				
Chromium (mg/L)	0.00033		0.1589	1.3329		0.0662	1.3840		0.050		0.100				
Copper (mg/L)	0.00032		0.0071	0.0103		0.0071	0.0103		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	0.01100					1.00				0.30		0.30			
Lead (mg/L)	0.00003	J	0.0021	0.0541		0.0021	0.0541		0.015		0.015				
Manganese (mg/L)	0.00156									0.050		0.050			0.1
Mercury (mg/L)	2.35E-07								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00148		0.0397	0.3570		0.0397	0.3570		0.100					0.61	4.60
Selenium (mg/L)	0.00023	J	0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	<0.000008				0.0023			0.0022		0.100					
Zinc (mg/L)	0.00003	J	0.0911	0.0911		0.0911	0.0911			5.000				7.4	26
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00043		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	0.00000	J	0.0018	0.0030		0.00020	0.0015								
Copper (mg/L)	0.00016		0.0068	0.0099		0.0068	0.0099								
Lead (mg/L)	<0.000002		0.0018	0.0454		0.0018	0.0454								
Mercury (mg/L)	2.95E-07					0.00077	0.0014								
Nickel (mg/L)	0.00080		0.0396	0.3563		0.0396	0.3563								
Silver (mg/L)	<0.000008				0.00198			0.00185							
Zinc (mg/L)	<0.00002		0.0899	0.0891		0.0899	0.0891								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					2.80	6.77								
Total Hardness, as CaCO3 (mg/L)	72.4														
Chloride (mg/L) 9	1.2					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								10		10			10	
Sulfate (mg/L)	5.4									250	500	250			
Alkalinity - Total (mg/L)	74.9					≥ 20									
Total Dissolved Solids (mg/L)	101.0									500		500			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL
and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Mill Creek (near mouth, Poe Project)

	2003			
	March	May	August	October
Time	13:17	9:00	9:10	9:15
In situ Parameters				
Water Temperature (°C)	7.9	8.5	13.4	9.90
Dissolved Oxygen (mg/L)	11.2	11.9	9.8	10.70
DO percent saturation (%)	99	108	99	99
Specific Conductance (μmhos/cm)	62	60	78	82
pH	8.0	7.9	8.0	8.30
Turbidity (NTU)	0.8	< 0.1	<1	0.4
Depth (M)				
Analytical Parameters				
Total Metals:				
Aluminum (mg/L)	0.022	0.24	0.0163 J	<0.010
Arsenic (mg/L)	<0.00010	<0.00010	<0.00010	0.00017
Barium (mg/L)	0.008	0.008	0.0111	0.012
Cadmium (mg/L)	<0.000002	<0.000002	<0.000002	<0.000002
Chromium (mg/L)	0.00083	0.00126	0.00114	0.00046
Copper (mg/L)	0.00016	0.00019	0.0002	0.00004
Iron (mg/L)	NS	NS	0.0124	0.006
Lead (mg/L)	<0.00001 DNQ	0.000011	<0.000002	<0.000002
Manganese (mg/L)	0.00056	0.00061	0.0006	0.00026
Mercury (mg/L)	1.54E-06	1.79E-06	<2.0E-7	3.19E-07
Nickel (mg/L)	0.00518	0.00586	0.00428	0.00391
Selenium (mg/L)	<0.0001	0.0001	0.00013	0.00038
Silver (mg/L)	<0.000008	<0.000008	<0.000008	<0.000008
Zinc (mg/L)	0.00031	<0.00006 DNQ	0.00004	<0.00002
Dissolved Metals:				
Arsenic (mg/L)	<0.00010	<0.00010	0.00012	0.00014
Cadmium (mg/L)	<0.000002	<0.000002	<0.000002	0.000006 J
Copper (mg/L)	0.00013	0.00006	0.00017	0.00005
Iron (mg/L)	<0.0050	<0.0050	<0.002	<0.0020
Lead (mg/L)	<0.00002	<0.000002	<0.000002	<0.000002
Mercury (mg/L)	1.31E-06	1.41E-06	<2.0E-7	2.6E-07
Nickel (mg/L)	0.00472	0.00526	0.00429	0.00362
Silver (mg/L)	<0.000008	<0.000008	<0.000008	<0.000008
Zinc (mg/L)	0.00013	<0.00002	0.00007	<0.00002
Ammonia - Total (mg/L)	<0.05	<0.05	<0.05	<0.05
Total Hardness, as CaCO3 (mg/L)	30.7	29.4	41.5	40.0
Chloride (mg/L)	0.41	0.51	0.57	0.56
Nitrate, as NO3 (mg/L) + Nitrite (mg/L)	0.0288	0.0579	0.0968	0.0876
Sulfate (mg/L)	1.26	1.16	1.79	2.04
Alkalinity - Total (mg/L)	31.4	32.1	39.6	39.1
Total Dissolved Solids (mg/L)	51	51	61	50
Total Suspended Solids (mg/L)	<1.0	<1.0	<1.0	<1.0
Total Phosphorous (mg/L)	<0.03	<0.03	<0.03	0.0159 J
Orthophosphate (mg/L)	0.0116	0.0115	0.0201	0.0262
Chlorophyll-a (μg/L)	0.060	1.270	0.075	0.080
Calcium (mg/L)	3.10	2.79	3.90	3.90
Magnesium (mg/L)	5.52	5.20	6.39	7.08
Potassium (mg/L)	0.41	0.40	0.38	0.01
Sodium (mg/L)	1.15	1.11	1.28	1.65

J = Estimated concentration below the reporting limit (RL) and above the method detection limit (MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL by the analytical laboratory.
DNQ = Detected above MDL and below RL, but not quantified (Marine Pollution Studies Laboratory).
Result reported as less than the RL for this flag.
NS = Constituent not sampled for during monitoring program
Non-detectable results without a flag (DNQ) are reported as less than the MDL.

Mill Creek (near mouth, Poe Project)	March	Flag	California Toxics Rules Criteria (USEPA)[1] Freshwater Aquatic Life Protection			USEPA National Recommended[2] Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept of Health Services (DHS)[3] Drinking Water Standards		USEPA Drinking Water Standards		RWQCB[4] Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	13:17														
In situ Parameters															
Water Temperature (°C)	7.90														
Dissolved Oxygen (mg/L)	11.20												*>7*		
Specific Conductance (µmhos/cm)	62									*900*			*150*		
pH (Standard Units)	8.00							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	0.8									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) [7]															
Aluminum (mg/L)	0.02200					*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	<0.00010								*0.050*		*0.010*				
Barium (mg/L)	0.00800								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.000002		*0.0010*	*0.0012*		*0.00011*	*0.00064*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00083		*0.0787*	*0.6602*		*0.0328*	*0.6854*		*0.050*		*0.100*				
Copper (mg/L)	0.00016		*0.0034*	*0.0046*		*0.0034*	*0.0046*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	NS					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	<0.00001	DNQ	*0.0007*	*0.0182*		*0.0007*	*0.0182*		*0.015*		*0.015*				
Manganese (mg/L)	0.00056									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	1.54E-06								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00518		*0.0192*	*0.1728*		*0.0192*	*0.1728*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	<0.0001		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.000008				*0.0005*			*0.0005*		*0.100*					
Zinc (mg/L)	0.00031		*0.0441*	*0.0441*		*0.0441*	*0.0441*			*5.000*				*7.4*	*26*
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	<0.00010		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	<0.000002		*0.0009*	*0.0012*		*0.00011*	*0.0006*								
Copper (mg/L)	0.00013		*0.0033*	*0.0044*		*0.0033*	*0.0044*								
Lead (mg/L)	<0.00002		*0.0007*	*0.0175*		*0.0007*	*0.0175*								
Mercury (mg/L)	1.31E-06					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00472		*0.0192*	*0.1724*		*0.0192*	*0.1724*								
Silver (mg/L)	<0.000008				*0.00045*			*0.00042*							
Zinc (mg/L)	0.00013		*0.0434*	*0.0431*		*0.0434*	*0.0431*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) [5]	<0.05					*2.43*	*5.62*								
Total Hardness, as CaCO3 (mg/L)	30.7														
Chloride (mg/L) [9]	0.4					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] [8]	0.0								*10*		*10*			*10*	
Sulfate (mg/L)	1.3									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	31.4					*≥ 20*									
Total Dissolved Solids (mg/L)	51.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [*California Toxics Rule*].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

Mill Creek (near mouth, Poe Project)	May	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking water	CTR (Human Health 30-day average) Other waters
			CCC	CMC	Instantaneous Max	CCC	CMC	Instantaneous Max	1° MCL	2° MCL	1° MCL	2° MCL		(water + organism consump)	(aquatic org. consump)
Time	9.00														
In situ Parameters															
Water Temperature (°C)	8.53														
Dissolved Oxygen (mg/L)	11.94												>7		
Specific Conductance (mmhos/cm)	60									900			150		
pH (Standard Units)	7.90							6.5-9.0					6.5-8.5		
Turbidity (NTU)	< 0.1									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.24000					0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	<0.00010								0.050		0.010				
Barium (mg/L)	0.00800								1.0		2.0			1.0	
Cadmium (mg/L)	<0.000002		0.0009	0.0011		0.00011	0.00061		0.0050		0.0050				
Chromium (mg/L)	0.00126		0.0759	0.6372		0.0316	0.6616		0.050		0.100				
Copper (mg/L)	0.00019		0.0033	0.0044		0.0033	0.0044		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	NS					1.00				0.30		0.30			
Lead (mg/L)	0.00001		0.0007	0.0172		0.0007	0.0172		0.015		0.015				
Manganese (mg/L)	0.00061									0.050		0.050			0.1
Mercury (mg/L)	1.79E-06								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00586		0.0185	0.1666		0.0185	0.1666		0.100					0.61	4.60
Selenium (mg/L)	0.00010		0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	<0.000008				0.0005			0.0005		0.100					
Zinc (mg/L)	<0.00006	DNQ	0.0425	0.0425		0.0425	0.0425			5.000				7.4	26
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	<0.00010		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	<0.000002		0.0009	0.0011		0.00010	0.0006								
Copper (mg/L)	0.00006		0.0031	0.0042		0.0031	0.0042								
Lead (mg/L)	<0.000002		0.0006	0.0167		0.0006	0.0167								
Mercury (mg/L)	1.41E-06					0.00077	0.0014								
Nickel (mg/L)	0.00526		0.0185	0.1662		0.0185	0.1662								
Silver (mg/L)	<0.000008				0.00042			0.00039							
Zinc (mg/L)	<0.00002		0.0419	0.0415		0.0419	0.0415								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					2.80	6.77								
Total Hardness, as CaCO3 (mg/L)	29.4														
Chloride (mg/L) 9	0.5					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								10		10			10	
Sulfate (mg/L)	1.2									250	500	250			
Alkalinity - Total (mg/L)	32.1					≥ 20									
Total Dissolved Solids (mg/L)	51.0									500		500			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria
J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory
Shaded cells represent exceedances of the criteria
NS = Constituent was not sampled for during this month
CCC = Continuous concentration (4-day average)
CMC = Maximum concentration (1-hour average)
1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

[redacted]

Mill Creek (near mouth, Poe Project)	August	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA National Recommended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day average) Sources of Drinking Water	CTR (Human Health 30-day average) Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org. consump)*
Time	9:10														
In situ Parameters															
Water Temperature (°C)	13.37														
Dissolved Oxygen (mg/L)	9.80												>7		
Specific Conductance (mmhos/cm)	77.7									900			150		
pH (Standard Units)	8.01							6.5-9.0					6.5-8.5		
Turbidity (NTU)	<1									5					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	0.01630					0.087	0.75		1.0	0.20		0.050 to 0.2			
Arsenic (mg/L)	<0.00010								0.050		0.010				
Barium (mg/L)	0.01110								1.0		2.0			1.0	
Cadmium (mg/L)	<0.000002		0.0012	0.0017		0.00014	0.00087		0.0050		0.0050				
Chromium (mg/L)	0.00114		0.1007	0.8450		0.0419	0.8774		0.050		0.100				
Copper (mg/L)	0.00020		0.0044	0.0061		0.0044	0.0061		1.3	1.0	1.3	1.0		1.3	
Iron (mg/L)	0.01240					1.00				0.30		0.30			
Lead (mg/L)	<0.000002		0.0010	0.0267		0.0010	0.0267		0.015		0.015				
Manganese (mg/L)	0.00060									0.050		0.050			0.1
Mercury (mg/L)	<2.0E-7								0.0020		0.0020			0.000050	0.000051
Nickel (mg/L)	0.00428		0.0248	0.2229		0.0248	0.2229		0.100					0.61	4.60
Selenium (mg/L)	0.00013		0.0050	0.0200		0.0050			0.050					0.170	4.2
Silver (mg/L)	<0.000008				0.0009			0.0008		0.100					
Zinc (mg/L)	0.00004		0.0569	0.0569		0.0569	0.0569			5.000				7.4	36
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00012		0.1500	0.3400		0.1500	0.3400								
Cadmium (mg/L)	<0.000002		0.0012	0.0016		0.00013	0.0009								
Copper (mg/L)	0.00017		0.0042	0.0059		0.0042	0.0059								
Lead (mg/L)	<0.000002		0.0010	0.0245		0.0010	0.0245								
Mercury (mg/L)	<2.0E-7					0.00077	0.0014								
Nickel (mg/L)	0.00429		0.0247	0.2225		0.0247	0.2225								
Silver (mg/L)	<0.000008				0.00076			0.00071							
Zinc (mg/L)	0.00007		0.0561	0.0556		0.0561	0.0556								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					2.40	5.51								
Total Hardness, as CaCO3 (mg/L)	41.5														
Chloride (mg/L) 9	0.6					230	860			250		250			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								10		10			10	
Sulfate (mg/L)	1.8									250	500	250			
Alkalinity - Total (mg/L)	39.6					≥20									
Total Dissolved Solids (mg/L)	61.0									500		500			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule]
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
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8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

M[illegible] reek (near mouth, Poe Project)	October	Flag	California Toxics Rules Criteria (USEPA) 1 Freshwater Aquatic Life Protection			USEPA Natio[illegible] [illegible]commended 2 Ambient Water Quality Criteria Freshwater Aquatic Life Protection			Cal Dept. of Health Services (DHS) 3 Drinking Water Standards		USEPA Drinking Water Standards		RWQCB 4 Basin Plan Objectives	CTR (Human Health 30-day ave[illegible]) Sources of Drinking water	CTR Other waters
			CCC	*CMC*	*Instantaneous Max*	*CCC*	*CMC*	*Instantaneous Max*	*1° MCL*	*2° MCL*	*1° MCL*	*2° MCL*		*(water + organism consump)*	*(aquatic org consump)*
Time	9:15														
In situ Parameters															
Water Temperature (°C)	9.90														
Dissolved Oxygen (mg/L)	10.70												>7		
Specific Conductance (mmhos/cm)	82									*900*			*150*		
pH (Standard Units)	8.30							*6.5-9.0*					*6.5-8.5*		
Turbidity (NTU)	0.4									*5*					
Analytical Parameters															
Total Metals (units of milligrams per liter) 7															
Aluminum (mg/L)	<0.010					*0.087*	*0.75*		*1.0*	*0.20*		*0.050 to 0.2*			
Arsenic (mg/L)	0.00017								*0.050*		*0.010*				
Barium (mg/L)	0.01200								*1.0*		*2.0*			*1.0*	
Cadmium (mg/L)	<0.000002		*0.0012*	*0.0016*		*0.00014*	*0.00084*		*0.0050*		*0.0050*				
Chromium (mg/L)	0.00046		*0.0977*	*0.8199*		*0.0407*	*0.8513*		*0.050*		*0.100*				
Copper (mg/L)	0.00004		*0.0043*	*0.0059*		*0.0043*	*0.0059*		*1.3*	*1.0*	*1.3*	*1.0*		*1.3*	
Iron (mg/L)	0.00600					*1.00*				*0.30*		*0.30*			
Lead (mg/L)	<0.000002		*0.0010*	*0.0254*		*0.0010*	*0.0254*		*0.015*		*0.015*				
Manganese (mg/L)	0.00026									*0.050*		*0.050*			*0.1*
Mercury (mg/L)	3.19E-07								*0.0020*		*0.0020*			*0.000050*	*0.000051*
Nickel (mg/L)	0.00391		*0.0240*	*0.2161*		*0.0240*	*0.2161*		*0.100*					*0.61*	*4.60*
Selenium (mg/L)	0.00038		*0.0050*	*0.0200*		*0.0050*			*0.050*					*0.170*	*4.2*
Silver (mg/L)	<0.000008				*0.0008*			*0.0008*		*0.100*					
Zinc (mg/L)	<0.00002		*0.0551*	*0.0551*		*0.0551*	*0.0551*			*5.000*				*7.4*	*26*
Dissolved Metals (units of milligrams per liter)															
Arsenic (mg/L)	0.00014		*0.1500*	*0.3400*		*0.1500*	*0.3400*								
Cadmium (mg/L)	0.00001	J	*0.0011*	*0.0016*		*0.00013*	*0.0008*								
Copper (mg/L)	0.00005		*0.0041*	*0.0057*		*0.0041*	*0.0057*								
Lead (mg/L)	<0.000002		*0.0009*	*0.0235*		*0.0009*	*0.0235*								
Mercury (mg/L)	2.60E-07					*0.00077*	*0.0014*								
Nickel (mg/L)	0.00362		*0.0240*	*0.2157*		*0.0240*	*0.2157*								
Silver (mg/L)	<0.000008				*0.00071*			*0.00067*							
Zinc (mg/L)	<0.00002		*0.0544*	*0.0539*		*0.0544*	*0.0539*								
Additional Analytical Parameters															
Ammonia - Total (mg/L) 5	<0.05					*1.52*	*3.15*								
Total Hardness, as CaCO3 (mg/L)	40.0														
Chloride (mg/L) 9	0.6					*230*	*860*			*250*		*250*			
Nitrate, as NO3 (mg/L), [Nitrite (mg/L)] 8	0.1								*10*		*10*			*10*	
Sulfate (mg/L)	2.0									*250*	*500*	*250*			
Alkalinity - Total (mg/L)	39.1					*≥ 20*									
Total Dissolved Solids (mg/L)	50.0									*500*		*500*			

Primary and Secondary MCL = Maximum contaminant levels (MCLs), primary MCLs are health based criteria and secondary MCLs are human welfare based criteria

J = Estimated concentration below the reporting limit (RL) and above the method detection limit(MDL), the MDL is based on a statistical calculation, the RL is normally set to 5 to 10 times the MDL and the RL represents higher analytical accuracy that can be achieved by the laboratory

Shaded cells represent exceedances of the criteria

NS = Constituent was not sampled for during this month

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

1. USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California [California Toxics Rule].
2. USEPA National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.
3. For DHS MCL's to apply, the watershed must be designated MUN in the Basin Plan. For example, Lake Almanor is not designated as having existing domestic or municipal water supply, but the North Fork Feather River is listed as a municipal water supply.
4. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.
5. Ammonia concentration range based on the pH and temperature measurements collected for the month during the sampling program, criteria are for when fish early life stages present (CCC) and when salmonid fish are present (CMC)
6. Dissolved metals criteria for cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the site and time specific hardness value
7. Criteria for CTR and USEPA National ambient criteria expressed as total recoverable based on calculation using hardness for cadmium, chromium, copper, lead, nickel, silver, and zinc.
8. Criteria for total nitrate + nitrite as nitrogen (N)
9. USEPA National Ambient Criterion for chloride is for dissolved chloride associated with sodium, criterion will probably not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium

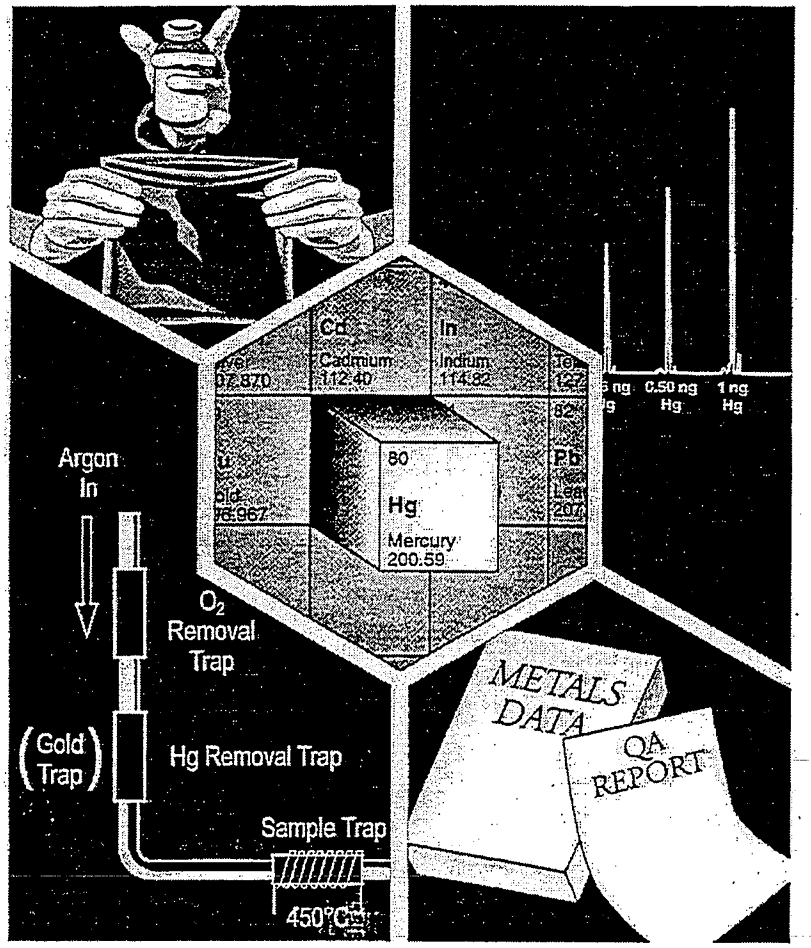
USEPA Method 1631e

Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry, August 2002

EPA
United States
Environmental Protection
Agency

Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry

August 2002



United States
Environmental Protection
Agency

Office of Water
4303

EPA-821-R-02-019
August 2002

Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry

Acknowledgments

This Method was developed under the direction of William A. Telliard and Maria Gomez-Taylor of the Engineering and Analysis Division (EAD) within the U.S. Environmental Protection Agency's (EPA's) Office of Science and Technology (OST). EPA acknowledges contributions to this method by Frontier Geosciences, Inc., Albion Environmental, Battelle Marine Sciences Laboratory, STL-Canton, and Tekran Inc. Additional assistance in preparing the Method was provided by DynCorp Environmental and Interface, Inc.

Disclaimer

This Method has been reviewed and approved for publication by the Statistics and Analytical Support Branch within EPA's Engineering and Analysis Division. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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Table of Contents

Introduction

Method 1631 (the "Method") supports technology-based and water quality-based monitoring programs authorized under the Clean Water Act (CWA; the "Act").

CWA Sections 301 and 306 require EPA to publish effluent standards that restrict the direct discharge of pollutants to the nations waters, and CWA Sections 307(b) and (c) require EPA to promulgate nationally applicable pretreatement standards which restrict pollutant discharges into sewers flowing to publicly owned treatment works (POTWs). The effluent limitations guidelines are published at CFR parts 401-503.

CWA Section 303 requires each State to set a water quality standard for each body of water within its boundaries. A State water quality standard consists of a designated use or uses of a water body or a segment of a water body, the water quality criteria that are necessary to protect the designated use or uses, and an antidegradation policy. CWA Section 304(a) requires EPA to publish water quality criteria that reflect the latest scientific knowledge concerning the physical fate of pollutants, the effects of pollutants on ecological and human health, and the effect of pollutants on biological community diversity, productivity, and stability. These water quality standards serve two purposes: (1) they establish the water quality goals for a specific water body, and (2) they are the basis for establishing water quality-based treatment controls and strategies beyond the technology-based controls required by CWA Sections 301(b) and 306.

In 1987, amendments to the CWA required States to adopt numeric criteria for toxic pollutants (designated in Section 307(a) of the Act) based on EPA Section 304(a) criteria or other scientific data, when the discharge or presence of those toxic pollutants could reasonably be expected to interfere with designated uses. Method 1631 was specifically developed to provide reliable measurements of mercury at EPA WQC levels.

In developing methods for determination of trace metals, EPA found that one of the greatest difficulties was precluding sample contamination during collection, transport, and analysis. The degree of difficulty, however, is highly dependent on the metal and site-specific conditions. Method 1631 is designed to preclude contamination in nearly all situations. It also contains procedures necessary to produce reliable results at the lowest WQC levels published by EPA. In recognition of the variety of situations to which this Method may be applied, and in recognition of continuing technological advances, Method 1631 is performance based. Alternative procedures may be used so long as those procedures are demonstrated to yield reliable results.

Requests for additional copies of this draft Method should be directed to:

U.S. EPA Sample Control Center
6101 Stevenson Avenue
Alexandria, VA 22304-3540
703/461–2100

Note: This Method is performance based. The laboratory is permitted to omit steps or modify procedures provided that all performance requirements in this Method are met. The laboratory must not omit or modify any procedure defined by the term "shall" or "must" and must perform all quality control tests.

Method 1631, Revision E

Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry

1.0 Scope and Application

1.1 Method 1631, Revision E (the "Method") is for determination of mercury (Hg) in filtered and unfiltered water by oxidation, purge and trap, desorption, and cold-vapor atomic fluorescence spectrometry (CVAFS). This Method is for use in EPA's data gathering and monitoring programs associated with the Clean Water Act, the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation and Liability Act, and the Safe Drinking Water Act. The Method is based on a contractor-developed procedure (Reference 16.1) and on peer-reviewed, published procedures for the determination of mercury in aqueous samples, ranging from sea water to sewage effluent (References 16.2–16.5).

1.2 This Method is accompanied by Method 1669: *Sampling Ambient Water for Determination of Trace Metals at EPA Water Quality Criteria Levels* (Sampling Method). The Sampling Method guidance document is recommended to preclude contamination during the sampling process.

1.3 This Method is for determination of Hg in the range of 0.5–100 ng/L. Application may be extended to higher levels by selection of a smaller sample size or by calibration of the analytical system across a higher range. For measurement of blank samples, the Method may be extended to a lower level by calibration to a lower calibration point. Section 10.4 gives requirements for extension of the calibration range.

1.4 The ease of contaminating ambient water samples with mercury and interfering substances cannot be overemphasized. This Method includes suggestions for improvements in facilities and analytical techniques that should minimize contamination and maximize the ability of the laboratory to make reliable trace metals determinations. Certain sections of this Method contain suggestions and other sections contain requirements to minimize contamination.

1.5 The detection limit and minimum level of quantitation in this Method usually are dependent on the level of interferences rather than instrument limitations. The method detection limit (MDL; 40 CFR 136, Appendix B) for Hg has been determined to be 0.2 ng/L when no interferences are present. The minimum level of quantitation (ML) has been established as 0.5 ng/L. An MDL as low as 0.05 ng/L can be achieved for low Hg samples by using a larger sample volume, a lower BrCl level (0.2%), and extra caution in sample handling.

1.6 Clean and ultraclean—The terms "clean" and "ultraclean" have been applied to the techniques needed to reduce or eliminate contamination in trace metals determinations. These terms are not used in this Method because they lack an exact definition. However, the information provided in this Method is consistent with the summary guidance on clean and ultraclean techniques (References 16.6-16.7).

1.7 This Method follows the EPA Environmental Methods Management Council's "Guidelines and Format for Methods to Be Proposed at 40 CFR, part 136 or part 141."

1.8 This Method is "performance based." The laboratory is permitted to modify the Method to overcome interferences or lower the cost of measurements if all performance criteria are met. Section 9.1.2.1 gives the requirements for establishing method equivalency.

1.9 Any modification of this Method, beyond those expressly permitted, shall be considered a major modification subject to application and approval of alternate test procedures under 40 CFR 136.4 and 136.5.

1.10 This Method should be used only by analysts experienced in the use of CVAFS techniques and who are trained thoroughly in the sample handling and instrument techniques described in this Method. Each laboratory that uses this Method must demonstrate the ability to generate acceptable results using the procedures in Section 9.2.

1.11 This Method is accompanied by a data verification and validation guidance document, *Guidance on the Documentation and Evaluation of Trace Metals Data Collected for CWA Compliance Monitoring* (Reference 16.8), that can be used for verification and validation of the data obtained.

1.12 This Method uses either a bubbler or flow-injection system for determination of mercury in water. Separate calibration, analysis, and calculation procedures are provided for a bubbler system (Sections 10.2, 11.2.1, and 12.2) and for a flow-injection system (Sections 10.3, 11.2.2, and 12.3).

2.0 Summary of Method

2.1 A 100- to 2000-mL sample is collected directly into a cleaned, pretested, fluoropolymer or glass bottle using sample handling techniques designed for collection of mercury at trace levels (Reference 16.9).

2.2 For dissolved Hg, the sample is filtered through a 0.45-µm capsule filter prior to preservation.

2.3 The sample is preserved by adding either pretested 12N hydrochloric acid (HCl) or bromine monochloride (BrCl) solution. If a sample will also be used for the determination of methyl mercury, it should be preserved according to procedures in the method that will be used for determination of methylmercury.

2.4 Prior to analysis, all Hg in a 100-mL sample aliquot is oxidized to Hg(II) with BrCl.

2.5 After oxidation, the sample is sequentially reduced with $NH_2OH{\cdot}HCl$ to destroy the free halogens, then reduced with stannous chloride ($SnCl_2$) to convert Hg(II) to volatile Hg(0).

2.6 The Hg(0) is separated from solution either by purging with nitrogen, helium, or argon, or by vapor/liquid separation. The Hg(0) is collected onto a gold trap (Figures 1, 2, and 3).

2.7 The Hg is thermally desorbed from the gold trap into an inert gas stream that carries the released Hg(0) to a second gold (analytical) trap. The Hg is desorbed from the analytical trap into a gas stream that carries the Hg into the cell of a cold-vapor atomic fluorescence spectrometer (CVAFS) for detection (Figures 2 and 3).

2.8 Quality is assured through calibration and testing of the oxidation, purging, and detection systems.

3.0 Definitions

3.1 Total mercury—all BrCl-oxidizable mercury forms and species found in an unfiltered aqueous solution. This includes, but is not limited to, Hg(II), Hg(0), strongly organo-complexed Hg(II) compounds, adsorbed particulate Hg, and several tested covalently bound organo-mercurials (e.g., CH_3HgCl, $(CH_3)_2Hg$, and $C_6H_5HgOOCCH_3$). The recovery of Hg bound within microbial cells may require the additional step of UV photo-oxidation. In this Method, total mercury and total recoverable mercury are synonymous.

3.2 Dissolved mercury—all BrCl-oxidizable mercury forms and species found in the filtrate of an aqueous solution that has been filtered through a 0.45-μm filter.

3.3 Apparatus—Throughout this Method, the sample containers, sampling devices, instrumentation, and all other materials and devices used in sample collection, sample processing, and sample analysis that come in contact with the sample and therefore require careful cleaning will be referred to collectively as the Apparatus.

3.4 Definitions of other terms used in this Method are given in the glossary (Section 17.0).

4.0 Contamination and Interferences

4.1 Preventing samples from becoming contaminated during the sampling and analysis process constitutes one of the greatest difficulties encountered in trace metals determinations. Over the last two decades, marine chemists have come to recognize that much of the historical data on the concentrations of dissolved trace metals in seawater are erroneously high because the concentrations reflect contamination from sampling and analysis rather than ambient levels. Therefore, it is imperative that extreme care be taken to avoid contamination when collecting and analyzing samples for trace metals.

4.2 Samples may become contaminated by numerous routes. Potential sources of trace metals contamination during sampling include: metallic or metal-containing labware (e.g., talc gloves that contain high levels of zinc), containers, sampling equipment, reagents, and reagent water; improperly cleaned or stored equipment, labware, and reagents; and atmospheric inputs such as dirt and dust. Even human contact can be a source of trace metals contamination. For example, it has been demonstrated that dental work (e.g., mercury amalgam fillings) in the mouths of laboratory personnel can contaminate samples directly exposed to exhalation (Reference 16.9).

4.3 Contamination Control

4.3.1 Philosophy—The philosophy behind contamination control is to ensure that any object or substance that contacts the sample is metal free and free from any material that may contain mercury.

4.3.1.1 The integrity of the results produced cannot be compromised by contamination of samples. This Method and the Sampling Method give requirements and suggestions for control of sample contamination.

4.3.1.2 Substances in a sample cannot be allowed to contaminate the laboratory work area or instrumentation used for trace metals measurements. This Method gives requirements and suggestions for protecting the laboratory.

4.3.1.3 Although contamination control is essential, personnel health and safety remain the highest priority. The Sampling Method and Section 5 of this Method give suggestions and requirements for personnel safety.

4.3.2 Avoiding contamination—The best way to control contamination is to completely avoid exposure of the sample to contamination in the first place. Avoiding exposure means performing operations in an area known to be free from contamination. Two of the most important factors in avoiding/reducing sample contamination are (1) an awareness of potential sources of contamination and (2) strict attention to work being done. Therefore, it is imperative that the procedures described in this Method be carried out by well-trained, experienced personnel.

4.3.3 Use a clean environment—The ideal environment for processing samples is a class-100 clean room. If a clean room is not available, all sample preparation should be performed in a class-100 clean bench or a nonmetal glove box fed by mercury-and particle-free air or nitrogen. Digestion should be performed in a nonmetal fume hood equipped with HEPA filtration and ideally situated in a clean room.

4.3.4 Minimize exposure—The Apparatus that will contact samples, blanks, or standard solutions should be opened or exposed only in a clean room, clean bench, or glove box so that exposure to an uncontrolled atmosphere is minimized. When not being used, the Apparatus should be covered with clean plastic wrap, stored in the clean bench or in a plastic box or glove box, or bagged in clean zip-type bags. Minimizing the time between cleaning and use will also minimize contamination.

4.3.5 Clean work surfaces—Before a given batch of samples is processed, all work surfaces in the hood, clean bench, or glove box in which the samples will be processed should be cleaned by wiping with a lint-free cloth or wipe soaked with reagent water.

4.3.6 Wear gloves—Sampling personnel must wear clean, non-talc gloves during all operations involving handling of the Apparatus, samples, and blanks. Only clean gloves may touch the Apparatus. If another object or substance is touched, the glove(s) must be changed before again handling the Apparatus. If it is even suspected that gloves have become contaminated, work must be halted, the contaminated gloves removed, and a new pair of clean gloves put on. Wearing multiple layers of clean gloves will allow the old pair to be quickly stripped with minimal disruption to the work activity.

4.3.7 Use metal-free Apparatus—All Apparatus used for determination of mercury at ambient water quality criteria levels must be nonmetallic, free of material that may contain metals, or both.

4.3.7.1 Construction materials—Only fluoropolymer or glass containers must be used for collection of samples that will be analyzed for mercury because mercury vapors can diffuse in or out of other materials, leading to results that are biased low or high. Polyethylene and/or polypropylene labware may be used for digestion and other purposes because the time of sample exposure to these materials is relatively short. All materials, regardless of construction, that will directly or indirectly contact the sample, must be known to be clean and free of Hg at the levels specified in this Method before proceeding.

4.3.7.2 Serialization—It is recommended that serial numbers be indelibly marked or etched on each piece of reusable Apparatus so that contamination can be traced, and logbooks should be maintained to track the sample from the container through the labware to introduction into the instrument. It may be useful to dedicate separate sets of labware to different sample types; e.g., receiving waters vs. effluents. However, the Apparatus used for processing blanks and standards must be mixed with the Apparatus used to process samples so that contamination of all labware can be detected.

4.3.7.3 The laboratory or cleaning facility is responsible for cleaning the Apparatus used by the sampling team. If there are any indications that the Apparatus is not clean when received by the sampling team (e.g., ripped storage bags), an assessment of the likelihood of contamination must be made. Sampling must not proceed if it is possible that the Apparatus is contaminated. If the Apparatus is contaminated, it must be returned to the laboratory or cleaning facility for proper cleaning before any sampling activity resumes.

4.3.8 Avoid sources of contamination—Avoid contamination by being aware of potential sources and routes of contamination.

4.3.8.1 Contamination by carryover—Contamination may occur when a sample containing a low concentration of mercury is processed immediately after a sample containing a relatively high concentration of mercury. The Hg concentration at which the analytical system (purge, traps, detector) will carry greater than 0.5 ng/L of Hg into a succeeding bubbler or system blank must be determined by analyzing calibration solutions containing successively larger concentrations of Hg. This test must be run prior to first use of the analytical system and whenever a change is made that would increase the amount of carryover. When a sample contains ½ or greater of this determined Hg concentration, a bubbler blank (bubbler system) or system blank (flow injection system) must be analyzed to demonstrate no carryover at the blank criteria level. For the bubbler system, the blank must be run using the same bubbler and sample trap used to run the high concentration sample. Samples analyzed following a sample that has been determined to result in carryover must be reanalyzed. Samples that are known or suspected to contain the lowest concentration of mercury should be analyzed first followed by samples containing higher levels.

4.3.8.2 Contamination by samples—Significant laboratory or instrument contamination may result when untreated effluents, in-process waters, landfill leachates, and other undiluted samples containing concentrations of mercury greater than 100 ng/L are processed and analyzed. Samples known or suspected to contain Hg concentrations greater than 100 ng/L should be diluted prior to bringing them into the clean room or laboratory dedicated for processing trace metals samples.

4.3.8.3 Contamination by indirect contact—Apparatus that may not directly come in contact with the samples may still be a source of contamination. For example, clean tubing placed in a dirty plastic bag may pick up contamination from the bag and subsequently transfer the contamination to the sample. It is imperative that every piece of the Apparatus that is directly or indirectly used in the collection, processing, and analysis of water samples be thoroughly cleaned (Section 6.1.2).

4.3.8.4 Contamination by airborne particulate matter—Less obvious substances capable of contaminating samples include airborne particles. Samples may be contaminated by airborne dust, dirt, particles, or vapors from unfiltered air supplies; nearby corroded or rusted pipes, wires, or other fixtures; or metal-containing paint. Whenever possible, sample processing and analysis should occur as far as possible from sources of airborne contamination.

4.3.8.5 Contamination from reagents— Contamination can be introduced into samples from method reagents used during processing and analysis. Reagent blanks must be analyzed for contamination prior to use (see Section 9.4.3). If reagent blanks are contaminated, a new batch of reagents must be prepared (see Section 9.4.3.2).

4.4 Interferences

4.4.1 At the time of promulgation of this Method, gold and iodide were known interferences. At a mercury concentration of 2.5 ng/L and at increasing iodide concentrations from 30 to 100 mg/L, test data have shown that mercury recovery will be reduced from 100 to 0 percent. At iodide concentrations greater than 3 mg/L, the sample should be pre-reduced with $SnCl_2$ (to remove the brown color) and additional or more concentrated $SnCl_2$ should be added. To preclude loss of Hg, the additional $SnCl_2$ should be added in a closed vessel or analysis should proceed immediately. If samples containing iodide concentrations greater than 30 mg/L are analyzed, it may be necessary to clean the analytical system with 4N HCl after the analysis (Reference 16.10).

4.4.2 The potential exists for destruction of the gold traps if free halogens are purged onto them, or if they are overheated (>500 °C). When the instructions in this Method are followed, neither of these outcomes is likely.

4.4.3 Water vapor may collect in the gold traps and subsequently condense in the fluorescence cell upon desorption, giving a false peak due to scattering of the excitation radiation. Condensation can be avoided by predrying the gold trap. Traps that tend to absorb large quantities of water vapor should not be used.

4.4.4 The fluorescent intensity is strongly dependent upon the presence of molecular species in the carrier gas that can cause "quenching" of the excited atoms. The dual amalgamation technique eliminates quenching due to trace gases, but it remains the laboratory's responsibility to ensure high purity inert carrier gas and a leak-free analytical train.

5.0 Safety

5.1 The toxicity or carcinogenicity of each chemical used in this Method has not been precisely determined; however, each compound should be treated as a potential health hazard. Exposure to these compounds should be reduced to the lowest possible level.

5.1.1 Chronic mercury exposure may cause kidney damage, muscle tremors, spasms, personality changes, depression, irritability and nervousness. Organo-mercurials may cause permanent brain damage. Because of the toxicological and physical properties of Hg, pure standards should be handled only by highly trained personnel thoroughly familiar with handling and cautionary procedures and the associated risks.

5.1.2 It is recommended that the laboratory purchase a dilute standard solution of the Hg in this Method. If primary solutions are prepared, they shall be prepared in a hood, and a NIOSH/MESA-approved toxic gas respirator shall be worn.

5.2 This Method does not address all safety issues associated with its use. The laboratory is responsible for maintaining a current file of OSHA regulations for safe handling of the chemicals specified in this Method. OSHA rules require that a reference file of material safety data sheets (MSDSs) must be made available to all personnel involved in these analyses (29 CFR 1917.28, Appendix E). It also is suggested that the laboratory perform personal hygiene monitoring of each analyst who uses this Method and that the results of this monitoring be made available to the analyst. Personal hygiene monitoring should be performed using OSHA or NIOSH approved personal hygiene monitoring methods. Additional information on laboratory safety can be found in References 16.11-16.14. The references and bibliography included in Reference 16.14 are particularly comprehensive in dealing with the general subject of laboratory safety.

5.3 Samples suspected to contain concentrations of Hg at µg/L or higher levels are handled using essentially the same techniques employed in handling radioactive or infectious materials. Well-ventilated, controlled access laboratories are required. Assistance in evaluating the health hazards of particular laboratory conditions may be obtained from certain consulting laboratories and from State Departments of Health or Labor, many of which have an industrial health service. Each laboratory must develop a safety program for handling Hg.

5.3.1 Facility—When samples known or suspected of containing high concentrations of mercury are handled, all operations (including removal of samples from sample containers, weighing, transferring, and mixing) should be performed in a glove box demonstrated to be leak-tight or in a fume hood demonstrated to have adequate airflow. Gross losses to the laboratory ventilation system must not be allowed. Handling of the dilute solutions normally used in analytical and animal work presents no inhalation hazards except in an accident.

5.3.2 Protective equipment—Disposable plastic gloves, apron or lab coat, safety glasses or mask, and a glove box or fume hood adequate for radioactive work should be used. During analytical operations that may give rise to aerosols or dusts, personnel should wear respirators equipped with activated carbon filters.

5.3.3 Training—Workers must be trained in the proper method of removing contaminated gloves and clothing without contacting the exterior surfaces.

5.3.4 Personal hygiene—Hands and forearms should be washed thoroughly after each manipulation and before breaks (coffee, lunch, and shift).

5.3.5 Confinement—Isolated work areas posted with signs, segregated glassware and tools, and plastic absorbent paper on bench tops will aid in confining contamination.

5.3.6 Effluent vapors—The effluent from the CVAFS should pass through either a column of activated charcoal or a trap containing gold or sulfur to amalgamate or react mercury vapors.

5.3.7 Waste handling—Good technique includes minimizing contaminated waste. Plastic bag liners should be used in waste cans. Janitors and other personnel must be trained in the safe handling of waste.

5.3.8 Decontamination

5.3.8.1 Decontamination of personnel—Use any mild soap with plenty of scrubbing action.

5.3.8.2 Glassware, tools, and surfaces—Sulfur powder will react with Hg to produce mercuric sulfide, thereby eliminating the possible volatilization of Hg. Satisfactory cleaning may be accomplished by dusting a surface lightly with sulfur powder, then washing with any detergent and water.

5.3.9 Laundry—Clothing known to be contaminated should be collected in plastic bags. Persons that convey the bags and launder the clothing should be advised of the hazard and trained in proper handling. If the launderer knows of the potential problem, the clothing may be put into a washer without contact. The washer should be run through a cycle before being used again for other clothing.

5.3.10 Wipe tests—A useful method of determining cleanliness of work surfaces and tools is to wipe the surface with a piece of filter paper. Extraction and analysis by this Method can achieve a limit of detection of less than 1 ng per wipe. Less than 0.1 µg per wipe indicates acceptable cleanliness; anything higher warrants further cleaning. More than 10 µg on a wipe constitutes an acute hazard and requires prompt cleaning before further use of the equipment or work space, and indicates that unacceptable work practices have been employed.

6.0 Apparatus and Materials

Disclaimer: The mention of trade names or commercial products in this Method is for illustrative purposes only and does not constitute endorsement or recommendation for use by the Environmental Protection Agency. Equivalent performance may be achievable using apparatus, materials, or cleaning procedures other than those suggested here. The laboratory is responsible for demonstrating equivalent performance.

6.1 Sampling equipment

6.1.1 Sample collection bottles-fluoropolymer or glass, 125- to 1000-mL, with fluoropolymer or fluoropolymer-lined cap.

6.1.2 Cleaning

6.1.2.1 New bottles are cleaned by heating to 65–75 °C in 4 N HCl or concentrated HNO_3 for at least 48 h. The bottles are cooled, rinsed three times with reagent water, and filled with reagent water containing 1% HCl. These bottles are capped and placed in a clean oven at 60-70°C overnight. After cooling, they are rinsed three more times with reagent water, filled with reagent water containing 0.4% (v/v) HCl, and placed in a mercury-free Class-100 clean bench until the outside surfaces are dry. The bottles are tightly capped (with a wrench), double-bagged in new polyethylene zip-type bags until needed, and stored in wooden or plastic boxes until use. The bottles may be shipped to the sampling site containing dilute HCl solution (e.g., 0.04%), containing reagent water, or empty.

6.1.2.2 Used bottles known not to have contained mercury at high (>100 ng/L) levels are cleaned as above, except for only 6–12 h in hot 4 N HCl.

6.1.2.3 Bottle blanks must be analyzed as described in Section 9.4.7. To verify the effectiveness of the cleaning procedures, bottle blanks must be demonstrated to be free of mercury at the ML of this Method.

6.1.2.4 As an alternative to cleaning by the laboratory, bottles may be purchased from a commercial supplier and each lot certified to be clean. Bottles from the lot must be tested as bottle blanks (Section 9.4.7) and demonstrated to be free of mercury at the ML of this Method. If mercury is present above this level in any bottle, either the lot must be rejected or the bottles must be re-cleaned.

6.1.3 Filtration Apparatus

6.1.3.1 Filter—0.45-µm, 15-mm diameter capsule filter (Gelman Supor 12175, or equivalent).

6.1.3.2 Peristaltic pump—115-V a.c., 12-V d.c., internal battery, variable-speed, single-head (Cole-Parmer, portable, "Masterflex L/S," Catalog No. 07570-10 drive with Quick Load pump head, Catalog No. 07021-24, or equivalent).

6.1.3.3 Tubing—styrene/ethylene/butylene/silicone (SEBS) resin for use with peristaltic pump, approx 3/8-in ID by approximately 3 ft (Cole-Parmer size 18, Catalog No. 06424-18, or approximately 1/4-in OD, Cole-Parmer size 17, Catalog No. 06424-17, or equivalent). Tubing is cleaned by soaking in 5–10% HCl solution for 8–24 h, rinsing with reagent water in a clean bench in a clean room, and drying in the clean bench by purging with metal-free air or nitrogen. After drying, the tubing is double-bagged in clear polyethylene bags, serialized with a unique number, and stored until use.

6.2 Equipment for bottle and glassware cleaning

6.2.1 Vat, 100–200 L, high-density polyethylene (HDPE), half filled with 4 N HCl in reagent water.

6.2.2 Panel immersion heater, 500-W, all-fluoropolymer coated, 120 vac (Cole-Parmer H-03053-04, or equivalent)

WARNING: *Read instructions carefully!! The heater will maintain steady state, without temperature feedback control, of 60–75°C in a vat of the size described. However, the equilibrium temperature will be higher (up to boiling) in a smaller vat. Also, the heater plate MUST be maintained in a vertical position, completely submerged and away from the vat walls to avoid melting the vat or burning out!*

6.2.3 Laboratory sink—in Class-100 clean area, with high-flow reagent water (Section 7.1) for rinsing.

6.2.4 Clean bench—Class-100, for drying rinsed bottles.

6.2.5 Oven—stainless steel, in Class-100 clean area, capable of maintaining ± 5°C in the 60–70°C temperature range.

6.3 Cold vapor atomic fluorescence spectrometer (CVAFS): The CVAFS system used may either be purchased from a supplier, or built in the laboratory from commercially available components.

6.3.1 Commercially available CVAFS—Tekran (Toronto, ON) Series 2600 CVAFS, Brooks-Rand (Seattle, WA) Model III CVAFS, Leeman Labs Hydra AF Gold*plus* CVAFS, or equivalent

6.3.2 Custom-built CVAFS (Reference 16.15). Figure 2 shows the schematic diagram. The system consists of the following:

6.3.2.1 Low-pressure 4-W mercury vapor lamp

6.3.2.2 Far UV quartz flow-through fluorescence cell—12 mm x 12 mm x 45 mm, with a 10-mm path length (NSG Cells, or equivalent).

6.3.2.3 UV-visible photomultiplier (PMT)—sensitive to < 230 nm. This PMT is isolated from outside light with a 253.7-nm interference filter (Oriel Corp., Stamford, CT, or equivalent).

6.3.2.4 Photometer and PMT power supply (Oriel Corp. or equivalent), to convert PMT output (nanoamp) to millivolts

6.3.2.5 Black anodized aluminum optical block—holds fluorescence cell, PMT, and light source at perpendicular angles, and provides collimation of incident and fluorescent beams (Frontier Geosciences Inc., Seattle, WA, or equivalent).

6.3.2.6 Flowmeter—with needle valve capable of reproducibly keeping the carrier gas flow rate at 30 mL/min

6.4 Hg purging system—Figure 2 shows the schematic diagram for the purging system. The system consists of the following:

6.4.1 Flow meter/needle valve—capable of controlling and measuring gas flow rate to the purge vessel at 350 ± 50 mL/min.

6.4.2 Fluoropolymer fittings—connections between components and columns are made using 6.4-mm OD fluoropolymer tubing and fluoropolymer friction-fit or threaded tubing connectors. Connections between components requiring mobility are made with 3.2-mm OD fluoropolymer tubing because of its greater flexibility.

6.4.3 Acid fume pretrap—10-cm long x 0.9-cm ID fluoropolymer tube containing 2–3 g of reagent grade, nonindicating, 8–14 mesh soda lime chunks, packed between wads of silanized glass wool. This trap is cleaned of Hg by placing on the output of a clean cold vapor generator (bubbler) and purging for 1 h with N_2 at 350 mL/min.

6.4.4 Cold vapor generator (bubbler)—200-mL borosilicate glass (15 cm high x 5.0 cm diameter) with standard taper 24/40 neck, fitted with a sparging stopper having a coarse glass frit that extends to within 0.2 cm of the bubbler bottom (Frontier Geosciences, Inc. or equivalent).

6.5 The dual-trap Hg(0) preconcentrating system

6.5.1 Figures 2 and 3 show the dual-trap amalgamation system (Reference 16.5).

6.5.2 Gold-coated sand traps—10-cm long x 6.5-mm OD x 4-mm ID quartz tubing. The tube is filled with 3.4 cm of gold-coated 45/60 mesh quartz sand (Frontier Geosciences Inc., Seattle, WA, or equivalent). The ends are plugged with quartz wool.

6.5.2.1 Traps are fitted with 6.5-mm ID fluoropolymer friction-fit sleeves for making connection to the system. When traps are not in use, fluoropolymer end plugs are inserted in trap ends to eliminate contamination.

6.5.2.2 At least six traps are needed for efficient operation, one as the "analytical" trap, and the others to sequentially collect samples.

6.5.3 Heating of gold-coated sand traps—To desorb Hg collected on a trap, heat for 3.0 min to 450–500 °C (a barely visible red glow when the room is darkened) with a coil consisting of 75 cm of 24-gauge Nichrome wire at a potential of 10-14 vac. Potential is applied and finely adjusted with an autotransformer.

6.5.4 Timers—The heating interval is controlled by a timer-activated 120-V outlet (Gralab, or equivalent), into which the heating coil autotransformer is plugged. Two timers are required, one each for the "sample" trap and the "analytical" trap.

6.5.5 Air blowers—After heating, traps are cooled by blowing air from a small squirrel-cage blower positioned immediately above the trap. Two blowers are required, one each for the "sample" trap and the "analytical" trap.

6.6 Recorder—Any multi-range millivolt chart recorder or integrator with a range compatible with the CVAFS is acceptable. By using a two-pen recorder with pen sensitivity offset by a factor of 10, the dynamic range of the system is extended to 10^3.

6.7 Pipettors—All-plastic pneumatic fixed-volume and variable pipettors in the range of 10 µL to 5.0 mL.

6.8 Analytical balance capable of weighing to the nearest 0.01 g

7.0 Reagents and Standards

Note: The quantities of reagents and the preparation procedures in this section are for illustrative purposes. Equivalent performance may be achievable using quantities of reagents and procedures other than those suggested here. The laboratory is responsible for demonstrating equivalent performance.

7.1 Reagent water—18-MΩ minimum, ultrapure deionized water starting from a prepurified (distilled, reverse osmosis, etc.) source. Water should be monitored for Hg, especially after ion exchange beds are changed.

7.2 Air—It is very important that the laboratory air be low in both particulate and gaseous mercury. Ideally, mercury work should be conducted in a new laboratory with mercury-free paint on the walls. A source of air that is very low in Hg should be brought directly into the Class-100 clean bench air intake. If this is not possible, air coming into the clean bench can be cleaned for mercury by placing a gold-coated cloth prefilter over the intake. Gold-coated cloth filter: Soak 2 m^2 of cotton gauze in 500 mL of 2% gold chloride solution at pH 7. In a hood, add 100 mL of 30% $NH_2OH \cdot HCl$ solution, and homogenize into the cloth with gloved hands. The material will turn black as colloidal gold is precipitated. Allow the mixture to set for several hours, then rinse with copious amounts of deionized water. Squeeze-dry the rinsed cloth, and spread flat on newspapers to air-dry. When dry, fold and place over the intake prefilter of the laminar flow hood.

CAUTION: Great care should be taken to avoid contaminating the laboratory with gold dust. This could cause interferences with the analysis if gold becomes incorporated into the samples or equipment. The gilding procedure should be done in a remote laboratory if at all possible.

7.3 Hydrochloric acid—trace-metal purified reagent-grade HCl containing less than 5 pg/mL Hg. The HCl should be analyzed for Hg before use.

7.4 Hydroxylamine hydrochloride—Dissolve 300 g of $NH_2OH{\cdot}HCl$ in reagent water and bring to 1.0 L. This solution may be purified by the addition of 1.0 mL of $SnCl_2$ solution and purging overnight at 500 mL/min with Hg-free N_2. Flow injection systems may require the use of less $SnCl_2$ for purification of this solution.

7.5 Stannous chloride—Bring 200 g of $SnCl_2{\cdot}2H_2O$ and 100 mL concentrated HCl to 1.0 L with reagent water. Purge overnight with mercury-free N_2 at 500 mL/min to remove all traces of Hg. Store tightly capped.

7.6 Bromine monochloride (BrCl)—In a fume hood, dissolve 27 g of reagent grade KBr in 2.5 L of low-Hg HCl. Place a clean magnetic stir bar in the bottle and stir for approximately 1 h in the fume hood. Slowly add 38 g reagent grade $KBrO_3$ to the acid while stirring. When all of the $KBrO_3$ has been added, the solution color should change from yellow to red to orange. Loosely cap the bottle, and allow to stir another hour before tightening the lid.

WARNING: This process generates copious quantities of free halogens (Cl_2, Br_2, BrCl), which are released from the bottle. Add the $KBrO_3$ slowly in a fume hood!

7.7 Stock mercury standard—NIST-certified 10,000-ppm aqueous Hg solution (NIST-3133). This solution is stable at least until the NIST expiration date.

7.8 Secondary Hg standard—Add approx 0.5 L of reagent water and 5 mL of BrCl solution (Section 7.6) to a 1.00-L Class A volumetric flask. Add 0.100 mL of the stock mercury standard (Section 7.7) to the flask and dilute to 1.00 L with reagent water. This solution contains 1.00 µg/mL (1.00 ppm) Hg. Transfer the solution to a fluoropolymer bottle and cap tightly. This solution is considered stable until the NIST expiration date.

7.9 Working Hg Standard A—Dilute 1.00 mL of the secondary Hg standard (Section 7.8) to 100 mL in a Class A volumetric flask with reagent water containing 0.5% by volume BrCl solution (Section 7.6). This solution contains 10.0 ng/mL and should be replaced monthly, or longer if extended stability is demonstrated.

7.10 Working Hg Standard B—Dilute 0.10 mL of the secondary Hg standard (Section 7.8) to 1000 mL in a Class A volumetric flask with reagent water containing 0.5% by volume BrCl solution (Section 7.6). This solution contains 0.10 ng/mL and should be replaced monthly, or longer if extended stability is demonstrated.

7.11 Initial Precision and Recovery (IPR) and Ongoing Precision and Recovery (OPR) solutions—Using the working Hg standard A (Section 7.9), prepare IPR and OPR solutions at a concentration of 5 ng/L Hg in reagent water. IPR/OPR solutions are prepared using the same amounts of reagents used for preparation of the calibration standards.

7.12 Nitrogen—Grade 4.5 (standard laboratory grade) nitrogen that has been further purified by the removal of Hg using a gold-coated sand trap.

7.13 Argon—Grade 5.0 (ultra high-purity, GC grade) argon that has been further purified by the removal of Hg using a gold-coated sand trap.

8.0 Sample Collection, Preservation, and Storage

8.1 Before samples are collected, consideration should be given to the type of data required (i.e., dissolved or total), so that appropriate preservation and pretreatment steps can be taken. An excess of BrCl should be confirmed either visually (presence of a yellow color) or with starch iodide indicating paper, using a separate sample aliquot, prior to sample processing or direct analysis to ensure the sample has been properly preserved.

8.2 Samples are collected into rigorously cleaned fluoropolymer bottles with fluoropolymer or fluoropolymer-lined caps. Glass bottles may be used if Hg is the only target analyte. It is critical that the bottles have tightly sealing caps to avoid diffusion of atmospheric Hg through the threads (Reference 16.4). Polyethylene sample bottles must not be used (Reference 16.15).

8.3 Collect samples using guidance provided in the Sampling Method (Reference 16.9). Procedures in the Sampling Method are based on rigorous protocols for collection of samples for mercury (References 16.4 and 16.15).

NOTE: Discrete samplers have been found to contaminate samples with Hg at the ng/L level. Therefore, great care should be exercised if this type of sampler is used. It may be necessary for the sampling team to use other means of sample collection if samples are found to be contaminated using the discrete sampler.

8.4 Sample filtration—For dissolved Hg, a sample is filtered through a 0.45-µm capsule filter (Section 6.1.3.1) in a mercury-free clean area prior to preservation. If the sample is filtered, it must be accompanied by a blank that has been filtered under the same conditions. The Sampling Method describes sample filtration procedures.

8.5 Preservation—Samples are preserved by adding either 5 mL/L of pretested 12N HCl or 5 mL/L BrCl solution to the sample bottle. If a sample will be used also for the determination of methyl mercury, it should be collected and preserved according to procedures in the method that will be used for determination of methyl mercury (e.g., HCl or H_2SO_4 solution). Preserved samples are stable for up to 90 days of the date of collection.

8.5.1 Samples to be analyzed for total or dissolved Hg only may be shipped to the laboratory unpreserved and unrefrigerated if they are collected in fluoropolymer or glass bottles and capped tightly. Samples must be either preserved or analyzed within 48 hours of collection. If a sample is oxidized in the sample bottle, the time to preservation can be extended to 28 days.

8.5.2 Samples that are acid-preserved may lose Hg to coagulated organic materials in the water or condensed on the walls (Reference 16.16). The best approach is to add BrCl directly to the sample bottle at least 24 hours before analysis. If other Hg species are to be analyzed, these aliquots must be removed prior to the addition of BrCl. If BrCl cannot be added directly to the sample bottle, the bottle must be shaken vigorously prior to sub-sampling.

8.5.3 Handling of the samples in the laboratory should be undertaken in a mercury-free clean bench, after rinsing the outside of the bottles with reagent water and drying in the clean air hood.

NOTE: Because of the potential for contamination, it is recommended that filtration and preservation of samples be performed in the clean room in the laboratory. However, if circumstances prevent overnight shipment of samples, samples should be filtered and preserved in a designated clean area in the field in accordance with the procedures given in Method 1669 (Reference 16.9). If filtered in the field, samples ideally should be filtered into the sample bottle.

8.6 Storage—Sample bottles should be stored in clean (new) polyethylene bags until sample analysis.

8.7 Sample preservation, storage, and holding time requirements also are given at 40 CFR part 136.3(e) Table II.

9.0 Quality Control

9.1 Each laboratory that uses this Method is required to operate a formal quality assurance program (Reference 16.17). The minimum requirements of this program consist of an initial demonstration of laboratory capability, ongoing analysis of standards and blanks as a test of continued performance, and the analysis of matrix spikes (MS) and matrix spike duplicates (MSD) to assess precision and recovery. Laboratory performance is compared to established performance criteria to determine that the results of analyses meet the performance characteristics of the Method.

9.1.1 The laboratory shall make an initial demonstration of the ability to generate acceptable accuracy and precision. This ability is established as described in Section 9.2.

9.1.2 In recognition of advances that are occurring in analytical technology, the laboratory is permitted certain options to improve results or lower the cost of measurements. These options include automation of the dual-amalgamation system, single-trap amalgamation (Reference 16.18), direct electronic data acquisition, calibration using gas-phase elemental Hg standards, use of the bubbler or flow-injection systems, or changes in the detector (i.e., CVAAS) when less sensitivity is acceptable or desired. Changes in the determinative technique, such as the use of colorimetry, are not allowed. If an analytical technique other than the CVAFS technique specified in this Method is used, that technique must have a specificity for mercury equal to or better than the specificity of the technique in this Method.

9.1.2.1 Each time this Method is modified, the laboratory is required to repeat the procedure in Section 9.2 to demonstrate that an MDL (40 CFR part 136, Appendix B) less than or equal to one-third the regulatory compliance limit or less than or equal to the MDL of this Method (Table 1), whichever is greater, can be achieved. If the change will affect calibration, the instrument must be recalibrated according to Section 10.

Note: If the compliance limit is greater than the concentration of Hg in the OPR/OPR (5 ng/L), the acceptance criteria for blanks and the concentrations of mercury spiked into quality control samples may be increased to support measurements at the compliance limit. For example, if the compliance limit is 12 *ng/L (National Toxics Rule, 40 CFR 131.36), the MDL must be less than or equal to 4 ng/L; concentrations of the calibration standards may be 5, 10, 20, 50, and 100 ng/L; concentrations of the IPR/OPR samples may be 10 ng/L; spike concentrations and acceptance criteria for MS/MSD samples would remain as specified in Section 9.3; and an appropriate blank acceptance criterion would be 5 ng/L.*

9.1.2.2 The laboratory is required to maintain records of modifications made to this Method. These records include the following, at a minimum:

9.1.2.2.1 The names, titles, addresses, and telephone numbers of the analyst(s) who performed the analyses and modification, and the quality control officer who witnessed and will verify the analyses and modification

9.1.2.2.2 A narrative stating the reason(s) for the modification(s)

9.1.2.2.3 Results from all quality control (QC) tests demonstrating the performance of the modified method, including the following:
(a) Calibration (Section 10)
(b) Initial precision and recovery (Section 9.2.2)
(c) Analysis of blanks (Section 9.4)
(d) Matrix spike/matrix spike duplicate analysis (Section 9.3)
(e) Ongoing precision and recovery (Section 9.5)
(f) Quality control sample (Section 9.6)
(g) Method detection limit (Section 9.2.1)

9.1.2.2.4 Data that will allow an independent reviewer to validate each determination by tracking the instrument output to the final result. These data are to include the following:
(a) Sample numbers and other identifiers
(b) Processing dates
(c) Analysis dates
(d) Analysis sequence/run chronology
(e) Sample weight or volume
(f) Copies of logbooks, chart recorder, or other raw data output
(g) Calculations linking raw data to the results reported

9.1.3 Analyses of MS and MSD samples are required to demonstrate the accuracy and precision and to monitor matrix interferences. Section 9.3 describes the procedure and QC criteria for spiking.

9.1.4 Analyses of blanks are required to demonstrate acceptable levels of contamination. Section 9.4 describes the procedures and criteria for analyzing blanks.

9.1.5 The laboratory shall, on an ongoing basis, demonstrate through analysis of the ongoing precision and recovery (OPR) sample and the quality control sample (QCS) that the system is in control. Sections 9.5 and 9.6 describe these procedures, respectively.

9.1.6 The laboratory shall maintain records to define the quality of the data that are generated. Sections 9.3.7 and 9.5.3 describe the development of accuracy statements.

9.1.7 Quality of the analyses is controlled by an analytical batch. An analytical batch is a set of samples oxidized with the same batch of reagents, and analyzed during the same 12-hour shift. A batch may be from 1 to as many as 20 samples. Each batch must be accompanied by 3 system blanks (Section 9.4.2 for the flow-injection system), a minimum of 3 bubbler blanks (Section 9.4.1 for the bubbler system), 1 OPR sample at the beginning and end of the batch (Section 9.5), a QCS (Section 9.6), and at least 3 method blanks (Section 9.4.4). In addition, there must be 1 MS and 1 MSD sample for every 10 samples (a frequency of 10%). A typical analytical sequence would be:

(a) Three system blanks (Section 9.4.2) or a minimum of 3 bubbler blanks (Section 9.4.1)
(b) A minimum of five, non-zero calibration standards (Section 10.2.2.1)
(c) On-going precision and recovery (Section 9.5)
(d) Quality control sample (Section 9.6)
(e) Method blank (Section 9.4.4)
(f) Seven samples
(g) Method blank (Section 9.4.4)
(h) Three samples
(i) Matrix spike (Section 9.3)
(j) Matrix spike duplicate (Section 9.3)
(k) Four samples
(l) Method blank (Section 9.4.4)
(m) Six samples
(n) Matrix spike (Section 9.3)
(o) Matrix spike duplicate (Section 9.3)
(p) Ongoing precision and recovery (Section 9.5)

The above sequence includes calibration. If system performance is verified at the end of the sequence using the OPR, analysis of samples and blanks may proceed without recalibration (i.e., the analytical sequence would be entered at Step (d) above), unless more than 12 hours has elapsed since verification of system performance. If more than 12 hours has elapsed, the sequence would be initiated at Step (c) above.

9.2 Initial demonstration of laboratory capability

9.2.1 Method detection limit—To establish the ability to detect Hg, the laboratory shall achieve an MDL that is less than or equal to the MDL listed in Section 1.5 or one-third the regulatory compliance limit, whichever is greater. The MDL shall be determined according to the procedure at 40 CFR 136, Appendix B using the apparatus, reagents, and standards that will be used in the practice of this Method. This MDL shall be used for determination of laboratory capability only, and should be determined when a new operator begins work or whenever, in the judgment of the laboratory, a change in instrument hardware or operating conditions would dictate reevaluation of capability.

9.2.2 Initial precision and recovery (IPR)—To establish the ability to generate acceptable precision and recovery, the laboratory shall perform the following operations:

9.2.2.1 Analyze four replicates of the IPR solution (5 ng/L, Section 7.11) according to the procedure beginning in Section 11.

9.2.2.2 Using the results of the set of four analyses, compute the average percent recovery (X), and the standard deviation of the percent recovery (s) for Hg.

9.2.2.3 Compare s and X with the corresponding limits for initial precision and recovery in Table 2. If s and X meet the acceptance criteria, system performance is acceptable and analysis of samples may begin. If, however, s exceeds the precision limit or X falls outside the acceptance range, system performance is unacceptable. Correct the problem and repeat the test (Section 9.2.2.1).

9.3 Matrix spike (MS) and matrix spike duplicate (MSD)—To assess the performance of the Method on a given sample matrix, the laboratory must spike, in duplicate, a minimum of 10% (1 sample in 10) from a given sampling site or, if for compliance monitoring, from a given discharge. Therefore, an analytical batch of 20 samples would require two pairs of MS/MSD samples (four spiked samples total).

9.3.1 The concentration of the spike in the sample shall be determined as follows:

9.3.1.1 If, as in compliance monitoring, the concentration of Hg in the sample is being checked against a regulatory compliance limit, the spiking level shall be at that limit or at 1–5 times the background concentration of the sample (as determined in Section 9.3.2), whichever is greater.

9.3.1.2 If the concentration of Hg in a sample is not being checked against a limit, the spike shall be at 1–5 times the background concentration or at 1-5 times the ML in Table 1, whichever is greater.

9.3.2 To determine the background concentration (B), analyze one sample aliquot from each set of 10 samples from each site or discharge according to the procedure in Section 11. If the expected background concentration is known from previous experience or other knowledge, the spiking level may be established *a priori*.

9.3.2.1 If necessary, prepare a standard solution to produce an appropriate level in the sample (Section 9.3.1).

9.3.2.2 Spike two additional sample aliquots with identical amounts of the spiking solution and analyze these aliquots as described in Section 11.1.2 to determine the concentration after spiking (A).

9.3.3 Calculate the percent recovery (R) in each aliquot using the following equation:

$$\% R = 100 \frac{(A-B)}{T}$$

where:

A = Measured concentration of analyte after spiking
B = Measured concentration of analyte before spiking
T = True concentration of the spike

9.3.4 Compare percent recovery (R) with the QC acceptance criteria in Table 2.

9.3.4.1 If results of the MS/MSD are similar and fail the acceptance criteria, and recovery for the OPR standard (Section 9.5) for the analytical batch is within the acceptance criteria in Table 2, an interference is present and the results may not be reported or otherwise used for permitting or regulatory compliance purposes. If the interference can be attributed to sampling, the site or discharge should be resampled. If the interference can be attributed to a method deficiency, the laboratory must modify the method, repeat the test required in Section 9.1.2, and repeat analysis of the sample and MS/MSD. However, during the development of Method 1631, very few interferences have been noted in the determination of Hg using this Method. (See Section 4.4 for information on interferences.)

9.3.4.2 If the results of both the spike and the OPR test fall outside the acceptance criteria, the analytical system is judged to be not in control, and the results may not be reported or used for permitting or regulatory compliance purposes. The laboratory must identify and correct the problem and reanalyze all samples in the sample batch.

9.3.5 Relative percent difference (RPD)—Compute the RPD between the MS and MSD results according to the following equation using the concentrations found in the MS and MSD. Do not use the recoveries calculated in Section 9.3.3 for this calculation because the RPD is inflated when the background concentration is near the spike concentration.

$$RPD = 200 \times \frac{(|D1-D2|)}{(D1+D2)}$$

Where:
D1 = concentration of Hg in the MS sample
D2 = concentration of Hg in the MSD sample

9.3.6 The RPD for the MS/MSD pair must not exceed the acceptance criterion in Table 2. If the criterion is not met, the system is judged to be out of control. The problem must be identified and corrected, and the MS/MSD and corresponding samples reanalyzed.

9.3.7 As part of the QC program for the laboratory, method precision and recovery for samples should be assessed and records maintained. After analyzing five samples in which the recovery passes the test in Section 9.3.4, compute the average percent recovery (R_a) and the standard deviation of the percent recovery (s_r). Express the accuracy assessment as a percent recovery interval from $R_a - 2s_r$ to $R_a + 2s_r$. For example, if $R_a = 90\%$ and $s_r = 10\%$ for five analyses, the accuracy interval is expressed as 70–110%. Update the accuracy assessment regularly (e.g., after every five to ten new accuracy measurements).

9.4 Blanks—Blanks are critical to the reliable determination of Hg at low levels. The sections below give the minimum requirements for analysis of blanks. Analysis of additional blanks is recommended as necessary to pinpoint sources of contamination in, and external to, the laboratory.

9.4.1 Bubbler blanks—Bubbler blanks are analyzed to demonstrate that bubbler systems are free from contamination at levels that could affect data quality. At least three bubbler blanks must be run during calibration and with each analytical batch.

9.4.1.1 To analyze a bubbler blank, place a clean gold trap on the bubbler. Purge and analyze previously purged water using the procedure in Section 11, and determine the amount of Hg remaining in the system.

9.4.1.2 If the bubbler blank is found to contain more than 50 pg Hg, the system is out of control. The problem must be investigated and remedied, and the samples run on that bubbler must be reanalyzed. If the blanks from other bubblers contain less than 50 pg Hg, the data associated with those bubblers remain valid, provided that all other criteria in Section 9 also are met.

9.4.1.3 The mean result for all bubbler blanks (from bubblers passing the specification in Section 9.4.1.2) must be < 25 pg (0.25 ng/L) Hg with a standard deviation (n-1) of <10 pg (0.10 ng/L). If the mean is < 25 pg, the average peak area or height is subtracted from all raw data before results are calculated (Section 12.2).

9.4.1.4 If Hg in the bubbler blank exceeds the acceptance criteria in Section 9.4.1.3, the system is out of control. The problem must be resolved and the system recalibrated. Usually, the bubbler blank is too high for one of the following reasons:
(a) Bubblers need rigorous cleaning;
(b) Soda-lime is contaminated; or
(c) Carrier gas is contaminated.

9.4.2 System blanks— System blanks are analyzed to demonstrate that flow injection systems are free from contamination at levels that could affect data quality. Three system blanks must be run during calibration and with each analytical batch.

9.4.2.1 To analyze a system blank, analyze reagent water containing the same amount of reagents used to prepare the calibration standards.

9.4.2.2 If a system blank is found to contain ≥ 0.50 ng/L Hg, the system is out of control. The problem must be investigated and remedied, and the system recalibrated. If the blanks contain < 0.50 ng/L Hg, the data associated with the blanks remain valid, provided that all other criteria in Section 9 also are met.

9.4.2.3 The mean result for the three system blanks must be <0.5 ng/L Hg with a standard deviation (n-1) <0.1 ng/L. If the mean exceeds these criteria, the system is out of control, and the problem must be resolved and the system recalibrated. If the mean is <0.5 ng/L, the average peak height or area is subtracted from all raw data before results are calculated (Section 12.3).

9.4.3 Reagent blanks—Reagent blanks are used to demonstrate that the reagents used to prepare samples for Hg analyses are free from contamination. The Hg concentration in reagent blanks is determined by analyzing the reagent solutions using either the bubbler or flow-injection system. For the bubbler system, reagent may be added directly to previously purged water in the bubbler.

9.4.3.1 Reagent blanks are required when the batch of reagents (bromine monochloride plus hydroxylamine hydrochloride) are prepared. The amount of Hg in a reagent blank containing 0.5% (v/v) BrCl solution (Section 7.6) and 0.2% (v/v) hydroxylamine hydrochloride solution (Section 7.4) must be < 20 pg (0.2 ng/L).

9.4.3.2 The presence of more than 20 pg (0.2 ng/L) of Hg indicates a problem with the reagent solution. The purging of certain reagent solutions, such as $SnCl_2$ or NH_2OH, with mercury-free nitrogen or argon can reduce Hg to acceptable levels. Because BrCl cannot be purified, a new batch must be prepared and tested if the BrCl is contaminated.

9.4.4 Method blanks— Method blanks are used to demonstrate that the analytical system is free from contamination that could otherwise compromise sample results. Method blanks are prepared and analyzed using sample containers, labware, reagents, and analytical procedures identical to those used to prepare and analyze the samples.

9.4.4.1 A minimum of three method blanks per analytical batch are required for both the bubbler and flow-injection systems.

9.4.4.2 If the result for any method blank containing the nominal amount of reagent used to prepare a sample (Section 11.1.1) is found to contain ≥ 0.50 ng/L (50 pg) Hg, the system is out of control. Mercury in the analytical system must be reduced until a method blank is free from contamination at the 0.50 ng/L level. Samples associated with a contaminated method blank must be reanalyzed.

9.4.4.3 Because method blanks are analyzed using procedures identical to those used to analyze samples, any sample requiring an increased amount of reagent must be accompanied by at least one method blank that includes an identical amount of reagent.

9.4.5 Field blanks–Field blanks are used to demonstrate that samples have not been contaminated by the sample collection and transport activities.

9.4.5.1 Analyze the field blank(s) shipped with each set of samples (samples collected from the same site at the same time, to a maximum of 10 samples). Analyze the blank immediately before analyzing the samples in the batch.

9.4.5.2 If Hg or any potentially interfering substance is found in the field blank at a concentration equal to or greater than the ML (Table 1), or greater than one-fifth the level in the associated sample, whichever is greater, results for associated samples may be the result of contamination and may not be reported or otherwise used for regulatory compliance purposes.

9.4.5.3 Alternatively, if sufficient multiple field blanks (a minimum of three) are collected, and the average concentration (of the multiple field blanks) plus two standard deviations is equal to or greater than the regulatory compliance limit or equal to or greater than one-half of the level in the associated sample, results for associated samples may be the result of contamination and may not be reported or otherwise used for regulatory compliance purposes.

9.4.5.4 If contamination of the field blanks and associated samples is known or suspected, the laboratory should communicate this to the sampling team so that the source of contamination can be identified and corrective measures taken before the next sampling event.

9.4.6 Equipment blanks—Before any sampling equipment is used at a given site, the laboratory or cleaning facility is required to generate equipment blanks on all sampling equipment that will be used to demonstrate that the sampling equipment is free from contamination.

9.4.6.1 Equipment blanks are generated in the laboratory or at the equipment cleaning facility by processing reagent water through the sampling devices using the same procedures that are used in the field (see Sampling Method). Therefore, the "clean hands/dirty hands" technique used during field sampling should be followed when preparing equipment blanks at the laboratory or cleaning facility for low level mercury measurements. If grab samples are to be collected using any ancillary equipment, e.g., an extension pole or a dipper, an equipment blank is generated by submersing this equipment into the reagent water and analyzing the resulting reagent water collected.

9.4.6.2 The equipment blank must be analyzed using the procedures in this Method. If mercury or any potentially interfering substance is detected in the blank at or above the level specified for the field blank (Section 9.4.5), the source of contamination or interference must be identified, and the problem corrected. The equipment must be demonstrated to be free from mercury and interferences before the equipment may be used in the field.

9.4.7 Bottle blanks— Bottles must be subjected to conditions of use to verify the effectiveness of the cleaning procedures. A representative set of sample bottles (Section 6.1.2) should be filled with reagent water acidified to pH <2 and allowed to stand for a minimum of 24 h. At least 5% of the bottles from a given lot should be tested, and the time that the bottles are allowed to stand should be as close as possible to the actual time that the sample will be in contact with the bottle. After standing, the water must be analyzed for any signs of contamination. If a bottle shows contamination at or above the level specified for the field blank (Section 9.4.5), the problem must be identified, the cleaning procedures corrected or cleaning solutions changed, and all affected bottles re-cleaned.

9.5 Ongoing precision and recovery (OPR)—To demonstrate that the analytical system is within the performance criteria of this Method and that acceptable precision and recovery is being maintained within each analytical batch, the laboratory shall perform the following operations:

9.5.1 Analyze the OPR solution (5 ng/L, Section 7.11) prior to the analysis of each analytical batch according to the procedure beginning in Section 11. An OPR also must be analyzed at the end of an analytical sequence or at the end of each 12-hour shift.

9.5.2 Compare the recovery with the limits for ongoing precision and recovery in Table 2. If the recovery is in the range specified, the analytical system is in control and analysis of samples and blanks may proceed. If, however, the concentration is not in the specified range, the analytical process is not in control. Correct the problem and repeat the ongoing precision and recovery test. All reported results must be associated with an OPR that meets the Table 2 performance criteria at the beginning and end of each batch.

9.5.3 The laboratory should add results that pass the specification in Section 9.5.2 to IPR and previous OPR data and update QC charts to form a graphic representation of continued laboratory performance. The laboratory also should develop a statement of laboratory data quality by calculating the average percent recovery (R_a) and the standard deviation of the percent recovery (s_r). Express the accuracy as a recovery interval from $R_a - 2s_r$ to $R_a + 2s_r$. For example, if $R_a = 95\%$ and $s_r = 5\%$, the accuracy is 85–105%.

9.6 Quality control sample (QCS) – The laboratory must obtain a QCS from a source different from the Hg used to produce the standards used routinely in this Method (Sections 7.7–7.10). The QCS should be analyzed as an independent check of system performance.

9.7 Depending on specific program requirements, the laboratory may be required to analyze field duplicates and field spikes collected to assess the precision and accuracy of the sampling, sample transportation, and storage techniques. The relative percent difference (RPD) between field duplicates should be less than 20%. If the RPD of the field duplicates exceeds 20%, the laboratory should communicate this to the sampling team so that the source of error can be identified and corrective measures taken before the next sampling event.

10.0 Calibration and Standardization

10.1 Calibration and standardization— Separate calibration procedures are provided for a bubbler system (Section 10.2) and flow-injection system (Section 10.3). Both systems are calibrated using standards traceable to NIST Standard Reference Materials. If system performance is verified at the end of an analytical batch using the OPR, analysis of samples and blanks may proceed without recalibration, unless more than 12 hours has elapsed since verification of system performance.

10.2 Bubbler system calibration

10.2.1 Establish the operating conditions necessary to purge Hg from the bubbler and to desorb Hg from the traps in a sharp peak. Further details for operation of the purge-and-trap, desorption, and analysis systems are given in Sections 11.2.1 and 11.2.2.

10.2.2 The calibration must contain a minimum of five non-zero points and the results of analysis of three bubbler blanks. The lowest calibration point must be at the Minimum Level (ML).

NOTE: The purge efficiency of the bubbler system is 100% and is independent of volume at the volumes used in this Method. Calibration of this system is typically performed using units of mass. For purposes of working in concentration, the volume is assumed to be 100 mL.

10.2.2.1 Standards are analyzed by the addition of aliquots of Hg working standard A (Section 7.9) and Hg working standard B (Section 7.10) directly into the bubblers. Add 0.50 mL of working standard B and 0.5 mL $SnCl_2$ to the bubbler. Swirl to produce a standard containing 50 pg of Hg (0.5 ng/L). Purge under the optimum operating conditions (Section 10.2.1). Sequentially follow with the addition of aliquots of 0.05, 0.25, 0.50 and 1.0 mL of working standard A to produce standards of 500, 2500, 5000, and 10,000 pg Hg (5.0, 25.0, 50.0 and 100.0 ng/L).

NOTE: If calibration to the higher levels results in carryover (Section 4.3.8.1), calibrate the system across a narrower range (Section 10.4)

10.2.2.2 Analyze the standards beginning with the lowest concentration and proceeding to the highest. Tabulate the height or area for each peak.

10.2.2.3 Prepare and analyze a minimum of 3 bubbler blanks. If multiple bubblers are used, there must be 1 bubbler blank per bubbler (to a maximum of 4 bubblers). Calculate the mean peak area or height for the bubbler blanks.

10.2.2.4 For each calibration point, subtract the mean peak height or area of the bubbler blanks from the peak height or area for each standard. Calculate the calibration factor (CF_x) for Hg in each of the five standards using the mean bubbler-blank-subtracted peak height or area and the following equation:

$$CF_x = \frac{(A_x) - (\bar{A}_{BB})}{(C_x)}$$

Where:

A_x = *peak height or area for Hg in standard*
$\bar{A}_{BB}$ = *mean peak height or area for Hg in bubbler blank*
C_x= *mass in standard analyzed (ng)*

10.2.2.5 Calculate the mean calibration factor (CF_m), the standard deviation of the calibration factor (SD; n-1), and the relative standard deviation (RSD) of the calibration factor, where RSD = 100 x SD/CF_m.

10.2.2.6 If RSD ≤ 15%, calculate the recovery for the lowest standard using CF_m. If the RSD ≤ 15% and the recovery of the lowest standard is in the range of 75-125%, the calibration is acceptable and CF_m may be used to calculate the concentration of Hg in samples. If RSD > 15% or if the recovery of the lowest standard is not in the range of 75-125%, recalibrate the analytical system and repeat the test.

10.2.2.7 Calculate the concentration of Hg in the bubbler blanks (Section 10.2.2.1) using CF_m. The bubbler blanks must meet the criteria in Section 9.4.1; otherwise, mercury in the system must be reduced and the calibration repeated until the bubbler blanks meet the criteria.

10.3 Flow-injection system calibration

10.3.1 Establish the operating conditions necessary to purge Hg from the gas-liquid separator and dryer tube and desorb Hg from the traps in a sharp peak. Further details for operating the analytical system are given in Section 11.2.1.

10.3.2 The calibration must contain a minimum of 5 non-zero points and the results of analysis of 3 system blanks. The lowest calibration point must be at the minimum level (ML).

10.3.2.1 Place 25-30 mL of reagent water and 250 µL of concentrated BrCl solution (Section 7.6) in each of 5 calibrated 50-mL autosampler vials. Prepare the 0.5 ng/L calibration standard by adding 250 µL of working standard B (Section 7.10) to the vial. Dilute to the mark with reagent water. Sequentially follow with the addition of aliquots of 25, 125, 250 and 500 µL of working standard A (Section 7.9) to produce standards of 5.0, 25.0, 50.0 and 100.0 ng/L, respectively. Cap the vials and invert once to mix.

10.3.2.2 Immediately prior to analysis, remove the caps and add 125 µL of NH_2OH solution (Section 7.4). Re-cap, invert once to mix, and allow to stand until the yellow color disappears. Remove all caps and place vials into the analysis rack.

10.3.2.3 Analyze the standards beginning with the lowest concentration and proceeding to the highest. Tabulate the height or area for the Hg peak.

10.3.2.4 Prepare and analyze a minimum of 3 system blanks and tabulate the peak heights or areas. Calculate the mean peak area or height for the system blanks.

10.3.2.5 For each calibration point, subtract the mean peak height or area of the system blanks (Section 9.4.2) from the peak height or area for each standard. Calculate the calibration factor (CF_x) for Hg in each of the five standards using the mean reagent-blank-subtracted peak height or area and the following equation:

$$CF_x = \frac{(A_x) - (\bar{A}_{SB})}{(C_x)}$$

Where:

A_x = *peak height or area for Hg in standard*
$\bar{A}_{SB}$ = *mean peak height or area for Hg in calibration blanks*
C_x= *concentration of standard analyzed (ng/L)*

10.3.2.6 Calculate the mean calibration factor (CF_m), the standard deviation of the calibration factor (SD; n-1), and the relative standard deviation (RSD) of the calibration factor, where RSD = 100 x SD/CF_m.

10.3.2.7 If RSD ≤ 15%, calculate the recovery for the lowest standard (0.5 ng/L) using CF_m. If the RSD ≤ 15% and the recovery of the lowest standard is in the range of 75-125%, the calibration is acceptable and CF_m may be used to calculate the concentration of Hg in samples, blanks, and OPRs. If RSD > 15% or if the recovery of the lowest standard is not in the range of 75-125%, recalibrate the analytical system and repeat the test.

10.3.2.8 Calculate the concentration of Hg in the system blanks (Section 9.4.2) using CF_m. The system blanks must meet the criteria in Section 9.4.2; otherwise, mercury in the system must be reduced and the calibration repeated until the system blanks meet the criteria.

10.4 Calibration to a range other than 0.5 to 100 ng/L—This Method may be calibrated to a range other than 0.5 to 100 ng/L, provided that the following requirements are met:

(a) There must be a minimum of five non-zero calibration points.
(b) The difference between successive calibration points must be no greater than a factor of 10 and no less than a factor of 2 and should be approximately evenly spaced on a logarithmic scale over the calibration range.
(c) The relative standard deviation (RSD) of the calibration factors for all calibration points must be less than 15%.
(d) The calibration factor for any calibration point at a concentration greater than 100 ng/L must be within ±15% of the average calibration factor for the points at or below 100 ng/L.
(e) The calibration factor for any point <0.5 ng/L must be within 25% of the average calibration factor for all points.
(f) If calibration is to a higher range and this Method is used for regulatory compliance, the ML must be less than one-third the regulatory compliance limit

11.0 Procedure

NOTE: The following procedures for analysis of samples are provided as guidelines. Laboratories may find it necessary to optimize the procedures, such as drying time or potential applied to the Nichrome wires, for the laboratory's specific instrument set-up.

11.1 Sample Preparation

11.1.1 Pour a 100-mL aliquot from a thoroughly shaken, acidified sample, into a 125-mL fluoropolymer bottle. If BrCl was not added as a preservative (Section 8.5), add the amount of BrCl solution (Section 7.6) given below, cap the bottle, and digest at room temperature for a 12 h minimum.

11.1.1.1 For clear water and filtered samples, add 0.5 mL of BrCl; for brown water and turbid samples, add 1.0 mL of BrCl. If the yellow color disappears because of consumption by organic matter or sulfides, more BrCl should be added until a permanent (12-h) yellow color is obtained.

11.1.1.2 Some highly organic matrices, such as sewage effluent, will require high levels of BrCl (e.g., 5 mL/100 mL of sample) and longer oxidation times, or elevated temperatures (e.g., place sealed bottles in oven at 50 °C for 6 h). The oxidation must be continued until it is complete. Complete oxidation can be determined by either observation of a permanent yellow color remaining in the sample or the use of starch iodide indicating paper to test for residual free oxidizer. The sample also may be diluted to reduce the amount of BrCl required, provided that the resulting level of mercury is sufficient for reliable determination.

11.1.2 Matrix spikes and matrix spike duplicates—For every 10 or fewer samples, pour 2 additional 100-mL aliquots from a selected sample (see Section 9.3), spike at the level specified in Section 9.3, and process in the same manner as the samples. There must be a minimum of 2 MS/MSD pairs for each analytical batch of 20 samples.

11.2 Hg reduction and purging—Separate procedures are provided for the bubbler system (Section 11.2.1) and flow-injection (Section 11.2.2).

11.2.1 Hg reduction and purging for the bubbler system

11.2.1.1 Add 0.2-0.25 mL of NH_2OH solution to the BrCl-oxidized sample in the 125-mL sample bottle. Cap the bottle and swirl the sample. The yellow color will disappear, indicating the destruction of the BrCl. Allow the sample to react for 5 min with periodic swirling to be sure that no traces of halogens remain.

***NOTE:** Purging of free halogens onto the gold trap will result in damage to the trap and low or irreproducible results.*

11.2.1.2 Connect a fresh trap to the bubbler, pour the reduced sample into the bubbler, add 0.5 mL of $SnCl_2$ solution, and purge the sample onto a gold trap with N_2 at 350 ± 50 mL/min for 20 min.

11.2.1.3 When analyzing Hg samples, the recovery is quantitative, and organic interferents are destroyed. Thus, standards, bubbler blanks, and small amounts of high-level samples may be run directly in previously purged water. After very high samples (Section 4.3.8.1), a small degree of carryover (<0.01%) may occur. Bubblers that contain such samples must be demonstrated to be clean prior to proceeding with low level samples. Samples run immediately following a sample that has been determined to result in carryover must be reanalyzed using a bubbler that is demonstrated to be clean as per Section 4.3.8.1.

11.2.2 Hg reduction and purging for the flow-injection system

11.2.2.1 Add 0.2-0.25 mL of NH_2OH solution (Section 7.4) to the BrCl-oxidized sample in the 125-mL sample bottle or in the autosampler tube (the amount of NH_2OH required will be approximately 30 percent of the BrCl volume). Cap the bottle and swirl the sample. The yellow color will disappear, indicating the destruction of the BrCl. Allow the sample to react for 5 minutes with periodic swirling to be sure that no traces of halogens remain.

NOTE: Purging of free halogens onto the gold trap will result in damage to the trap and low or irreproducible results.

11.2.2.2 Pour the sample solution into an autosampler vial and place the vial in the rack.

11.2.2.3 Carryover may occur after analysis of a sample containing a high level of mercury. Samples run immediately following a sample that has been determined to result in carryover (Section 4.3.8.1) must be reanalyzed using a system demonstrated to be clean as per Section 4.3.8.1.

11.3 Desorption of Hg from the gold trap

11.3.1 Remove the sample trap from the bubbler, place the Nichrome wire coil around the trap and connect the trap into the analyzer train between the incoming Hg-free argon and the second gold-coated (analytical) sand trap (Figure 2).

11.3.2 Pass argon through the sample and analytical traps at a flow rate of approximately 30 mL/min for approximately 2 min to drive off condensed water vapor.

11.3.3 Apply power to the coil around the sample trap for 3 minutes to thermally desorb the Hg (as Hg(0)) from the sample trap onto the analytical trap.

11.3.4 After the 3-min desorption time, turn off the power to the Nichrome coil, and cool the sample trap using the cooling fan.

11.3.5 Turn on the chart recorder or other data acquisition device to start data collection, and apply power to the Nichrome wire coil around the analytical trap. Heat the analytical trap for 3 min (1 min beyond the point at which the peak returns to baseline).

11.3.6 Stop data collection, turn off the power to the Nichrome coil, and cool the analytical trap to room temperature using the cooling fan.

11.3.7 Place the next sample trap in line and proceed with analysis of the next sample.

NOTE: Do not heat a sample trap while the analytical trap is still warm; otherwise, the analyte may be lost by passing through the analytical trap.

11.4 Peaks generated using this technique should be very sharp and almost symmetrical. Mercury elutes at approximately 1 minute and has a width at half-height of about 5 seconds.

11.4.1 Broad or asymmetrical peaks indicate a problem with the desorption train, such as improper gas flow rate, water vapor on the trap(s), or an analytical trap damaged by chemical fumes or overheating.

11.4.2 Damage to an analytical trap is also indicated by a sharp peak, followed by a small, broad peak.

11.4.3 If the analytical trap has been damaged, the trap and the fluoropolymer tubing downstream from it should be discarded because of the possibility of gold migration onto downstream surfaces.

11.4.4 Gold-coated sand traps should be tracked by unique identifiers so that any trap producing poor results can be quickly recognized and discarded.

12.0 Data Analysis and Calculations

12.1 Separate procedures are provided for calculation of sample results using the bubbler system (Section 12.2) and the flow-injection system (Section 12.3), and for method blanks (Section 12.4).

12.2 Calculations for the bubbler system

12.2.1 Calculate the mean peak height or area for Hg in the bubbler blanks measured during system calibration or with the analytical batch (A_{BB}; n = 3 minimum).

12.2.2 Calculate the concentration of Hg in ng/L (parts-per-trillion; ppt) in each sample according to the following equation:

$$[Hg]\ (ng/L) = \frac{A_s - \overline{A}_{BB}}{CF_m \times V}$$

where:
A_s = *peak height (or area) for Hg in sample*
$\overline{A}_{BB}$ = *peak height (or area) for Hg in bubbler blank*
CF_m = *mean calibration factor (Section 10.2.2.5)*
V = *Volume of sample (L)*

12.3 Calculations for the flow-injection system

12.3.1 Calculate the mean peak height or area for Hg in the system blanks measured during system calibration or with each analytical batch (A_{SB}; n = 3)

12.3.2 Calculate the concentration of Hg in ng/L in each sample according to the following equation:

$$[Hg]\ (ng/L) = \frac{(A_s - \overline{A}_{SB})}{CF_m} \times \frac{V_{std}}{V_{sample}}$$

where:
A_s = *peak height (or area) for Hg in sample*
$\overline{A}_{SB}$ = *mean peak height (or area) for Hg in system blanks*
CF_m = *mean calibration factor (Section 10.3.2.6)*
V_{std} = *volume (mL) used for standards - volume (mL) reagent used in standards*
V_{sample} = *volume (mL) of sample - volume (mL) reagent used in sample*

12.4 Calculations for concentration of Hg in method blanks, field blanks, and reagent blanks.

12.4.1 Calculate the concentration of Hg in the method blanks (C_{MB}), field blanks (C_{FB}), or reagent blanks (C_{RB}) in ng/L, using the equation in Section 12.2.2 (if bubbler system is used) or Section 12.3.2 (if flow injection system is used) and substituting the peak height or area resulting from the method blank, field blank, or reagent blank for A_s.

12.4.2 Determine the mean concentration of Hg in the method blanks associated with the analytical batch (a minimum of three). If a sample requires additional reagent(s) (e.g., BrCl), a corresponding method blank containing an identical amount of reagent must be analyzed (Section 9.4.4.3). The concentration of Hg in the corresponding method blank may be subtracted from the concentration of Hg in the sample per Section 12.5.2.

12.5 Reporting

12.5.1 Report results for Hg at or above the ML, in ng/L, to three significant figures. Report results for Hg in samples below the ML as <0.5 ng/L, or as required by the regulatory authority or in the permit. Report results for Hg in reagent blanks and field blanks at or above the ML, in ng/L, to three significant figures. Report results for Hg in reagent blanks, method blanks, or field blanks below the ML but at or above the MDL to two significant figures. Report results for Hg not detected in reagent blanks, method blanks, or field blanks as <0.2 ng/L, or as required by the regulatory authority or in the permit.

12.5.2 Report results for Hg in samples, method blanks and field blanks separately. In addition to reporting results for the samples and blank(s) separately, the concentration of Hg in the method blanks or field blanks associated with the sample may be subtracted from the results for that sample, or must be subtracted if requested or required by a regulatory authority or in a permit.

12.5.3 Results from tests performed with an analytical system that is not in control must not be reported or otherwise used for permitting or regulatory compliance purposes, but do not relieve a discharger or permittee of reporting timely results.

13.0 Method Performance

13.1 This Method was tested in 12 laboratories using reagent water, freshwater, marine water and effluent (Reference 16.19). The quality control acceptance criteria listed in Table 2 were verified by data gathered in the interlaboratory study, and the method detection limit (MDL) given in Section 1.5 was verified in all 12 laboratories. In addition, the techniques in this Method have been compared with other techniques for low-level mercury determination in water in a variety of studies, including ICES-5 (Reference 16.20) and the International Mercury Speciation Intercomparison Exercise (Reference 16.21).

13.2 Precision and recovery data for reagent water, freshwater, marine water, and secondary effluent are given in Table 3.

14.0 Pollution Prevention

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Many opportunities for pollution prevention exist in laboratory operation. EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address waste generation. When it is not feasible to reduce wastes at the source, the Agency recommends recycling as the next best option. The acids used in this Method should be reused as practicable by purifying by electrochemical techniques. The only other chemicals used in this Method are the neat materials used in preparing standards. These standards are used in extremely small amounts and pose little threat to the environment when managed properly. Standards should be prepared in volumes consistent with laboratory use to minimize the disposal of excess volumes of expired standards.

14.2 For information about pollution prevention that may be applied to laboratories and research institutions, consult *Less is Better: Laboratory Chemical Management for Waste Reduction*, available from the American Chemical Society's Department of Governmental Relations and Science Policy, 1155 16th Street NW, Washington DC 20036, 202/872–4477.

15.0 Waste Management

15.1 The laboratory is responsible for complying with all Federal, State, and local regulations governing waste management, particularly hazardous waste identification rules and land disposal restrictions, and for protecting the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required. An overview of requirements can be found in *Environmental Management Guide for Small Laboratories* (EPA 233-B-98-001).

15.2 Acids, samples at pH <2, and BrCl solutions must be neutralized before being disposed of, or must be handled as hazardous waste.

15.3 For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* and *Less is Better: Laboratory Chemical Management for Waste Reduction*, both available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street NW, Washington, DC 20036.

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17.0 Glossary

The definitions and purposes below are specific to this Method, but have been conformed to common usage as much as possible.

17.1 **Ambient Water**—Waters in the natural environment (e.g., rivers, lakes, streams, and other receiving waters), as opposed to effluent discharges.

17.2 **Analytical Batch**—A batch of up to 20 samples that are oxidized with the same batch of reagents and analyzed during the same 12-hour shift. Each analytical batch must also include at least three bubbler blanks, an OPR, and a QCS. In addition, MS/MSD samples must be prepared at a frequency of 10% per analytical batch (one MS/MSD for every 10 samples).

17.3 **Bottle Blank**—The bottle blank is used to demonstrate that the bottle is free from contamination prior to use. Reagent water known to be free of mercury at the MDL of this Method is added to a bottle, acidified to pH <2 with BrCl or HCl, and allowed to stand for a minimum of 24 hours. The time that the bottle is allowed to stand should be as close as possible to the actual time that the sample will be in contact with the bottle. After standing, the water is analyzed.

17.4 **Bubbler Blank**—For this Method, the bubbler blank is specific to the bubbler system and is used to determine that the analytical system is free from contamination. After analysis of a standard, blank, or sample, the solution in the bubbler is purged and analyzed. A minimum of three bubbler blanks is required for system calibration.

17.5 **Equipment Blank**—Reagent water that has been processed through the sampling device at a laboratory or other equipment cleaning facility prior to shipment of the sampling equipment to the sampling site. The equipment blank is used to demonstrate that the sampling equipment is free from contamination prior to use. Where appropriate, the "clean hands/dirty hands" technique used during field sampling should be followed when preparing equipment blanks at the laboratory or cleaning facility.

17.6 **Field Blank**—Reagent water that has been transported to the sampling site and exposed to the same equipment and operations as a sample at the sampling site. The field blank is used to demonstrate that the sample has not been contaminated by the sampling and sample transport systems.

17.7 **Intercomparison Study**—An exercise in which samples are prepared and split by a reference laboratory, then analyzed by one or more testing laboratories and the reference laboratory. The intercomparison, with a reputable laboratory as the reference laboratory, serves as the best test of the precision and accuracy of the analyses at natural environmental levels.

17.8 **Matrix Spike (MS) and Matrix Spike Duplicate (MSD)**—Aliquots of an environmental sample to which known quantities of the analyte(s) of interest is added in the laboratory. The MS and MSD are analyzed exactly like a sample. Their purpose is to quantify the bias and precision caused by the sample matrix. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS and MSD corrected for these background concentrations.

17.9 **May**—This action, activity, or procedural step is allowed but not required.

17.10 **May not**—This action, activity, or procedural step is prohibited.

17.11 **Method blank**— Method blanks are used to determine the concentration of mercury in the analytical system during sample preparation and analysis, and consist of a volume of reagent water that is carried through the entire sample preparation and analysis. Method blanks are prepared by placing reagent water in a sample bottle and analyzing the water using reagents and procedures identical to those used to prepare and analyze the corresponding samples. A minimum of three method blanks is required with each analytical batch.

17.12 **Minimum Level (ML)**—The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. It is equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed. The ML is calculated by multiplying the MDL by 3.18 and rounding the result to the number nearest to (1, 2, or 5) x 10^n, where n is an integer (See Section 1.5).

17.13 **Must**—This action, activity, or procedural step is required.

17.14 **Quality Control Sample (QCS)**—A sample containing Hg at known concentrations. The QCS is obtained from a source external to the laboratory, or is prepared from a source of standards different from the source of calibration standards. It is used as an independent check of instrument calibration.

17.15 **Reagent blank**—Reagent blanks are used to determine the concentration of mercury in the reagents (BrCl, $NH_2OH{\cdot}HCl$, and $SnCl_2$) that are used to prepare and analyze the samples. In this Method, reagent blanks are required when each new batch of reagents is prepared.

17.16 **Reagent Water**—Water demonstrated to be free of mercury at the MDL of this Method. It is prepared from 18 MΩ ultrapure deionized water starting from a prepurified source. Reagent water is used to wash bottles, as trip and field blanks, and in the preparation of standards and reagents.

17.17 **Regulatory Compliance Limit**—A limit on the concentration or amount of a pollutant or contaminant specified in a nationwide standard, in a permit, or otherwise established by a regulatory authority.

17.18 **Shall**—This action, activity, or procedure is required.

17.19 **Should**—This action, activity, or procedure is suggested, but not required.

17.20 **Stock Solution**— A solution containing an analyte that is prepared from a reference material traceable to NIST, or a source that will attest to the purity and authenticity of the reference material.

17.21 **System Blank**— For this Method, the system blank is specific for the flow-injection system and is used to determine contamination in the analytical system and in the reagents used to prepare the calibration standards. A minimum of three system blanks is required during system calibration.

17.22 **Ultraclean Handling**— A series of established procedures designed to ensure that samples are not contaminated during sample collection, storage, or analysis.

18.0 Tables and Figures

Table 1

Lowest Ambient Water Quality Criterion for Mercury and the Method Detection Limit and Minimum Level of Quantitation for EPA Method 1631

Metal	Lowest Ambient Water Quality Criterion(1)	Method Detection Limit (MDL) and Minimum Level (ML)	
		MDL(2)	ML(3)
Mercury (Hg)	1.3 ng/L	0.2 ng/L	0.5 ng/L

1. Lowest water quality criterion for the Great Lakes System (Table 4, 40 CFR 132.6). The lowest Nationwide criterion is 12 ng/L (40 CFR 131.36).
2. Method detection limit (40 CFR 136, Appendix B)
3. Minimum level of quantitation (see Glossary)

Table 2

Quality Control Acceptance Criteria for Performance Tests in EPA Method 1631

Acceptance Criteria	Section	Limit (%)
Initial Precision and Recovery (IPR)	9.2.2	
Precision (RSD)	9.2.2.3	21
Recovery (X)	9.2.2.3	79-121
Ongoing Precision and Recovery (OPR)	9.5.2	77-123
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	9.3	
Recovery	9.3.4	71-125
Relative Percent Difference (RPD)	9.3.5	24

Table 3

Precision and Recovery for Reagent Water, Fresh Water, Marine Water, and Effluent Water Using Method 1631

Matrix	*Mean Recovery (%)	*Precision (% RSD)
Reagent Water	98.0	5.6
Fresh Water (Filtered)	90.4	8.3
Marine Water (Filtered)	92.3	4.7
Marine Water (Unfiltered)	88.9	5.0
Secondary Effluent (Filtered)	90.7	3.0
Secondary Effluent (Unfiltered)	92.8	4.5

*Mean percent recoveries and RSDs are based on expected Hg concentrations.

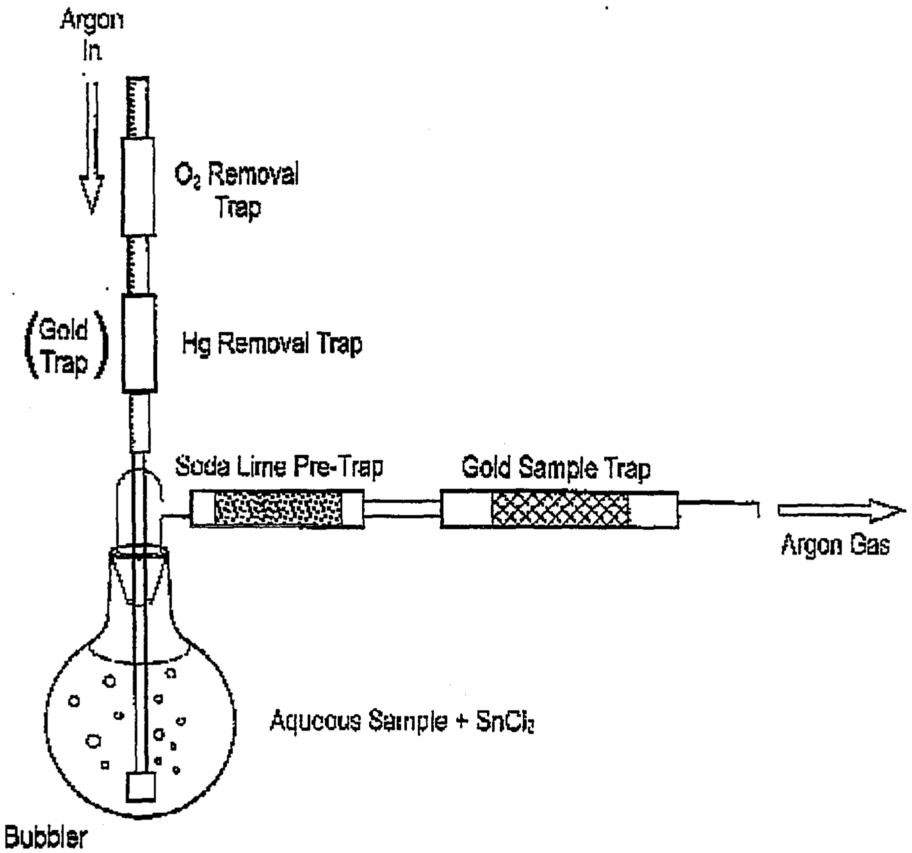

Figure 1. Schematic Diagram of Bubbler Setup

USEPA Method 1638

Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma – Mass Spectrometry

January 1996

Method 1638

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January 1996

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Acknowledgements

Method 1638 was prepared under the direction of William A. Telliard of the U.S. Environmental Protection Agency's (EPA's) Office of Water (OW), Engineering and Analysis Division (EAD). The method was prepared under EPA Contract 68–C3–0337 by the DynCorp Environmental Programs Division with assistance from Interface, Inc.

The following researchers contributed to the philosophy behind this method. Their contribution is gratefully acknowledged:

Shier Berman, National Research Council, Ottawa, Ontario, Canada;
Nicholas Bloom, Frontier Geosciences Inc., Seattle, Washington;
Paul Boothe and Gary Steinmetz, Texas A&M University, College Station, Texas;
Eric Crecelius, Battelle Marine Sciences Laboratory, Sequim, Washington;
Russell Flegal, University of California/Santa Cruz, California;
Gary Gill, Texas A&M University at Galveston, Texas;
Carlton Hunt and Dion Lewis, Battelle Ocean Sciences, Duxbury, Massachusetts;
Carl Watras, Wisconsin Department of Natural Resources, Boulder Junction, Wisconsin; and
Herb Windom and Ralph Smith, Skidaway Institute of Oceanography, Savannah, Georgia.

In addition, the following personnel at the EPA Office of Research and Development's Environmental Monitoring Systems Laboratory in Cincinnati, Ohio, are gratefully acknowledged for the development of the analytical procedures described in this method:

C.A. Brockhoff
J.T. Creed
T.D. Martin
E.R. Martin
S.E. Long (DynCorp, formerly Technology Applications Inc.)

Disclaimer

This method has been reviewed and approved for publication by the Engineering and Analysis Division of the U.S. Environmental Protection Agency. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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Introduction

This analytical method was designed to support water quality monitoring programs authorized under the Clean Water Act. Section 304(a) of the Clean Water Act requires EPA to publish water quality criteria that reflect the latest scientific knowledge concerning the physical fate (e.g., concentration and dispersal) of pollutants, the effects of pollutants on ecological and human health, and the effect of pollutants on biological community diversity, productivity, and stability.

Section 303 of the Clean Water Act requires states to set a water quality standard for each body of water within its boundaries. A state water quality standard consists of a designated use or uses of a waterbody or a segment of a waterbody, the water quality criteria that are necessary to protect the designated use or uses, and an antidegradation policy. These water quality standards serve two purposes: (1) they establish the water quality goals for a specific waterbody, and (2) they are the basis for establishing water quality-based treatment controls and strategies beyond the technology-based controls required by Sections 301(b) and 306 of the Clean Water Act.

In defining water quality standards, the state may use narrative criteria, numeric criteria, or both. However, the 1987 amendments to the Clean Water Act required states to adopt numeric criteria for toxic pollutants (designated in Section 307(a) of the Act) based on EPA Section 304(a) criteria or other scientific data, when the discharge or presence of those toxic pollutants could reasonably be expected to interfere with designated uses.

In some cases, these water quality criteria are as much as 280 times lower than those achievable using existing EPA methods and required to support technology-based permits. Therefore, EPA developed new sampling and analysis methods to specifically address state needs for measuring toxic metals at water quality criteria levels, when such measurements are necessary to protect designated uses in state water quality standards. The latest criteria published by EPA are those listed in the National Toxics Rule (57 *FR* 60848) and the Stay of Federal Water Quality Criteria for Metals (60 *FR* 22228). These rules include water quality criteria for 13 metals, and it is these criteria on which the new sampling and analysis methods are based. Method 1638 was specifically developed to provide reliable measurements of nine of these metals at EPA WQC levels using inductively coupled plasma-mass spectrometry techniques.

In developing these methods, EPA found that one of the greatest difficulties in measuring pollutants at these levels was precluding sample contamination during collection, transport, and analysis. The degree of difficulty, however, is highly dependent on the metal and site-specific conditions. This analytical method, therefore, is designed to provide the level of protection necessary to preclude contamination in nearly all situations. It is also designed to provide the procedures necessary to produce reliable results at the lowest possible water quality criteria published by EPA. In recognition of the variety of situations to which this method may be applied, and in recognition of continuing technological advances, the method is performance-based. Alternative procedures may be used, so long as those procedures are demonstrated to yield reliable results.

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Note: This method is intended to be performance-based, and the laboratory is permitted to omit any step or modify any procedure provided that *all* performance requirements set forth in this method are met. The laboratory is *not* allowed to omit any quality control analyses. The terms "must," "may," and "should" are included throughout this method and are intended to illustrate the importance of the procedures in producing verifiable data at water quality criteria levels. The term "must" is used to indicate that researchers in trace metals analysis have found certain procedures essential in successfully analyzing samples and avoiding contamination; however, these procedures can be modified or omitted if the laboratory can demonstrate that data quality is not affected.

Method 1638
Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma — Mass Spectrometry

1.0 Scope and Application

1.1 This method is for the determination of dissolved elements in ambient waters at EPA water quality criteria (WQC) levels using inductively coupled plasma-mass spectrometry (ICP-MS). It may also be used for determination of total recoverable element concentrations in these waters. This method was developed by integrating the analytical procedures in EPA Method 200.8 with the quality control (QC) and sample handling procedures necessary to avoid contamination and ensure the validity of analytical results during sampling and analysis for metals at EPA WQC levels. This method contains QC procedures that will assure that contamination will be detected when blanks accompanying samples are analyzed. This method is accompanied by Method 1669: *Sampling Ambient Water for Determination of Trace Metals at EPA Water Quality Criteria Levels* ("Sampling Method"). The Sampling Method is necessary to assure that trace metals determinations will not be compromised by contamination during the sampling process.

1.2 This method is applicable to the following elements:

Analyte	Symbol	Chemical Abstract Services Registry Number (CASRN)
Antimony	(Sb)	7440-36-0
Cadmium	(Cd)	7440-43-9
Copper	(Cu)	7440-50-8
Lead	(Pb)	7439-92-1
Nickel	(Ni)	7440-02-0
Selenium	(Se)	7782-49-2
Silver	(Ag)	7440-22-4
Thallium	(Tl)	7440-28-0
Zinc	(Zn)	7440-66-6

Table 1 lists the EPA WQC levels, the Method Detection Limit (MDL) for each metal, and the minimum level for each metal in this method. Linear working ranges will be dependent on the sample matrix, instrumentation, and selected operating conditions.

1.3 This method is not intended for determination of metals at concentrations normally found in treated and untreated discharges from industrial facilities. Existing regulations (40 *CFR* Parts 400-500) typically limit concentrations in industrial discharges to the mid to high part-per-billion (ppb) range, whereas ambient metals concentrations are normally in the low part-per-trillion (ppt) to low ppb range.

1.4 The ease of contaminating ambient water samples with the metal(s) of interest and interfering substances cannot be overemphasized. This method includes suggestions for improvements in facilities and analytical techniques that should maximize the ability of the laboratory to make reliable trace metals determinations and minimize contamination. These suggestions are given in Section 4.0, "Contamination and Interferences" and are based on findings of researchers performing trace metals analyses (References 1-8). Additional suggestions for improvement of existing facilities may be found in EPA's *Guidance for Establishing Trace Metals Clean Rooms in Existing Facilities*, which is available from the National Center for Environmental Publications and Information (NCEPI) at the address listed in the introduction to this document.

1.5 Clean and Ultraclean—The terms "clean" and "ultraclean" have been applied to the techniques needed to reduce or eliminate contamination in trace metals determinations. These terms are not used in this method because of their lack of an exact definition. However, the information provided in this method is consistent with the summary guidance on clean and ultraclean techniques (Reference 9).

1.6 This method follows the EPA Environmental Methods Management Council's "Format for Method Documentation" (Reference 10).

1.7 This method is "performance-based"; i.e., an alternate procedure or technique may be used, as long as the performance requirements in the method are met. Section 9.1.2 gives details of the tests and documentation required to support and document equivalent performance.

1.8 For dissolved metal determinations, samples must be filtered through a 0.45 μm capsule filter at the field site. The filtering procedures are described in the Sampling Method. The filtered samples may be preserved in the field or transported to the laboratory for preservation. Procedures for field preservation are detailed in the Sampling Method; procedures for laboratory preservation are provided in this method.

1.9 For the determination of total recoverable analytes in ambient water samples, a digestion/extraction (see Section 12.2) is required before analysis when the elements are not in solution (e.g., aqueous samples that may contain particulate and suspended solids).

1.10 The procedure given in this method for digestion of total recoverable metals is suitable for the determination of silver in aqueous samples containing concentrations up to 0.1 mg/L. For the analysis of samples containing higher concentrations of silver, succeedingly smaller volume, well-mixed sample aliquots must be prepared until the analysis solution contains <0.1 mg/L silver.

1.11 This method should be used by analysts experienced in the use of inductively coupled plasma mass spectrometry (ICP-MS), including the interpretation of spectral and matrix interferences and procedures for their correction, and this method should be used only by personnel thoroughly trained in the handling and analysis of samples for determination of metals at EPA WQC levels. A minimum of six months experience with commercial instrumentation is recommended.

1.12 This method is accompanied by a data verification and validation guidance document, *Guidance on the Documentation and Evaluation of Trace Metals Data Collected for CWA Compliance Monitoring*. Before using this method, data users should state the data quality objectives (DQOs) required for a project.

2.0 Summary of Method

2.1 An aliquot of a well-mixed, homogeneous aqueous sample is accurately measured for sample processing. For total recoverable analysis of an aqueous sample containing undissolved material, analytes are first solubilized by gentle refluxing with nitric and hydrochloric acids. After cooling, the sample is made to volume, mixed, and centrifuged or allowed to settle overnight prior to analysis. For the determination of dissolved analytes in a filtered aqueous sample aliquot, the sample is made ready for analysis by the appropriate addition of nitric acid, and then diluted to a predetermined volume and mixed before analysis.

2.2 The digested sample is introduced into a radiofrequency plasma where energy transfer processes cause desolvation, atomization, and ionization. The ions are extracted from the plasma through a differentially pumped vacuum interface and separated on the basis of their mass-to-charge ratio (m/z) by a mass spectrometer having a minimum resolution capability of 1 amu peak width at 5% peak height at m/z 300. Ions transmitted through the mass analyzer are detected by an electron multiplier or Faraday detector and the resulting current is processed by a data handling system (References 11-13).

3.0 Definitions

3.1 Apparatus—Throughout this method, the sample containers, sampling devices, instrumentation, and all other materials and devices used in sample collection, sample processing, and sample analysis activities will be referred to collectively as the Apparatus.

3.2 Other definitions of terms are given in Section 18.0 at the end of this method.

4.0 Contamination and Interferences

4.1 Preventing ambient water samples from becoming contaminated during the sampling and analytical process constitutes one of the greatest difficulties encountered in trace metals determinations. Over the last two decades, marine chemists have come to recognize that much of the historical data on the concentrations of dissolved trace metals in seawater are erroneously high because the concentrations reflect contamination from sampling and analysis rather than ambient levels. More recently, historical trace metals data collected from freshwater rivers and streams have been shown to be similarly biased because of contamination during sampling and analysis (Reference 14). Therefore, it is imperative that extreme care be taken to avoid contamination when collecting and analyzing ambient water samples for trace metals.

4.2 There are numerous routes by which samples may become contaminated. Potential sources of trace metals contamination during sampling include: metallic or metal-containing labware (e.g., talc gloves which contain high levels of zinc), containers, sampling equipment, reagents, and reagent water; improperly cleaned and stored equipment, labware, and reagents; and atmospheric inputs such as dirt and dust. Even human contact can be a source of trace metals contamination. For example, it has been demonstrated that dental work (e.g., mercury amalgam fillings) in the mouths of laboratory personnel can contaminate samples that are directly exposed to exhalation (Reference 3).

4.3 Contamination Control

4.3.1 Philosophy—The philosophy behind contamination control is to ensure that any object or substance that contacts the sample is metal-free and free from any material that may contain metals.

4.3.1.1 The integrity of the results produced cannot be compromised by contamination of samples. Requirements and suggestions for control of sample contamination are given in this method and the Sampling Method.

4.3.1.2 Substances in a sample cannot be allowed to contaminate the laboratory work area or instrumentation used for trace metals measurements. Requirements and suggestions for protecting the laboratory are given in this method.

4.3.1.3 While contamination control is essential, personnel health and safety remain the highest priority. Requirements and suggestions for personnel safety are given in Section 5 of this method and the Sampling Method.

4.3.2 Avoiding contamination—The best way to control contamination is to completely avoid exposure of the sample to contamination in the first place. Avoiding exposure means performing operations in an area known to be free from contamination. Two of the most important factors in avoiding/reducing sample contamination are: (1) an awareness of potential sources of contamination and (2) strict attention to work being done. Therefore it is imperative that the procedures described in this method be carried out by well-trained, experienced personnel.

4.3.3 Use a clean environment—The ideal environment for processing samples is a class 100 clean room (Section 6.1.1). If a clean room is not available, all sample preparation should be performed in a class 100 clean bench or a nonmetal glove box fed by particle-free air or nitrogen. Digestions should be performed in a nonmetal fume hood situated, ideally, in the clean room.

4.3.4 Minimize exposure—The Apparatus that will contact samples, blanks, or standard solutions should be opened or exposed only in a clean room, clean bench, or glove box so that exposure to an uncontrolled atmosphere is minimized. When not being used, the Apparatus should be covered with clean plastic wrap, stored in the clean bench or in a plastic box or glove box, or bagged in clean zip-type bags. Minimizing the time between cleaning and use will also minimize contamination.

4.3.5 Clean work surfaces—Before processing a given batch of samples, all work surfaces in the hood, clean bench, or glove box in which the samples will be processed should be cleaned by wiping with a lint-free cloth or wipe soaked with reagent water.

4.3.6 Wear gloves—Sampling personnel must wear clean, nontalc gloves (Section 6.9.7) during all operations involving handling of the Apparatus, samples, and blanks. Only clean gloves may touch the Apparatus. If another object or substance is touched, the glove(s) must be changed before handling the Apparatus again. If it is even suspected that gloves have become contaminated, work must be halted, the contaminated gloves removed, and a new pair of clean gloves put on. Wearing multiple layers of clean gloves will allow the old pair to be quickly stripped with minimal disruption to the work activity.

4.3.7 Use metal-free Apparatus—All Apparatus used for determination of metals at ambient water quality criteria levels must be nonmetallic, free of material that may contain metals, or both.

4.3.7.1 Construction materials—Only the following materials should come in contact with samples: fluoropolymer (FEP, PTFE), conventional or linear polyethylene, polycarbonate, polypropylene, polysulfone, or ultrapure quartz. PTFE is less desirable than FEP because the sintered material in PTFE may contain contaminates and is susceptible to serious memory contamination (Reference 6). Fluoropolymer or glass containers should be used for samples that will be analyzed for mercury because mercury vapors can diffuse in or out of the other materials resulting either in contamination or low-biased results (Reference 3). All materials, regardless of construction, that will directly or indirectly contact the sample must be cleaned using the procedures described in Section 11.0 and must be known to be clean and metal-free before proceeding.

4.3.7.2 The following materials have been found to contain trace metals and should not contact the sample or be used to hold liquids that contact the sample, *unless* these materials have been shown to be free of the metals of interest at the desired level: Pyrex, Kimax, methacrylate, polyvinylchloride, nylon, and Vycor (Reference 6). In addition, highly colored plastics, paper cap liners, pigments used to mark increments on plastics, and rubber all contain trace levels of metals and must be avoided (Reference 15).

4.3.7.3 Serialization—It is recommended that serial numbers be indelibly marked or etched on each piece of Apparatus so that contamination can be traced, and logbooks should be maintained to track the sample from the container through the labware to injection into the instrument. It may be useful to dedicate separate sets of labware to different sample types; e.g., receiving waters vs. effluents. However, the Apparatus used for processing blanks and standards must be mixed with the Apparatus used to process samples so that contamination of all labware can be detected.

4.3.7.4 The laboratory or cleaning facility is responsible for cleaning the Apparatus used by the sampling team. If there are any indications that the Apparatus is not clean when received by the sampling team (e.g., ripped storage bags), an assessment of the likelihood of contamination must be made. Sampling must not proceed if it is possible that the Apparatus is contaminated. If the Apparatus is contaminated, it must be returned to the laboratory or cleaning facility for proper cleaning before any sampling activity resumes.

4.3.8 Avoid sources of contamination—Avoid contamination by being aware of potential sources and routes of contamination.

4.3.8.1 Contamination by carryover—Contamination may occur when a sample containing low concentrations of metals is processed immediately after a sample containing relatively high concentrations of these metals. To reduce carryover, the sample introduction system may be rinsed between samples with dilute acid and reagent water. When an unusually concentrated sample is encountered, it is followed by analysis of a laboratory blank to check for carryover. For samples containing high levels of metals, it may be necessary to acid clean or replace the connecting tubing or inlet system to ensure that contamination will not affect subsequent measurements.

Samples known or suspected to contain the lowest concentration of metals should be analyzed first followed by samples containing higher levels. For instruments containing autosamplers, the laboratory should keep track of which station is used for a given sample. When an unusually high concentration of a metal is detected in a sample, the station used for that sample should be cleaned more thoroughly to prevent contamination of subsequent samples, and the results for subsequent samples should be checked for evidence of the metal(s) that occurred in high concentration.

4.3.8.2 Contamination by samples—Significant laboratory or instrument contamination may result when untreated effluents, in-process waters, landfill leachates, and other samples containing high concentrations of inorganic substances are processed and analyzed. As stated in Section 1.0, this method is not intended for application to these samples, and samples containing high concentrations should not be permitted into the clean room and laboratory dedicated for processing trace metals samples.

4.3.8.3 Contamination by indirect contact—Apparatus that may not directly come in contact with the samples may still be a source of contamination. For example, clean tubing placed in a dirty plastic bag may pick up contamination from the bag and then subsequently transfer the contamination to the sample. Therefore, it is imperative that every piece of the Apparatus that is directly or indirectly used in the collection, processing, and analysis of ambient water samples be cleaned as specified in Section 11.0.

4.3.8.4 Contamination by airborne particulate matter—Less obvious substances capable of contaminating samples include airborne particles. Samples may be contaminated by airborne dust, dirt, particles, or vapors from unfiltered air supplies; nearby corroded or rusted pipes, wires, or other fixtures; or metal-containing paint. Whenever possible, sample processing and analysis should occur as far as possible from sources of airborne contamination.

4.4 Interferences—Interference sources that may cause inaccuracies in the determination of trace elements by ICP-MS are given below and must be recognized and corrected for. Instrumental drift, as well as suppressions or enhancements of instrument response caused by the sample matrix, should be corrected for by the use of internal standards.

4.4.1 Isobaric elemental interferences—Are caused by isotopes of different elements that form singly or doubly charged ions of the same nominal m/z and that cannot be resolved by the mass spectrometer. All elements determined by this method have, at a minimum, one isotope free of isobaric elemental interferences. Of the isotopes recommended for use with this method (Table 5), only selenium-82 (krypton) has an isobaric elemental interference. If an alternative isotope that has a higher natural abundance is selected to achieve greater sensitivity, an isobaric interference may occur. All data obtained under such conditions must be corrected by measuring the signal from another isotope of the interfering element and subtracting the contribution the isotope of interest based on the relative abundance of the alternate isotope and isotope of interest. A record of this correction process should be included with the report of the data. It should be noted that such corrections will only be as accurate as the accuracy of the relative abundance used in the equation for data calculations. Relative abundances should be established before applying any corrections.

4.4.2 Abundance sensitivity—Is a property defining the degree to which the wings of a mass peak contribute to adjacent m/z's. The abundance sensitivity is affected by ion energy and quadruple operating pressure. Wing overlap interferences may result when a small m/z peak is being measured adjacent to a large one. The potential for these interferences should be recognized and the spectrometer resolution adjusted to minimize them.

4.4.3 Isobaric polyatomic ion interferences—Are caused by ions consisting of more than one atom which have the same nominal mass-to-charge ratio as the isotope of interest, and which cannot be resolved by the mass spectrometer in use. These ions are commonly formed in the plasma or interface system from support gases or sample components. Most of the common interferences have been identified (Reference 13), and these are listed in Table 3 together with elements affected. Such interferences must be recognized, and when they cannot be avoided by the selection of an alternative m/z, appropriate corrections must be made to the data. Equations for the correction of data should be established at the time of the analytical run sequence because the polyatomic ion interferences will be highly dependent on the sample matrix and chosen instrument conditions. In particular, the common ^{82}Kr interference that affects the determination of both arsenic and selenium can be greatly reduced with the use of high-purity krypton-free argon.

4.4.4 Physical interferences—Are associated with the physical processes which govern the transport of sample into the plasma, sample conversion processes in the plasma, and the transmission of ions through the plasma-mass spectrometer interface. These interferences may result in differences between instrument responses for the sample and the calibration standards. Physical interferences may occur in the transfer of solution to the nebulizer (e.g., viscosity effects), at the point of aerosol formation and transport to the plasma (e.g., surface tension), or during excitation and ionization processes within the plasma itself. High levels of dissolved solids in the sample may contribute deposits of material on the extraction cone, skimmer cone, or both, reducing the effective diameter of the orifices and therefore ion transmission. Dissolved solids levels not exceeding 0.2% (w/v) have been recommended (Reference 13) to reduce such effects. Internal standardization may be effectively used to compensate for many physical interference effects (Reference 16). Internal standards ideally should have analytical behavior similar to the elements being determined.

4.4.5 Memory interferences—Result when isotopes of elements in a previous sample contribute to the signals measured in a new sample. Memory effects can result from sample deposition on the sampler and skimmer cones, and from the buildup of sample material in the plasma torch and spray chamber. The site where these effects occur is dependent on the element and can be minimized by flushing the system with a rinse blank between samples (Section 7.6.3). The possibility of memory interferences should be recognized within an analytical run and suitable rinse times should be used to reduce them. The rinse times necessary for a particular element should be estimated before analysis. This may be achieved by aspirating a standard containing elements corresponding to ten times the upper end of the linear range for a normal sample analysis period, followed by analysis of the rinse blank at designated intervals. The length of time required to reduce analyte signals below the minimum level (ML) should be noted. Memory interferences may also be assessed within an analytical run by using a minimum of three replicate integrations for data acquisition. If the integrated signal values drop consecutively, the analyst should be alerted to the possibility of a memory effect, and should examine the analyte concentration in the previous sample to identify if this was high. If a memory interference is suspected, the sample should be reanalyzed after a long rinse period.

5.0 Safety

5.1 The toxicity or carcinogenicity of reagents used in this method have not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable.

5.1.1 Each laboratory is responsible for maintaining a current awareness file of OSHA regulations for the safe handling of the chemicals specified in this method (References 17-20). A reference file of material safety data sheets (MSDSs) should also be available to all personnel involved in the chemical analysis. It is also suggested that the laboratory perform personal hygiene monitoring of each analyst who uses this method and that the results of this monitoring be made available to the analyst. The references and bibliography at the end of Reference 20 are particularly comprehensive in dealing with the general subject of laboratory safety.

5.1.2 Concentrated nitric and hydrochloric acids present various hazards and are moderately toxic and extremely irritating to skin and mucus membranes. Use these reagents in a fume hood whenever possible and if eye or skin contact occurs, flush with large volumes of water. Always wear protective clothing and safety glasses or a shield for eye protection, and observe proper mixing when working with these reagents.

5.2 The acidification of samples containing reactive materials may result in the release of toxic gases, such as cyanides or sulfides. Acidification of samples should be done in a fume hood.

5.3 All personnel handling environmental samples known to contain or to have been in contact with human waste should be immunized against known disease-causative agents.

5.4 Analytical plasma sources emit radiofrequency radiation in addition to intense UV radiation. Suitable precautions should be taken to protect personnel from such hazards. The inductively coupled plasma should only be viewed with proper eye protection from UV emissions.

6.0 Apparatus, Equipment, and Supplies

DISCLAIMER: *The mention of trade names or commercial products in this method is for illustrative purposes only and does not constitute endorsement or recommendation for use by the Environmental Protection Agency. Equivalent performance may be achievable using apparatus and materials other than those suggested here. Demonstration of equivalent performance is the responsibility of the laboratory.*

6.1 Facility

6.1.1 Clean room—Class 100, 200 ft^2 minimum, with down-flow, positive-pressure ventilation, air-lock entrances, and pass-through doors.

6.1.1.1 Construction materials—Nonmetallic, preferably plastic sheeting attached without metal fasteners. If painted, paints that do not contain the metal(s) of interest should be used.

6.1.1.2 Adhesive mats—For use at entry points to control dust and dirt from shoes.

6.1.2 Fume hoods—Nonmetallic, two minimum, with one installed internal to the clean room.

6.1.3 Clean benches—Class 100, one installed in the clean room; the other adjacent to the analytical instrument(s) for preparation of samples and standards.

6.2 Inductively Coupled Plasma Mass Spectrometer:

6.2.1 Instrument capable of scanning the mass range 5-250 amu with a minimum resolution capability of 1 amu peak width at 5% peak height. Instrument may be fitted with a conventional or extended dynamic range detection system.

6.2.2 Radio-frequency generator compliant with FCC regulations.

6.2.3 Argon gas supply—High-purity grade (99.99%). When analyses are conducted frequently, liquid argon is more economical and requires less frequent replacement of tanks than compressed argon in conventional cylinders (Section 4.1.3).

6.2.4 A variable-speed peristaltic pump is required for solution delivery to the nebulizer.

6.2.5 A mass-flow controller on the nebulizer gas supply is required. A water-cooled spray chamber may be of benefit in reducing some types of interferences (e.g., from polyatomic oxide species).

6.2.6 If an electron multiplier detector is being used, precautions should be taken, where necessary, to prevent exposure to high ion flux. Otherwise changes in instrument response or damage to the multiplier may result. Samples having high concentrations of elements beyond the linear range of the instrument and with isotopes falling within scanning windows should be diluted before analysis.

6.3 Analytical Balance—With capability to measure to 0.1 mg, for use in weighing solids and for preparing standards.

6.4 Temperature Adjustable Hot Plate—Capable of maintaining a temperature of 95°C.

6.5 Centrifuge—With guard bowl, electric timer, and brake (optional).

6.6 Drying Oven—Gravity convection, with thermostatic control capable of maintaining 105°C (±5°C).

6.7 Alkaline Detergent—Liquinox®, Alconox®, or equivalent.

6.8 pH meter or pH paper.

6.9 Labware—For determination of trace levels of elements, contamination and loss are of prime consideration. Potential contamination sources include improperly cleaned laboratory apparatus and general contamination within the laboratory environment from dust, etc. A clean laboratory work area should be designated for trace element sample handling. Sample containers can introduce positive and negative errors in the determination of trace elements by (1) contributing contaminants through surface desorption or leaching, and (2) depleting element concentrations through adsorption processes. All labware must be metal-free. Suitable construction materials are fluoropolymer (FEP, PTFE), conventional or linear polyethylene, polycarbonate, and polypropylene. Fluoropolymer should be used when samples are to be analyzed for mercury. All labware should be cleaned according to the procedure in Section 11.4. Gloves, plastic wrap, storage bags, and filters may all be used new without additional cleaning unless results of the equipment blank pinpoint any of these materials as a source of contamination. In this case, either an alternate supplier must be obtained or the materials must be cleaned.

NOTE: *Chromic acid must not be used for cleaning glassware.*

6.9.1 Volumetric flasks, graduated cylinders, funnels and centrifuge tubes.

6.9.2 Assorted calibrated pipettes.

6.9.3 Beakers—Fluoropolymer (or other suitable material), 250 mL with fluoropolymer covers.

6.9.4 Storage bottles—Narrow-mouth, fluoropolymer with fluoropolymer screw closure, 125-250 mL capacities.

6.9.5 Wash bottle—One-piece stem fluoropolymer, with screw closure, 125 mL capacity.

6.9.6 Tongs—For removal of Apparatus from acid baths. Coated metal tongs may not be used.

6.9.7 Gloves—clean, nontalc polyethylene, latex, or vinyl; various lengths. Heavy gloves should be worn when working in acid baths since baths will contain hot, strong acids.

6.9.8 Buckets or basins—5-50 L capacity, for acid soaking of the Apparatus.

6.9.9 Brushes—Nonmetallic, for scrubbing Apparatus.

6.9.10 Storage bags—Clean, zip-type, nonvented, colorless polyethylene (various sizes) for storage of Apparatus.

6.9.11 Plastic wrap—Clean, colorless polyethylene for storage of Apparatus.

6.10 Sampling Equipment—The sampling team may contract with the laboratory or a cleaning facility that is responsible for cleaning, storing, and shipping all sampling devices, sample bottles, filtration equipment, and all other Apparatus used for the collection of ambient water samples. Before shipping the equipment to the field site, the laboratory or facility must generate an acceptable equipment blank (Section 9.6.3) to demonstrate that the sampling equipment is free from contamination.

6.10.1 Sampling devices—Before ambient water samples are collected, consideration should be given to the type of sample to be collected and the devices to be used (grab, surface, or subsurface samplers). The laboratory or cleaning facility must clean all devices used for sample collection. Various types of samplers are described in the Sampling Method. Cleaned sampling devices should be stored in polyethylene bags or wrap.

6.10.2 Sample bottles—Fluoropolymer, conventional or linear polyethylene, polycarbonate, or polypropylene; 500 mL with lids. Cleaned sample bottles should be filled with 0.1% HCl (v/v) until use.

NOTE: If mercury is a target analyte, fluoropolymer or glass bottles must be used.

6.10.3 Filtration apparatus

6.10.3.1 Filter—Gelman Supor 0.45 µm, 15 mm diameter capsule filter (Gelman 12175, or equivalent).

6.10.3.2 Peristaltic pump—115 V a.c., 12 V d.c., internal battery, variable-speed, single-head (Cole-Parmer, portable, "Masterflex L/S," Catalog No. H-07570-10 drive with Quick Load pump head, Catalog No. H-07021-24, or equivalent).

6.10.3.3 Tubing for use with peristaltic pump—styrene/ethylene/ butylene/silicone (SEBS) resin, approximately 3/8 in i.d. by approx 3 ft (Cole-Parmer size 18, Catalog No. G-06464-18, or approximately 1/4 in i.d., Cole-Parmer Size 17, Catalog. No. G-06464-17, or equivalent). Tubing is cleaned by soaking in 5-10% HCl solution for 8-24 hours, rinsing with reagent water in a clean bench in a clean room, and drying in the clean bench by purging with metal-free air or nitrogen. After drying, the tubing is double-bagged in clear polyethylene bags, serialized with a unique number, and stored until use.

7.0 Reagents and Standards

Reagents may contain elemental impurities that might affect the integrity of analytical data. Because of the high sensitivity of ICP-MS, high-purity reagents should be used. Each reagent lot should be tested for the metals of interest by diluting and analyzing an aliquot from the lot using the techniques and instrumentation to be used for analysis of samples. The lot will be acceptable if the concentration of the metal of interest is below the MDL listed in this method. All acids used for this method must be of ultra high-purity grade. Suitable acids are available from a number of manufacturers or may be prepared by sub-boiling distillation. Nitric acid is preferred for ICP-MS to minimize polyatomic ion interferences. Several polyatomic ion interferences result when hydrochloric acid is used (Table 3); however, hydrochloric acid is required to maintain stability in solutions containing antimony and silver. When hydrochloric acid is used, corrections for the chloride polyatomic ion interferences must be applied to all data.

7.1 Reagents for cleaning Apparatus, sample bottle storage, and sample preservation.

7.1.1 Nitric acid—Concentrated (sp gr 1.41), Seastar or equivalent.

7.1.2 Nitric acid (1+1)—Add 500 mL conc. nitric acid to 400 mL of regent water and dilute to 1 L.

7.1.3 Nitric acid (1+9)—Add 100 mL conc. nitric acid to 400 mL of reagent water and dilute to 1 L.

7.1.4 Hydrochloric acid—Concentrated (sp gr 1.19).

7.1.5 Hydrochloric acid (1+1)—Add 500 mL concentrated hydrochloric acid to 400 mL of reagent water and dilute to 1 L.

7.1.6 Hydrochloric acid (1+4)—Add 200 mL concentrated hydrochloric acid to 400 mL of reagent water and dilute to 1 L.

7.1.7 Hydrochloric acid (HCl)—1 N trace metal grade.

7.1.8 Hydrochloric acid (HCl)—10% wt, trace metal grade.

7.1.9 Hydrochloric acid (HCl)—1% wt, trace metal grade.

7.1.10 Hydrochloric acid (HCl)—0.5% (v/v), trace metal grade.

7.1.11 Hydrochloric acid (HCl)—0.1% (v/v) ultrapure grade.

7.1.12 Tartaric acid (CASRN 87-69-4).

7.2 Reagent Water—Water demonstrated to be free from the metal(s) of interest and potentially interfering substances at the MDL for that metal listed in Table 1. Prepared by distillation, deionization, reverse osmosis, anodic/cathodic stripping voltammetry, or other technique that removes the metal(s) and potential interferent(s).

7.3 Stock Standard Solutions—Stock standards may be purchased from a reputable commercial source or prepared from ultra high-purity grade chemicals or metals (99.99-99.999% pure). All salts should be dried for one hour at 105□C, unless otherwise specified. Stock solutions should be stored in FEP bottles. Replace stock standards when succeeding dilutions for preparation of the multielement stock standards can not be verified.

CAUTION: *Many metal salts are extremely toxic if inhaled or swallowed. Wash hands thoroughly after handling.*

The following procedures may be used for preparing standard stock solutions:

NOTE: *Some metals, particularly those which form surface oxides, require cleaning prior to being weighed. This may be achieved by pickling the surface of the metal in acid. An amount in excess of the desired weight should be pickled repeatedly, rinsed with water, dried, and weighed until the desired weight is achieved.*

7.3.1 Antimony solution, stock 1 mL = 1000 µg Sb—Dissolve 0.100 g antimony powder in 2 mL (1+1) nitric acid and 0.5 mL concentrated hydrochloric acid, heating to effect solution. Cool, add 20 mL reagent water and 0.15 g tartaric acid. Warm the solution to dissolve the white precipitate. Cool and dilute to 100 mL with reagent water.

7.3.2 Beryllium solution, stock 1 mL = 1000 µg Be—Dissolve 1.965 g $BeSO_4$□$4H_2O$ (DO NOT DRY) in 50 mL reagent water. Add 1 mL concentrated nitric acid. Dilute to 100 mL with reagent water.

7.3.3 Bismuth solution, stock 1 mL = 1000 µg Bi—Dissolve 0.1115 g Bi_2O_3 in 5 mL concentrated nitric acid. Heat to effect solution. Cool and dilute to 100 mL with reagent water.

7.3.4 Cadmium solution, stock 1 mL = 1000 µg Cd—Pickle cadmium metal in (1+9) nitric acid to an exact weight of 0.100 g. Dissolve in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent water.

7.3.5 Cobalt solution, stock 1 mL = 1000 µg Co—Pickle cobalt metal in (1+9) nitric acid to an exact weight of 0.100 g. Dissolve in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent water.

7.3.6 Copper solution, stock 1 mL = 1000 µg Cu—Pickle copper metal in (1+9) nitric acid to an exact weight of 0.100 g. Dissolve in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent water.

7.3.7 Indium solution, stock 1 mL = 1000 µg In—Pickle indium metal in (1+1) nitric acid to an exact weight of 0.100 g. Dissolve in 10 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent water.

7.3.8 Lead solution, stock 1 mL = 1000 µg Pb—Dissolve 0.1599 g $PbNO_3$ in 5 mL (1+1) nitric acid. Dilute to 100 mL with reagent water.

7.3.9 Magnesium solution, stock 1 mL = 1000 µg Mg—Dissolve 0.1658 g MgO in 10 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent water.

7.3.10 Nickel solution, stock 1 mL = 1000 µg Ni—Dissolve 0.100 g nickel powder in 5 mL concentrated nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent water.

7.3.11 Scandium solution, stock 1 mL = 1000 µg Sc—Dissolve 0.1534 g Sc_2O_3 in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent water.

7.3.12 Selenium solution, stock 1 mL = 1000 µg Se—Dissolve 0.1405 g SeO_2 in 20 mL reagent water. Dilute to 100 mL with reagent water.

7.3.13 Silver solution, stock 1 mL = 1000 µg Ag—Dissolve 0.100 g silver metal in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent water. Store in dark container.

7.3.14 Terbium solution, stock 1 mL = 1000 µg Tb—Dissolve 0.1176 g Tb_4O_7 in 5 mL concentrated nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent water.

7.3.15 Thallium solution, stock 1 mL = 1000 µg Tl—Dissolve 0.1303 g $TlNO_3$ in a solution mixture of 10 mL reagent water and 1 mL concentrated nitric acid. Dilute to 100 mL with reagent water.

7.3.16 Yttrium solution, stock 1 mL = 1000 µg Y—Dissolve 0.1270 g Y_2O_3 in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent water.

7.3.17 Zinc solution, stock 1 mL = 1000 µg Zn—Pickle zinc metal in (1+9) nitric acid to an exact weight of 0.100 g. Dissolve in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent water.

7.4 Multielement Stock Standard Solutions—Care must be taken in the preparation of multielement stock standards so that the elements are compatible and stable. Originating element stocks should be checked for the presence of impurities which might influence the accuracy of the standard. Freshly prepared standards should be transferred to acid-cleaned, not previously used, FEP fluorocarbon bottles for storage and monitored periodically for stability. The following combinations of elements are suggested:

Standard Solution A		Standard Solution B
Antimony	Nickel	Silver
Cadmium	Selenium	
Copper	Thallium	
Lead	Zinc	

Except for selenium, multielement stock standard solutions A and B (1 mL = 10 µg) may be prepared by diluting 1.0 mL of each single element stock standard in the combination list to 100 mL with reagent water containing 1% (v/v) nitric acid. For selenium in solution A, an aliquot of 5.0 mL of the stock standard should be diluted to the specified 100 mL (1 ml = 50 µg Se). Replace the multielement stock standards when succeeding dilutions for preparation of the calibration standards cannot be verified with the quality control sample.

7.4.1 Preparation of calibration standards—Fresh multielement calibration standards should be prepared every two weeks or as needed. Dilute each of the stock multielement standard solutions A and B to levels appropriate to the operating range of the instrument using reagent water containing 1% (v/v) nitric acid. Calibration standards should be prepared at a minimum of three concentrations, one of which must be at the minimum level (Table 1), and another which must be near the upper end of the linear dynamic range. It should be noted the selenium concentration is always a factor of 5 greater than the other analytes. If the direct addition procedure is being used (Method A, Section 10.3), add internal standards (Section 7.5) to the calibration standards and store in fluoropolymer bottles. Calibration standards should be verified initially using a quality control sample (Section 7.8).

7.5 Internal Standard Stock Solution—1 mL = 100 µg. Dilute 10 mL of scandium, yttrium, indium, terbium, and bismuth stock standards (Section 7.3) to 100 mL with reagent water, and store in a FEP bottle. Use this solution concentrate for addition to blanks, calibration standards and samples, or dilute by an appropriate amount using 1% (v/v) nitric acid, if the internal standards are being added by peristaltic pump (Method B, Section 10.3).

7.6 Blanks—The laboratory should prepare the following types of blanks. A calibration blank is used to establish the analytical calibration curve; the laboratory (method) blank is used to assess possible contamination from the sample preparation procedure and to assess spectral background; and the rinse blank is used to flush the instrument between samples to reduce memory interferences. In addition to these blanks, the laboratory may be required to analyze field blanks (Section 9.6.2) and equipment blanks (Section 9.6.3).

7.6.1 Calibration blank—Consists of 1% (v/v) nitric acid in reagent water. If the direct addition procedure (Method A, Section 10.3) is being used, add internal standards.

7.6.2 Laboratory blank—Must contain all the reagents in the same volumes as used in processing the samples. The laboratory blank must be carried through the same entire preparation scheme as the samples including digestion, when applicable (Section 9.6.1). If the direct addition procedure (Method A, Section 10.3) is being used, add internal standards to the solution after preparation is complete.

7.6.3 Rinse blank—Consists of 2% (v/v) nitric acid in reagent water.

7.7 Tuning Solution—This solution is used for instrument tuning and mass calibration prior to analysis. The solution is prepared by mixing beryllium, magnesium, cobalt, indium, and lead stock solutions (Section 7.3) in 1% (v/v) nitric acid to produce a concentration of 100 µg/L of each element. Internal standards are not added to this solution. (Depending on the sensitivity of the instrument, this solution may need to be diluted 10 fold.)

7.8 Quality Control Sample (QCS)—The QCS should be obtained from a source outside the laboratory. The concentration of the QCS solution analyzed will depend on the sensitivity of the instrument. To prepare the QCS, dilute an appropriate aliquot of analytes to a concentration □100 µg/L in 1% (v/v) nitric acid. Because of lower sensitivity, selenium may be diluted to a concentration of <500 µg/L. If the direct addition procedure (Method A, Section 10.3) is being used, add internal standards after dilution, mix, and store in a FEP bottle. The QCS should be analyzed as needed to meet data quality needs and a fresh solution should be prepared quarterly or more frequently as needed.

7.9 Ongoing Precision and Recovery (OPR) Sample—To an aliquot of reagent water, add aliquots from multielement stock standards A and B (Section 7.4) to prepare the OPR. The OPR must be carried through the same entire preparation scheme as the samples including sample digestion, when applicable (Section 9.7). If the direct addition procedure (Method A, Section 10.3) is being used, add internal standards to this solution after preparation has been completed.

8.0 Sample Collection, Filtration, Preservation, and Storage

8.1 Before an aqueous sample is collected, consideration should be given to the type of data required, (i.e., dissolved or total recoverable), so that appropriate preservation and pretreatment steps can be taken. The pH of all aqueous samples must be tested immediately before aliquotting for processing or direct analysis to ensure the sample has been properly preserved. If properly acid-preserved, the sample can be held up to six months before analysis.

8.2 Sample Collection—Samples are collected as described in the Sampling Method.

8.3 Sample Filtration—For dissolved metals, samples and field blanks are filtered through a 0.45-µm capsule filter at the field site. Filtering procedures are described in the Sampling Method. For the determination of total recoverable elements, samples are not filtered but should be preserved according to the procedures in Section 8.4.

8.4 Sample Preservation—Preservation of samples and field blanks for both dissolved and total recoverable elements may be performed in the field at time of collection or in the laboratory. However, to avoid the hazards of strong acids in the field and transport restrictions, to minimize the potential for sample contamination, and to expedite field operations, the sampling team may prefer to ship the samples to the laboratory within two weeks of collection. Samples and field blanks should be preserved at the laboratory immediately upon receipt. For all metals, preservation involves the addition of 10% HNO_3 (Section 7.1.3) to bring the sample to pH <2. For samples received at neutral pH, approx 5 mL of 10% HNO_3 per liter will be required.

8.4.1 Wearing clean gloves, remove the cap from the sample bottle, add the volume of reagent grade acid that will bring the pH to <2, and recap the bottle immediately. If the bottle is full, withdraw the necessary volume using a precleaned pipet and then add the acid. Record the volume withdrawn and the amount of acid used.

NOTE: *Do not dip pH paper or a pH meter into the sample; remove a small aliquot with a clean pipet and test the aliquot. When the nature of the sample is either unknown or known to be hazardous, acidification should be done in a fume hood. See Section 5.2.*

8.4.2 Store the preserved sample for a minimum of 48 hours at 0-4°C to allow the acid to completely dissolve the metal(s) adsorbed on the container walls. The sample pH should be verified as <2 immediately before withdrawing an aliquot for processing or direct analysis. If, for some reason such as high alkalinity, the sample pH is verified to be >2, more acid must be added and the sample held for sixteen hours until verified to be pH <2. See Section 8.1.

8.4.3 With each sample batch, preserve a method blank and an OPR sample in the same way as the sample(s).

8.4.4 Sample bottles should be stored in polyethylene bags at 0-4°C until analysis.

9.0 Quality Assurance/Quality Control

9.1 Each laboratory that uses this method is required to operate a formal quality assurance program (Reference 21). The minimum requirements of this program consist of an initial demonstration of laboratory capability, analysis of samples spiked with metals of interest to evaluate and document data quality, and analysis of standards and blanks as tests of continued performance. Laboratory performance is compared to established performance criteria to determine that results of the analysis meet the performance characteristics of the method.

9.1.1 The analyst shall make an initial demonstration of the ability to generate acceptable accuracy and precision with this method. This ability is established as described in Section 9.2.

9.1.2 In recognition of advances that are occurring in analytical technology, the analyst is permitted to exercise certain options to eliminate interferences or lower the costs of measurements. These options include alternate digestion, concentration, and cleanup procedures, and changes in instrumentation. Alternate determinative techniques, such as the substitution of a colorimetric technique or changes that degrade method performance, are not allowed. If an analytical technique other than the techniques specified in the method is used, that technique must have a specificity equal to or better than the specificity of the techniques in the method for the analytes of interest.

9.1.2.1 Each time the method is modified, the analyst is required to repeat the procedure in Section 9.2. If the detection limit of the method will be affected by the change, the laboratory is required to demonstrate that the MDL (40 *CFR* Part 136, Appendix B) is lower than the MDL for that analyte in this method, or one-third the regulatory compliance level, whichever is higher. If calibration will be affected by the change, the analyst must recalibrate the instrument according to Section 10.0.

9.1.2.2 The laboratory is required to maintain records of modifications made to this method. These records include the following, at a minimum:

9.1.2.2.1 The names, titles, addresses, and telephone numbers of the analyst(s) who performed the analyses and modification, and of the quality control officer who witnessed and will verify the analyses and modification.

9.1.2.2.2 A listing of metals measured, by name and CAS Registry number.

9.1.2.2.3 A narrative stating reason(s) for the modification(s).

9.1.2.2.4 Results from all quality control (QC) tests comparing the modified method to this method, including:

(a) Calibration.
(b) Calibration verification.
(c) Initial precision and recovery (Section 9.2).
(d) Analysis of blanks.
(e) Accuracy assessment.

9.1.2.2.5 Data that will allow an independent reviewer to validate each determination by tracing the instrument output (peak height, area, or other signal) to the final result. These data are to include, where possible:

(a) Sample numbers and other identifiers.
(b) Digestion/preparation or extraction dates.
(c) Analysis dates and times.
(d) Analysis sequence/run chronology.
(e) Sample weight or volume.
(f) Volume prior to extraction/concentration step.
(g) Volume after each extraction/concentration step.
(h) Final volume prior to analysis.
(i) Injection volume.
(j) Dilution data, differentiating between dilution of a sample or extract.
(k) Instrument and operating conditions (make, model, revision, modifications).
(l) Sample introduction system (ultrasonic nebulizer, flow injection system, etc).
(m) Operating conditions (background corrections, temperature program, flow rates, etc).
(n) Detector (type, operating conditions, etc).
(o) Mass spectra, printer tapes, and other recordings of raw data.
(p) Quantitation reports, data system outputs, and other data to link raw data to results reported.

9.1.3 Analyses of blanks are required to demonstrate freedom from contamination. The required types, procedures, and criteria for analysis of blanks are described in Section 9.6.

9.1.4 The laboratory shall spike at least 10% of the samples with the metal(s) of interest to monitor method performance. This test is described in Section 9.3 of this method. When results of these spikes indicate atypical method performance for samples, an alternative extraction or cleanup technique must be used to bring method performance within acceptable limits. If method performance for spikes cannot be brought within the limits given in this method, the result may not be reported for regulatory compliance purposes.

9.1.5 The laboratory shall, on an ongoing basis, demonstrate through calibration verification and through analysis of the ongoing precision and recovery aliquot that the analytical system is in control. These procedures are described in Sections 10.2 and 9.7 of this method.

9.1.6 The laboratory shall maintain records to define the quality of data that are generated. Development of accuracy statements is described in Section 9.3.4.

9.2 Initial Demonstration of Laboratory Capability

9.2.1 Method detection limit—To establish the ability to detect the trace metals of interest, the analyst shall determine the MDL for each analyte according to the procedure in 40 *CFR* 136, Appendix B using the apparatus, reagents, and standards that will be used in the practice of this method. The laboratory must produce an MDL that is less than or equal to the MDL listed in Table 1, or one-third the regulatory compliance limit, whichever is greater. MDLs should be determined when a new operator begins work or whenever, in the judgment of the analyst, a change in instrument hardware or operating conditions would dictate that they be redetermined.

9.2.2 Initial precision and recovery (IPR)—To establish the ability to generate acceptable precision and recovery, the analyst shall perform the following operations.

9.2.2.1 Analyze four aliquots of reagent water spiked with the metal(s) of interest at two to three times the ML (Table 1), according to the procedures in Section 12.0. All digestion, extraction, and concentration steps, and the containers, labware, and reagents that will be used with samples, must be used in this test.

9.2.2.2 Using results of the set of four analyses, compute the average percent recovery (X) for the metal(s) in each aliquot and the standard deviation of the recovery(ies) for each metal.

9.2.2.3 For each metal, compare s and X with the corresponding limits for initial precision and recovery in Table 2. If s and X for all metal(s) meet the acceptance criteria, system performance is acceptable and analysis of blanks and samples may begin. If, however, any individual s exceeds the precision limit or any individual X falls outside the range for accuracy, system performance is unacceptable for that metal. Correct the problem and repeat the test (Section 9.2.2.1).

9.2.3 Linear calibration ranges—Linear calibration ranges are primarily detector limited. The upper limit of the linear calibration range should be established for each analyte by determining the signal responses from a minimum of three different concentration standards, one of which is close to the upper limit of the linear range. Care should be taken to avoid potential damage to the detector during this process. The linear calibration range that may be used for the analysis of samples should be judged by the analyst from the resulting data.

The upper limit should be an observed signal no more than 10% below the level extrapolated from lower standards. Determined sample analyte concentrations that are greater than 90% of the determined upper limit must be diluted and reanalyzed. The upper limits should be verified whenever, in the judgment of the analyst, a change in analytical performance caused by either a change in instrument hardware or operating conditions would dictate they be redetermined.

9.2.4 Quality control sample (QCS)—When beginning the use of this method, quarterly or as required to meet data quality needs, verify the calibration standards and acceptable instrument performance with the preparation and analyses of a QCS (Section 7.8). To verify the calibration standards the determined mean concentration from three analyses of the QCS must be within ±10% of the stated QCS value. If the QCS is not within the required limits, an immediate second analysis of the QCS is recommended to confirm unacceptable performance. If the calibration standards, acceptable instrument performance, or both cannot be verified, the source of the problem must be identified and corrected before proceeding with further analyses.

9.3 Method Accuracy—To assess the performance of the method on a given sample matrix, the laboratory must perform matrix spike (MS) and matrix spike duplicate (MSD) sample analyses on 10% of the samples from each site being monitored, or at least one MS sample analysis and one MSD sample analysis must be performed for each sample batch (samples collected from the same site at the same time, to a maximum of 10 samples), whichever is more frequent. Blanks (e.g., field blanks) may not be used for MS/MSD analysis.

9.3.1 The concentration of the MS and MSD is determined as follows:

9.3.1.1 If, as in compliance monitoring, the concentration of a specific metal in the sample is being checked against a regulatory concentration limit, the spike must be at that limit or at one to five times the background concentration, whichever is greater.

9.3.1.2 If the concentration is not being checked against a regulatory limit, the concentration must be at one to five times the background concentration or at one to five times the ML in Table 1, whichever is greater.

9.3.2 Assessing spike recovery

9.3.2.1 Determine the background concentration (B) of each metal by analyzing one sample aliquot according to the procedure in Section 12.0.

9.3.2.2 If necessary, prepare a QC check sample concentrate that will produce the appropriate level (Section 9.3.1) in the sample when the concentrate is added.

9.3.2.3 Spike a second sample aliquot with the QC check sample concentrate and analyze it to determine the concentration after spiking (A) of each metal.

9.3.2.4 Calculate each percent recovery (P) as 100(A-B)/T, where T is the known true value of the spike.

9.3.3 Compare the percent recovery (P) for each metal with the corresponding QC acceptance criteria found in Table 2. If any individual P falls outside the designated range for recovery, that metal has failed the acceptance criteria.

9.3.3.1 For a metal that has failed the acceptance criteria, analyze the ongoing precision and recovery standard (Section 9.7). If the OPR is within its respective limit for the metal(s) that failed (Table 2), the analytical system is in control and the problem can be attributed to the sample matrix.

9.3.3.2 For samples that exhibit matrix problems, further isolate the metal(s) from the sample matrix using dilution, chelation, extraction, concentration, hydride generation, or other means, and repeat the accuracy test (Section 9.3.2).

9.3.3.3 If the recovery for the metal remains outside the acceptance criteria, the analytical result for that metal in the unspiked sample is suspect and may not be reported for regulatory compliance purposes.

9.3.4 Recovery for samples should be assessed and records maintained.

9.3.4.1 After the analysis of five samples of a given matrix type (river water, lake water, etc.) for which the metal(s) pass the tests in Section 9.3.3, compute the average percent recovery (R) and the standard deviation of the percent recovery (SR) for the metal(s). Express the accuracy assessment as a percent recovery interval from R-2SR to R+2SR for each matrix. For example, if R = 90% and SR = 10% for five analyses of river water, the accuracy interval is expressed as 70-110%.

9.3.4.2 Update the accuracy assessment for each metal in each matrix regularly (e.g., after each 5-10 new measurements).

9.4 Precision of Matrix Spike and Duplicate

9.4.1 Calculate the relative percent difference (RPD) between the MS and MSD per the equation below using the concentrations found in the MS and MSD. Do not use the recoveries calculated in Section 9.3.2.4 for this calculation because the RPD is inflated when the background concentration is near the spike concentration.

$$RPD = 100 \frac{(|D1 - D2|)}{(D1 + D2)/2}$$

where,

D1 = Concentration of the analyte in the MS sample.
D2 = Concentration of the analyte in the MSD sample.

9.4.2 The relative percent difference between the matrix spike and the matrix spike duplicate must be less than 20%. If this criterion is not met, the analytical system is judged to be out of control. In this case, correct the problem and reanalyze all samples in the sample batch associated with the MS/MSD which failed the RPD test.

9.5 Internal Standards Responses—The analyst is expected to monitor the responses from the internal standards throughout the sample batch being analyzed. Ratios of the internal standards responses against each other should also be monitored routinely. This information may be used to detect potential problems caused by mass dependent drift, errors incurred in adding the internal standards, or increases in the concentrations of individual internal standards caused by background contributions from the sample. The absolute response of any one internal standard must not deviate more than 60-125% of the original response in the calibration blank. If deviations greater than these are observed, flush the instrument with the rinse blank and monitor the responses in the calibration blank. If the responses of the internal standards are now within the limit, take a fresh aliquot of the sample, dilute by a further factor of two, add the internal standards, and reanalyze. If, after flushing, the responses of the internal standards in the calibration blank are out of limits, terminate the analysis and determine the cause of the drift. Possible causes of drift may be a partially blocked sampling cone or a change in the tuning condition of the instrument.

9.6 Blanks—Blanks are analyzed to demonstrate freedom from contamination.

9.6.1 Laboratory (method) blank

9.6.1.1 Prepare a method blank with each sample batch (samples of the same matrix started through the sample preparation process (Section 12.0) on the same 12-hour shift, to a maximum of 10 samples). Analyze the blank immediately after analysis of the OPR (Section 9.7) to demonstrate freedom from contamination.

9.6.1.2 If the metal of interest or any potentially interfering substance is found in the blank at a concentration equal to or greater than the MDL (Table 1), sample analysis must be halted, the source of the contamination determined, the samples and a new method blank prepared, and the sample batch and fresh method blank reanalyzed.

9.6.1.3 Alternatively, if a sufficient number of blanks (three minimum) are analyzed to characterize the nature of a blank, the average concentration plus two standard deviations must be less than the regulatory compliance level.

9.6.1.4 If the result for a single blank remains above the MDL or if the result for the average concentration plus two standard deviations of three or more blanks exceeds the regulatory compliance level, results for samples associated with those blanks may not be reported for regulatory compliance purposes. Stated another way, results for all initial precision and recovery tests (Section 9.2) and all samples must be associated with an uncontaminated method blank before these results may be reported for regulatory compliance purposes.

9.6.2 Field blank

9.6.2.1 Analyze the field blank(s) shipped with each set of samples (samples collected from the same site at the same time, to a maximum of 10 samples). Analyze the blank immediately before analyzing the samples in the batch.

9.6.2.2 If the metal of interest or any potentially interfering substance is found in the field blank at a concentration equal to or greater than the ML (Table 1), or greater than one-fifth the level in the associated sample, whichever is greater, then results for associated samples may be the result of contamination and may not be reported for regulatory compliance purposes.

9.6.2.3 Alternatively, if a sufficient number of field blanks (three minimum) are analyzed to characterize the nature of the field blank, the average concentration plus two standard deviations must be less than the regulatory compliance level or less than one-half the level in the associated sample, whichever is greater.

9.6.2.4 If contamination of the field blanks and associated samples is known or suspected, the laboratory should communicate this to the sampling team so that the source of contamination can be identified and corrective measures taken prior to the next sampling event.

9.6.3 Equipment blanks—Before any sampling equipment is used at a given site, the laboratory or cleaning facility is required to generate equipment blanks to demonstrate that the sampling equipment is free from contamination. Two types of equipment blanks are required: bottle blanks and sampler check blanks.

9.6.3.1 Bottle blanks—After undergoing appropriate cleaning procedures (Section 11.4), bottles should be subjected to conditions of use to verify the effectiveness of the cleaning procedures. A representative set of sample bottles should be filled with reagent water acidified to pH<2 and allowed to stand for a minimum of 24 hours. Ideally, the time that the bottles are allowed to stand should be as close as possible to the actual time that sample will be in contact with the bottle. After standing, the water should be analyzed for any signs of contamination. If any bottle shows signs of contamination, the problem must be identified, the cleaning procedures corrected or cleaning solutions changed, and all affected bottles recleaned.

9.6.3.2 Sampler check blanks—Sampler check blanks are generated in the laboratory or at the equipment cleaning contractor's facility by processing reagent water through the sampling devices using the same procedures that are used in the field (see Sampling Method). Therefore, the "clean hands/dirty hands" technique used during field sampling should be followed when preparing sampler check blanks at the laboratory or cleaning facility.

9.6.3.2.1 Sampler check blanks are generated by filling a large carboy or other container with reagent water (Section 7.2) and processing the reagent water through the equipment using the same procedures that are used in the field (see Sampling Method). For example, manual grab sampler check blanks are collected by directly submerging a sample bottle into the water, filling the bottle, and capping. Subsurface sampler check blanks are collected by immersing the sampler into the water and pumping water into a sample container.

9.6.3.2.2 The sampler check blank must be analyzed using the procedures given in this method. If any metal of interest or any potentially interfering substance is detected in the blank, the source of contamination or interference must be identified, and the problem corrected. The equipment must be demonstrated to be free from the metal(s) of interest before the equipment may be used in the field.

9.6.3.2.3 Sampler check blanks must be run on all equipment that will be used in the field. If, for example, samples are to be collected using both a grab sampling device and a subsurface sampling device, a sampler check blank must be run on both pieces of equipment.

9.7 Ongoing Precision and Recovery

9.7.1 Prepare an ongoing precision and recovery sample (laboratory-fortified method blank) identical to the initial precision and recovery aliquots (Section 9.2) with each sample batch (samples of the same matrix started through the sample preparation process (Section 12.0) on the same 12-hour shift, to a maximum of 10 samples) by spiking an aliquot of reagent water with the metal(s) of interest.

9.7.2 Analyze the OPR sample before analyzing the method blank and samples from the same batch.

9.7.3 Compute the percent recovery of each metal in the OPR sample.

9.7.4 For each metal, compare the concentration to the limits for ongoing recovery in Table 2. If all metals meet the acceptance criteria, system performance is acceptable and analysis of blanks and samples may proceed. If, however, any individual recovery falls outside of the range given, the analytical processes are not being performed properly for that metal. In this event, correct the problem, reprepare the sample batch, and repeat the ongoing precision and recovery test (Section 9.7).

9.7.5 Add results that pass the specifications in Section 9.7.4 to initial and previous ongoing data for each metal in each matrix. Update QC charts to form a graphic representation of continued laboratory performance. Develop a statement of laboratory accuracy for each metal in each matrix type by calculating the average percent recovery (R) and the standard deviation of percent recovery (SR). Express the accuracy as a recovery interval from R-2SR to R+2SR. For example, if R = 95% and SR = 5%, the accuracy is 85-105%.

9.8 The specifications contained in this method can be met if the instrument used is calibrated properly and then maintained in a calibrated state. A given instrument will provide the most reproducible results if dedicated to the settings and conditions required for the analyses of metals by this method.

9.9 Depending on specific program requirements, the laboratory may be required to analyze field duplicates collected to determine the precision of the sampling technique. The relative percent difference (RPD) between field duplicates should be less than 20%. If the RPD of the field duplicates exceeds 20%, the laboratory should communicate this to the sampling team so that the source of error can be identified and corrective measures taken before the next sampling event.

10.0 Calibration and Standardization

10.1 Operating Conditions—Because of the diversity of instrument hardware, no detailed instrument operating conditions are provided. The analyst is advised to follow the recommended operating conditions provided by the manufacturer. The analyst is responsible for verifying that the instrument configuration and operating conditions satisfy the quality control requirements in this method. Table 7 lists instrument operating conditions that may be used as a guide for analysts in determining instrument configuration and operating conditions.

10.2 Precalibration Routine—The following precalibration routine should be completed before calibrating the instrument until it can be documented with periodic performance data that the instrument meets the criteria listed below without daily tuning.

10.2.1 Initiate proper operating configuration of instrument and data system. Allow a period of not less than 30 minutes for the instrument to warm up. During this period, conduct mass calibration and resolution checks using the tuning solution. Resolution at low mass is indicated by magnesium isotopes 24, 25, 26. Resolution at high mass is indicated by lead isotopes 206, 207, 208. For good performance adjust spectrometer resolution to produce a peak width of approximately 0.75 amu at 5% peak height. Adjust mass calibration if it has shifted by more than 0.1 amu from unit mass.

10.2.2 Instrument stability must be demonstrated by running the tuning solution (Section 7.7) a minimum of five times with resulting relative standard deviations of absolute signals for all analytes of less than 10%.

10.3 Internal Standardization—Internal standardization must be used in all analyses to correct for instrument drift and physical interferences.

10.3.1 A list of acceptable internal standards is provided in Table 4. For full mass range scans, a minimum of three internal standards must be used. Procedures described in this method for general application detail the use of five internal standards: scandium, yttrium, indium, terbium, and bismuth.

10.3.2 Internal standards must be present in all samples, standards, and blanks at identical levels. This may be achieved by directly adding an aliquot of the internal standards to the CAL standard, blank, or sample solution (Method A), or alternatively by mixing with the solution before nebulization using a second channel of the peristaltic pump and a mixing coil (Method B).

10.3.3 The concentration of the internal standard should be sufficiently high to obtain good precision in the measurement of the isotope used for data correction and to minimize the possibility of correction errors if the internal standard is naturally present in the sample. Depending on the sensitivity of the instrument, a concentration range of 1-200 µg/L of each internal standard is recommended. Internal standards should be added to blanks, samples, and standards in a like manner, so that dilution effects resulting from the addition may be disregarded.

10.4 Calibration—Before initial calibration, set up proper instrument software routines for quantitative analysis. The instrument must be calibrated at a minimum of three points for each analyte to be determined.

10.4.1 Inject the calibration blank (Section 7.6.1) and calibration standards A and B (Section 7.4.1) prepared at three or more concentrations, one of which must be at the Minimum Level (Table 1), and another that must be near the upper end of the linear dynamic range. A minimum of three replicate integrations is required for data acquisition. Use the average of the integrations for instrument calibration and data reporting.

10.4.2 Compute the response factor at each concentration, as follows:

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

where,

C_s = Concentration of the analyte in the standard or blank solution.
C_{is} = Concentration of the internal standard in the solution.
A_s = Height or area of the response at the m/z for the analyte.
A_{is} = Height or area of the m/z for the internal standard.

10.4.3 Using the individual response factors at each concentration, compute the mean RF for each analyte.

10.4.4 Linearity—If the RF over the calibration range is constant (<20% RSD), the RF can be assumed to be invariant and the mean RF can be used for calculations. Alternatively, the results can be used to plot a calibration curve of response ratios, A_s/A_{is}, vs. RF.

10.5 Calibration Verification—Immediately following calibration, an initial calibration verification should be performed. Adjustment of the instrument is performed until verification criteria are met. Only after these criteria are met may blanks and samples be analyzed.

10.5.1 Analyze the mid-point calibration standard (Section 10.4).

10.5.2 Compute the percent recovery of each metal using the mean RF or calibration curve obtained in the initial calibration.

10.5.3 For each metal, compare the recovery with the corresponding limit for calibration verification in Table 2. If all metals meet the acceptance criteria, system performance is acceptable and analysis of blanks and samples may continue using the response from the initial calibration. If any individual value falls outside the range given, system performance is unacceptable for that compound. In this event, locate and correct the problem and/or prepare a new calibration check standard and repeat the test (Sections 10.5.1 through 10.5.3), or recalibrate the system according to Section 10.4.

10.5.5 Calibration must be verified following every ten samples by analyzing the mid-point calibration standard. If the recovery does not meet the acceptance criteria specified in Table 2, analysis must be halted, the problem corrected, and the instrument recalibrated. All samples after the last acceptable calibration verification must be reanalyzed.

10.6 A calibration blank must be analyzed following every calibration verification to demonstrate that there is no carryover of the analytes of interest and that the analytical system is free from contamination. If the concentration of an analyte in the blank result exceeds the MDL, correct the problem, verify the calibration (Section 10.5), and repeat the analysis of the calibration blank.

11.0 Procedures for Cleaning the Apparatus

11.1 All sampling equipment, sample containers, and labware should be cleaned in a designated cleaning area that has been demonstrated to be free of trace element contaminants. Such areas may include class 100 clean rooms as described by Moody (Reference 22), labware cleaning areas as described by Patterson and Settle (Reference 6), or clean benches.

11.2 Materials, such as gloves (Section 6.9.7), storage bags (Section 6.9.10), and plastic wrap (Section 6.9.11), may be used new without additional cleaning unless the results of the equipment blank pinpoint any of these materials as a source of contamination. In this case, either an alternate supplier must be obtained or the materials must be cleaned.

11.3 Cleaning Procedures—Proper cleaning of the Apparatus is extremely important, because the Apparatus may not only contaminate the samples but may also remove the analytes of interest by adsorption onto the container surface.

***NOTE:** If laboratory, field, and equipment blanks (Section 9.6) from the Apparatus cleaned with fewer cleaning steps than those detailed below show no levels of analytes above the MDL, those cleaning steps that do not eliminate these artifacts may be omitted provided all performance criteria outlined in Section 9.0 are met.*

11.3.1 Bottles, labware, and sampling equipment

11.3.1.1 Fill a precleaned basin (Section 6.9.8) with a sufficient quantity of a 0.5% solution of liquid detergent (Section 6.7), and completely immerse each piece of ware. Allow to soak in the detergent for at least 30 minutes.

11.3.1.2 Using a pair of clean gloves (Section 6.9.7) and clean nonmetallic brushes (Section 6.9.9), thoroughly scrub down all materials with the detergent.

11.3.1.3 Place the scrubbed materials in a precleaned basin. Change gloves.

11.3.1.4 Thoroughly rinse the inside and outside of each piece with reagent water until there is no sign of detergent residue (e.g., until all soap bubbles disappear).

11.3.1.5 Change gloves, immerse the rinsed equipment in a hot (50-60□C) bath of concentrated reagent grade HNO_3 (Section 7.1.1) and allow to soak for at least two hours.

11.3.1.6 After soaking, use clean gloves and tongs to remove the Apparatus and thoroughly rinse with distilled, deionized water (Section 7.2).

11.3.1.7 Change gloves and immerse the Apparatus in a hot (50-60□C) bath of 1 N trace metal grade HCl (Section 7.1.7), and allow to soak for at least 48 hours.

11.3.1.8 Thoroughly rinse all equipment and bottles with reagent water. Proceed with Section 11.3.2 for labware and sampling equipment. Proceed with Section 11.3.3 for sample bottles.

11.3.2 Labware and sampling equipment

11.3.2.1 After cleaning, air-dry in a class 100 clean air bench.

11.3.2.2 After drying, wrap each piece of ware and equipment in two layers of polyethylene film.

11.3.3 Fluoropolymer sample bottles—These bottles should be used if mercury is a target analyte.

11.3.3.1 After cleaning, fill sample bottles with 0.1% (v/v) ultrapure HCl (Section 7.1.11) and cap tightly. It may be necessary to use a strap wrench to assure a tight seal.

11.3.3.2 After capping, double-bag each bottle in polyethylene zip-type bags. Store at room temperature until sample collection.

11.3.4 Bottles, labware, and sampling equipment—Polyethylene or material other than fluoropolymer.

11.3.4.1 Apply the steps outlined above in Sections 11.3.1.1 through 11.3.1.8 to all bottles, labware, and sampling equipment. Proceed with Section 11.3.4.2 for bottles or Section 11.3.4.3 for labware and sampling equipment.

11.3.4.2 After cleaning, fill each bottle with 0.1% (v/v) ultrapure HCl (Section 7.1.11). Double-bag each bottle in a polyethylene bag to prevent contamination of the surfaces with dust and dirt. Store at room temperature until sample collection.

11.3.4.3 After rinsing labware and sampling equipment, air-dry in a class 100 clean air bench. After drying, wrap each piece of ware and equipment in two layers of polyethylene film.

***NOTE:** Polyethylene bottles cannot be used to collect samples that will be analyzed for mercury at trace (e.g., 0.012 µg/L) levels because of the potential of vapors diffusing through the polyethylene.*

11.3.4.4 Polyethylene bags—If polyethylene bags need to be cleaned, clean according to the following procedure:

11.3.4.4.1 Partially fill with cold, (1+1) HNO_3 (Section 7.1.2) and rinse with distilled deionized water (Section 7.2).

11.3.4.4.2 Dry by hanging upside down from a plastic line with a plastic clip.

11.3.5 Silicone tubing, fluoropolymer tubing, and other sampling apparatus—Clean any silicone, fluoropolymer, or other tubing used to collect samples by rinsing with 10% HCl (Section 7.1.8) and flushing with water from the site before sample collection.

11.3.6 Extension pole—Because of its length, it is impractical to submerse the 2 m polyethylene extension pole (used in with the optional grab sampling device) in acid solutions as described above. If such an extension pole is used, a nonmetallic brush (Section 6.9.9) should be used to scrub the pole with reagent water and the pole wiped down with acids described in Section 11.3.4 above. After cleaning, the pole should be wrapped in polyethylene film.

11.4 Storage—Store each piece or assembly of the Apparatus in a clean, single polyethylene zip-type bag. If shipment is required, place the bagged apparatus in a second polyethylene zip-type bag.

11.5 All cleaning solutions and acid baths should be periodically monitored for accumulation of metals that could lead to contamination. When levels of metals in the solutions become too high, the solutions and baths should be changed and the old solutions neutralized and discarded in compliance with state and federal regulations.

12.0 Procedures for Sample Preparation and Analysis

12.1 Aqueous Sample Preparation—Dissolved analytes.

12.1.1 For determination of dissolved analytes in ground and surface waters, pipet an aliquot (□20 mL) of the filtered, acid-preserved sample into a clean 50 mL polypropylene centrifuge tube. Add an appropriate volume of (1+1) nitric acid to adjust the acid concentration of the aliquot to approximate a 1% (v/v) nitric acid solution (e.g., add 0.4 mL (1+1) HNO_3 to a 20 mL aliquot of sample). Add the internal standards, cap the tube, and mix. The sample is now ready for analysis. Allowance for sample dilution should be made in the calculations.

12.2 Aqueous Sample Preparation—Total recoverable analytes.

***NOTE:** To preclude contamination during sample digestion, it may be necessary to perform the open beaker, total-recoverable digestion procedure described in Sections 12.2.1 through 12.2.7 in a fume hood that is located in a clean room. An alternate digestion procedure is provided in Section 12.2.8; however, this procedure has not undergone interlaboratory testing.*

12.2.1 For the determination of total recoverable analytes in ambient water samples, transfer a 100 mL (±1 mL) aliquot from a well-mixed, acid-preserved sample to a 250 mL Griffin beaker (Section 6.9.3). If appropriate, a smaller sample volume may be used.

12.2.2 Add 2 mL (1+1) nitric acid and 1.0 mL of (1+1) hydrochloric acid to the beaker and place the beaker on the hot plate for digestion. The hot plate should be located in a fume hood and previously adjusted to provide evaporation at a temperature of approximately but no higher than 85□C. (See the following note.) The beaker should be covered or other necessary steps should be taken to prevent sample contamination from the fume hood environment.

***NOTE:** For proper heating, adjust the temperature control of the hot plate such that an uncovered Griffin beaker containing 50 mL of water placed in the center of the hot plate can be maintained at a temperature approximately but no higher than 85□C. (Once the beaker is covered with a watch glass, the temperature of the water will rise to approximately 95□C.)*

12.2.3 Reduce the volume of the sample aliquot to about 20 mL by gentle heating at 85□C. Do not boil. This step takes about two hours for a 100 mL aliquot with the rate of evaporation rapidly increasing as the sample volume approaches 20 mL. (A spare beaker containing 20 mL of water can be used as a gauge.)

12.2.4 Cover the lip of the beaker with a watch glass to reduce additional evaporation and gently reflux the sample for 30 minutes. (Slight boiling may occur, but vigorous boiling must be avoided to prevent loss of the HCl-H_2O azeotrope.)

12.2.5 Allow the beaker to cool. Quantitatively transfer the sample solution to a 50 mL volumetric flask or 50 mL class A stoppered graduated cylinder, make to volume with reagent water, stopper, and mix.

12.2.6 Allow any undissolved material to settle overnight, or centrifuge a portion of the prepared sample until clear. (If, after centrifuging or standing overnight, the sample contains suspended solids that would clog the nebulizer, a portion of the sample may be filtered to remove the solids before analysis. However, care should be exercised to avoid potential contamination from filtration.)

12.2.7 Prior to analysis, adjust the chloride concentration by pipetting 20 mL of the prepared solution into a 50 mL volumetric flask, dilute to volume with reagent water and mix. (If the dissolved solids in this solution are >0.2%, additional dilution may be required to prevent clogging of the extraction and/or skimmer cones.) Add the internal standards and mix. The sample is now ready for analysis. Because the effects of various matrices on the stability of diluted samples cannot be characterized, all analyses should be performed as soon as possible after the completed preparation.

12.2.8 Alternate total recoverable digestion procedure.

12.2.8.1 Open the preserved sample under clean conditions. Add ultrapure nitric and hydrochloric acid at the rate of 10 mL/L and 5 mL/L, respectively. Remove the cap from the original container only long enough to add each aliquot of acid. The sample container should not be filled to the lip by the addition of the acids. However, only minimal headspace is needed to avoid leakage during heating.

12.2.8.2 Tightly recap the container and shake thoroughly. Place the container in an oven preheated to 85□C. The container should be placed on an insulating piece of material such as wood rather than directly on the typical metal grating. After the samples have reached 85□C, heat for two hours. (Total time will be two and one-half to three hours depending on the sample size). Temperature can be monitored using an identical sample container with distilled water and a thermocouple to standardize heating time.

12.2.8.3 Allow the sample to cool. Add the internal standards and mix. The sample is now ready for analysis. Remove aliquots for analysis under clean conditions.

12.3 Sample Analysis

12.3.1 For every new or unusual matrix, it is highly recommended that a semiquantitative analysis be carried out to screen the sample for elements that may be present at high concentration. Information gained from this screening may be used to prevent potential damage to the detector during sample analysis and to identify elements that may exceed the linear range. Matrix screening may be carried out using intelligent software, if available, or by diluting the sample by a factor of 500 and analyzing in a semiquantitative mode. The sample should also be screened for background levels of all elements chosen for use as internal standards to prevent bias in the calculation of the analytical data.

12.3.2 Initiate instrument operating configuration. Tune and calibrate the instrument for the analytes of interest (Section 10.0).

12.3.3 Establish instrument software run procedures for quantitative analysis. For all sample analyses, a minimum of three replicate integrations is required for data acquisition. Use the average of the integrations for data reporting.

12.3.4 All m/z's that may affect data quality must be monitored during the analytical run. As a minimum, those m/z's prescribed in Table 5 must be monitored in the same scan as is used for the collection of the data. This information should be used to correct the data for identified interferences.

12.3.5 The rinse blank should be used to flush the system between samples. Allow sufficient time to remove traces of the previous sample or a minimum of one minute. Samples should be aspirated for 30 seconds before data is collected.

12.3.6 Samples having concentrations higher than the established linear dynamic range should be diluted into range and reanalyzed. The sample should first be analyzed for the trace elements in the sample, protecting the detector from the high concentration elements if necessary, by the selection of appropriate scanning windows. The sample should then be diluted for the determination of the remaining elements. Alternatively, the dynamic range may be adjusted by selecting an alternative isotope of lower natural abundance, if quality control data for that isotope have been established. The dynamic range must not be adjusted by altering instrument conditions to an uncharacterized state.

13.0 Data Analysis and Calculations

13.1 Table 6 lists elemental equations recommended for sample data calculations. Sample data should be reported in units of µg/L (parts-per-billion; ppb). Report results at or above the ML for metals found in samples and determined in standards. Report all results for metals found in blanks, regardless of level.

13.2 For data values less than the ML, two significant figures should be used for reporting element concentrations. For data values greater than or equal to the ML, three significant figures should be used.

13.3 For aqueous samples prepared by total recoverable procedure (Sections 12.2.1 through 12.2.7), multiply solution concentrations by the dilution factor 1.25. If additional dilutions were made to any samples, the appropriate factor should be applied to the calculated sample concentrations.

13.4 Compute the concentration of each analyte in the sample using the response factor determined from calibration data (Section 10.4) and the following equation:

$$C_s\ (\mu g/L) = \frac{A_s \times C_{is}}{A_{is} \times RF}$$

where,

The terms are as defined in Section 10.4.2.

13.5 Corrections for characterized spectral interferences should be applied to the data. Chloride interference corrections should be made on all samples, regardless of the addition of hydrochloric acid, because the chloride ion is a common constituent of environmental samples.

13.6 If an element has more than one monitored m/z, examination of the concentration calculated for each m/z, or the relative abundances, will provide useful information for the analyst in detecting a possible spectral interference. Consideration should therefore be given to both primary and secondary m/z's in the evaluation of the element concentration. In some cases, the secondary m/z may be less sensitive or more prone to interferences than the primary recommended m/z; therefore, differences between the results do not necessarily indicate a problem with data calculated for the primary m/z.

13.7 The QC data obtained during the analyses provide an indication of the quality of the sample data and should be provided with the sample results.

13.8 Do not perform blank subtraction on the sample results. Report results for samples and accompanying blanks.

14.0 Method Performance

14.1 The method detection limits (MDLs) listed in Table 1 and the quality control acceptance criteria listed in Table 2 were validated in two laboratories (Reference 23) for dissolved analytes.

15.0 Pollution Prevention

15.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option. The acids used in this method should be reused as practicable by purifying by electrochemical techniques. The only other chemicals used in this method are the neat materials used in preparing standards. These standards are used in extremely small amounts and pose little threat to the environment when managed properly. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

15.2 For information about pollution prevention that may be applicable to laboratories and research institutions, consult *Less is Better: Laboratory Chemical Management for Waste Reduction*, available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street NW, Washington DC 20036, 202/872-4477.

16.0 Waste Management

16.1 The Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. The Agency urges laboratories to protect the air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management consult *The Waste Management Manual for Laboratory Personnel*, available from the American Chemical Society at the address listed in Section 15.2.

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18.0 Glossary

Many of the terms and definitions listed below are used in the EPA 1600-series methods, but terms have been cross-referenced to terms commonly used in other methods where possible.

18.1 Ambient Water—Waters in the natural environment (e.g., rivers, lakes, streams, and other receiving waters), as opposed to effluent discharges.

18.2 Analyte—A metal tested for by the methods referenced in this method. The analytes are listed in Table 1.

18.3 Apparatus—The sample container and other containers, filters, filter holders, labware, tubing, pipets, and other materials and devices used for sample collection or sample preparation, and that will contact samples, blanks, or analytical standards.

18.4 Calibration Blank—A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to calibrate the ICP instrument (Section 7.6.1).

18.5 Calibration Standard (CAL)—A solution prepared from a dilute mixed standard and/or stock solutions and used to calibrate the response of the instrument with respect to analyte concentration.

18.6 Dissolved Analyte—The concentration of analyte in an aqueous sample that will pass through a 0.45 µm membrane filter assembly prior to sample acidification (Section 8.3).

18.7 Equipment Blank—An aliquot of reagent water that is subjected in the laboratory to all aspects of sample collection and analysis, including contact with all sampling devices and apparatus. The purpose of the equipment blank is to determine if the sampling devices and apparatus for sample collection have been adequately cleaned before they are shipped to the field site. An acceptable equipment blank must be achieved before the sampling devices and apparatus are used for sample collection. In addition, equipment blanks should be run on random, representative sets of gloves, storage bags, and plastic wrap for each lot to determine if these materials are free from contamination before use.

18.8 Field Blank—An aliquot of reagent water that is placed in a sample container in the laboratory, shipped to the field, and treated as a sample in all respects, including contact with the sampling devices and exposure to sampling site conditions, storage, preservation, and all analytical procedures, which may include filtration. The purpose of the field blank is to determine if the field or sample transporting procedures and environments have contaminated the sample.

18.9 Field Duplicates (FD1 and FD2)—Two separate samples collected in separate sample bottles at the same time and place under identical circumstances and treated exactly the same throughout field and laboratory procedures. Analyses of FD1 and FD2 give a measure of the precision associated with sample collection, preservation, and storage, as well as with laboratory procedures.

18.10 Initial Precision and Recovery (IPR)—Four aliquots of the OPR standard analyzed to establish the ability to generate acceptable precision and accuracy. IPRs are performed before a method is used for the first time and any time the method or instrumentation is modified.

18.11 Instrument Detection Limit (IDL)—The concentration equivalent to the analyte signal which is equal to three times the standard deviation of a series of ten replicate measurements of the calibration blank signal at the selected analytical mass(es).

18.12 Internal Standard—Pure analyte(s) added to a sample, extract, or standard solution in known amount(s) and used to measure the relative responses of other method analytes that are components of the same sample or solution. The internal standard must be an analyte that is not a sample component (Sections 7.5 and 9.5).

18.13 Laboratory Blank—An aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with samples. The laboratory blank is used to determine if method analytes or interferences are present in the laboratory environment, the reagents, or the apparatus (Sections 7.6.2 and 9.6.1).

18.14 Laboratory Control Sample (LCS)—See Ongoing Precision and Recovery (OPR) Standard.

18.15 Laboratory Duplicates (LD1 and LD2)—Two aliquots of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of LD1 and LD2 indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

18.16 Laboratory Fortified Blank (LFB)—See Ongoing Precision and Recovery (OPR) Standard.

18.17 Laboratory Fortified Sample Matrix (LFM)—See Matrix Spike (MS) and Matrix Spike duplicate (MSD).

18.18 Laboratory Reagent Blank (LRB)—See Laboratory Blank.

18.19 Linear Dynamic Range (LDR)—The concentration range over which the instrument response to an analyte is linear (Section 9.2.3).

18.20 Matrix Spike (MS) and Matrix Spike Duplicate (MSD)—Aliquots of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS and MSD are analyzed exactly like a sample. Their purpose is to quantify the bias and precision caused by the sample matrix. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS and MSD corrected for background concentrations (Section 9.3).

18.21 m/z—Mass-to-charge ratio.

18.22 May—This action, activity, or procedural step is optional.

18.23 May Not—This action, activity, or procedural step is prohibited.

18.24 Method Blank—See Laboratory Blank.

18.25 Method Detection Limit (MDL)—The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero (Section 9.2.1 and Table 1).

18.26 Minimum Level (ML)—The lowest level at which the entire analytical system gives a recognizable signal and acceptable calibration point (Reference 9).

18.27 Must—This action, activity, or procedural step is required.

18.28 Ongoing Precision and Recovery (OPR) Standard—A laboratory blank spiked with known quantities of the method analytes. The OPR is analyzed exactly like a sample. Its purpose is to determine whether the methodology is in control and to assure that the results produced by the laboratory remain within the method-specified limits for precision and accuracy (Sections 7.9 and 9.7).

18.29 Preparation Blank—See Laboratory Blank.

18.30 Primary Dilution Standard—A solution containing the analytes that is purchased or prepared from stock solutions and diluted as needed to prepare calibration solutions and other solutions.

18.31 Quality Control Sample (QCS)—A sample containing all or a subset of the method analytes at known concentrations. The QCS is obtained from a source external to the laboratory or is prepared from a source of standards different from the source of calibration standards. It is used to check laboratory performance with test materials prepared external to the normal preparation process.

18.32 Reagent Water—Water demonstrated to be free from the method analytes and potentially interfering substances at the MDL for that metal in the method.

18.33 Should—This action, activity, or procedural step is suggested but not required.

18.34 Stock Standard Solution—A solution containing one or more method analytes that is prepared using a reference material traceable to EPA, the National Institute of Science and Technology (NIST), or a source that will attest to the purity and authenticity of the reference material.

18.35 Total Recoverable Analyte—The concentration of analyte determined by analysis of the solution extract of an unfiltered aqueous sample following digestion by refluxing with hot dilute mineral acid(s) as specified in the method (Section 12.2).

18.36 Tuning Solution—A solution which is used to determine acceptable instrument performance before calibration and sample analyses (Section 7.7).

TABLE 1. LIST OF ANALYTES AMENABLE TO ANALYSIS USING METHOD 1638: LOWEST WATER QUALITY CRITERION FOR EACH METAL SPECIES, METHOD DETECTION LIMITS, MINIMUM LEVELS, AND RECOMMENDED ANALYTICAL M/Z's

Metal	Lowest Ambient Water Quality Criterion (µg/L) [1]	Method Detection Limit (MDL) and Minimum Level (ML); µg/L		Recommended Analytical m/z
		MDL [2]	ML [3]	
Antimony	14	0.0097	0.02	123
Cadmium	0.37	0.025	0.1	111
Copper	2.4	0.087	0.2	63
Lead	0.54	0.015	0.05	206, 207, 208
Nickel	8.2	0.33	1	60
Selenium	5	0.45	1	82
Silver	0.32	0.029	0.1	107
Thallium	1.7	0.0079	0.02	205
Zinc	32	0.14	0.5	66

[1] Lowest of the freshwater, marine, or human health WQC promulgated by EPA for 14 states at 40 *CFR* Part 131 (57 *FR* 60848), with hardness-dependent freshwater aquatic life criteria adjusted in accordance with 57 *FR* 60848 to reflect the worst case hardness of 25 mg/L $CaCO_3$ and all aquatic life criteria adjusted in accordance with the 10/1/93 Office of Water guidance to reflect dissolved metals criteria.
[2] Method Detection Limit as determined by 40 *CFR* Part 136, Appendix B.
[3] Minimum Level (ML) calculated by multiplying laboratory-determined MDL by 3.18 and rounding result to nearest multiple of 1, 2, 5, 10, etc. in accordance with procedures used by EAD and described in EPA *Draft National Guidance for the Permitting, Monitoring, and Enforcement of Water Quality-Based Effluent Limitations Set Below Analytical Detection/Quantitation Levels*, March 22, 1994.

TABLE 2. QUALITY CONTROL ACCEPTANCE CRITERIA FOR PERFORMANCE TESTS IN EPA METHOD 1638[1]

Metal	Initial Precision and Recovery (Section 9.2) s	X	Calibration Verification (Section 10.5)	Ongoing Precision and Recovery (Section 9.7)	Spike Recovery (Section 9.3)
Antimony	20	81–120	90–111	79–122	79–122
Cadmium	13	85–112	91–105	84–113	84–113
Copper	43	55–141	76–120	51–145	51–145
Lead	30	75–140	91–120	72–143	72–143
Nickel	30	71–131	86–116	68–134	68–134
Selenium	41	63–145	69–127	59–149	59–149
Silver	19	82–120	81–107	74–119	74–119
Thallium	30	66–134	82–118	64–137	64–137
Zinc	43	55–142	76–121	46–146	46–146

[1]All specification expressed as percent.

TABLE 3. COMMON MOLECULAR ION INTERFERENCES IN ICP-MS

BACKGROUND MOLECULAR IONS

Molecular Ion	m/z	Element Interference
NH^+	15	
OH^+	17	
OH_2^+	18	
C_2^+	24	
CN^+	26	
CO^+	28	
N_2^+	28	
N_2H^+	29	
NO^+	30	
NOH^+	31	
O_2^+	32	
O_2H^+	33	
$^{36}ArH^+$	37	
$^{38}ArH^+$	39	
$^{40}ArH^+$	41	
CO_2^+	44	
CO_2H^+	45	Sc
ArC^+,ArO^+	52	Cr
ArN^+	54	Cr
$ArNH^+$	55	Mn
ArO^+	56	
$ArOH^+$	57	
$^{40}Ar^{36}Ar^+$	76	Se
$^{40}Ar^{38}Ar^+$	78	Se
$^{40}Ar_2^+$	80	Se

[a]Elements or internal standards affected by the molecular ions.

TABLE 3. COMMON MOLECULAR ION INTERFERENCES IN ICP-MS (Continued)

MATRIX MOLECULAR IONS

BROMIDE (Reference 24)

Molecular Ion	m/z	Element Interference
$^{81}BrH^+$	82	Se
$^{79}BrO^+$	95	Mo
$^{81}BrO^+$	97	Mo
$^{81}BrOH^+$	98	Mo
$Ar^{81}Br^+$	121	Sb

CHLORIDE

Molecular Ion	m/z	Element Interference
$^{35}ClO^+$	51	V
$^{35}ClOH^+$	52	Cr
$^{37}ClO^+$	53	Cr
$^{37}ClOH^+$	54	Cr
$Ar^{35}Cl^+$	75	As
$Ar^{37}Cl^+$	77	Se

SULFATE

Molecular Ion	m/z	Element Interference
$^{32}SO^+$	48	
$^{32}SOH^+$	49	
$^{34}SO^+$	50	V,Cr
$^{34}SOH^+$	51	V
SO_2^+, S_2^+	64	Zn
$Ar^{32}S^+$	72	
$Ar^{34}S^+$	74	

PHOSPHATE

Molecular Ion	m/z	Element Interference
PO^+	47	
POH^+	48	
PO_2^+	63	Cu
ArP^+	71	

TABLE 3. COMMON MOLECULAR ION INTERFERENCES IN ICP-MS (Continued)

GROUP I, II METALS

Molecular Ion	**m/z**	**Element Interference**
$ArNa^+$	63	Cu
ArK^+	79	
$ArCa^+$	80	

MATRIX OXIDES*

Molecular Ion	**m/z**	**Element Interference**
TiO	62-66	Ni,Cu,Zn
ZrO	106-112	Ag,Cd
MoO	108-116	Cd

*Oxide interferences will normally be very small and will only impact the method elements when present at relatively high concentrations. Some examples of matrix oxides of which the analyst should be aware are listed.

TABLE 4. INTERNAL STANDARDS AND LIMITATIONS OF USE

Internal Standard	**m/z**	**Possible Limitation**
^{6}Lithium	6	a
Scandium	45	polyatomic ion interference
Yttrium	89	a,b
Rhodium	103	
Indium	115	isobaric interference by Sn
Terbium	159	
Holmium	165	
Lutetium	175	
Bismuth	209	a

[a]May be present in environmental samples.
[b]In some instruments, yttrium may form measurable amounts of YO^+ (105 amu) and YOH^+ (106 amu). If this is the case, care should be taken in the use of the cadmium elemental correction equation.

NOTE: Internal standards recommended for use with this method are shown in boldface. Preparation procedures for these are included in Section 7.3.

TABLE 5. RECOMMENDED ISOTOPES AND ADDITIONAL M/Z'S THAT MUST BE MONITORED

Isotope	Element of Interest
27	Aluminum
121,123	Antimony
75	Arsenic
135,137	Barium
9	Beryllium
106,108,111,114	Cadmium
52,53	Chromium
59	Cobalt
63,65	Copper
206,207,208	Lead
55	Manganese
95,97,98	Molybdenum
60,62	Nickel
77,82	Selenium
107,109	Silver
203,205	Thallium
232	Thorium
238	Uranium
51	Vanadium
66,67,68	Zinc
83	Krypton
99	Ruthenium
105	Palladium
118	Tin

NOTE: *Isotopes recommended for analytical determination are underlined.*

TABLE 6. RECOMMENDED ELEMENTAL EQUATIONS FOR DATA CALCULATIONS

Element	Elemental Equation	Note
Sb	$(1.000)(^{123}C)$	
Cd	$(1.000)(^{111}C)-(1.073)[(^{108}C)-(0.712)(^{106}C)]$	(1)
Cu	$(1.000)(^{63}C)$	
Pb	$(1.000)(^{206}C)+(1.000)(^{207}C)+(1.000)(^{208}C)$	(2)
Ni	$(1.000)(^{60}C)$	
Se	$(1.000)(^{82}C)$	(3)
Ag	$(1.000)(^{107}C)$	
Tl	$(1.000)(^{205}C)$	
Zn	$(1.000)(^{66}C)$	

INTERNAL STANDARDS

Element	Elemental Equation	Note
Bi	$(1.000)(^{209}C)$	
In	$(1.000)(^{115}C)-(0.016)(^{118}C)$	(4)
Sc	$(1.000)(^{45}C)$	
Tb	$(1.000)(^{159}C)$	
Y	$(1.000)(^{89}C)$	

C = Counts at specified m/z.

(1) Correction for MoO interference. M/z 106 must be from Cd only, not ZrO^+. An additional correction should be made if palladium is present.

(2) Allowance for variability of lead isotopes.

(3) Some argon supplies contain krypton as an impurity. Selenium is corrected for ^{82}Kr by background subtraction.

(4) Correction for tin.

TABLE 7. RECOMMENDED INSTRUMENT OPERATING CONDITION

Instrument	**VG PlasmaQuad Type I**
Plasma forward power	1.35 kW
Coolant flow rate	13.5 L/min
Auxiliary flow rate	0.6 L/min
Nebulizer flow rate	0.78 L/min
Solution uptake rate	0.6 mL/min
Spray chamber temperature	15□C
Data Acquisition	
Detector mode	Pulse counting
Replicate integrations	3
Mass range	8–240 amu
Dwell time	320 µs
Number of MCA channels	2048
Number of scan sweeps	85
Total acquisition time	3 minutes per sample

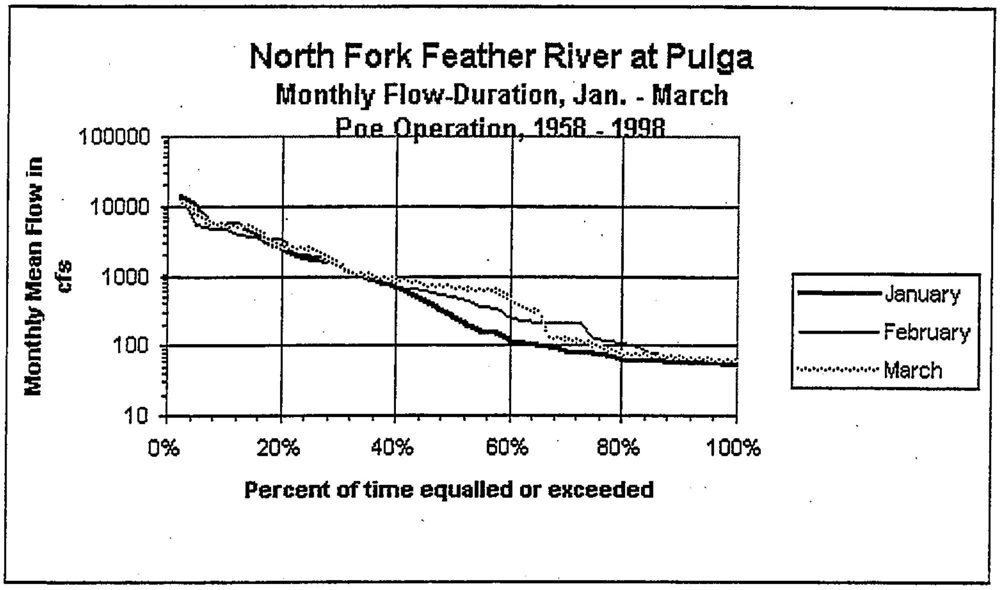
POE HYDROELECTRIC PROJECT

FERC NO. 2107

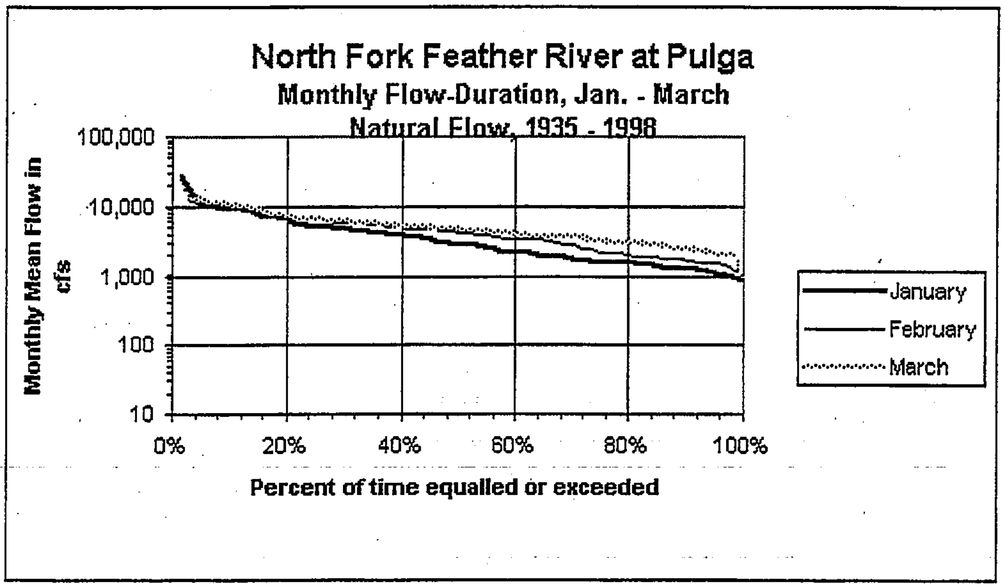
APPENDIX E2-5

Comparison of Monthly Flow Duration Curves between the Project and the Natural Flow Conditions

Appendix E2-5
Comparison of Monthly Flow Duration Curves between the Project and the Natural Flow Conditions

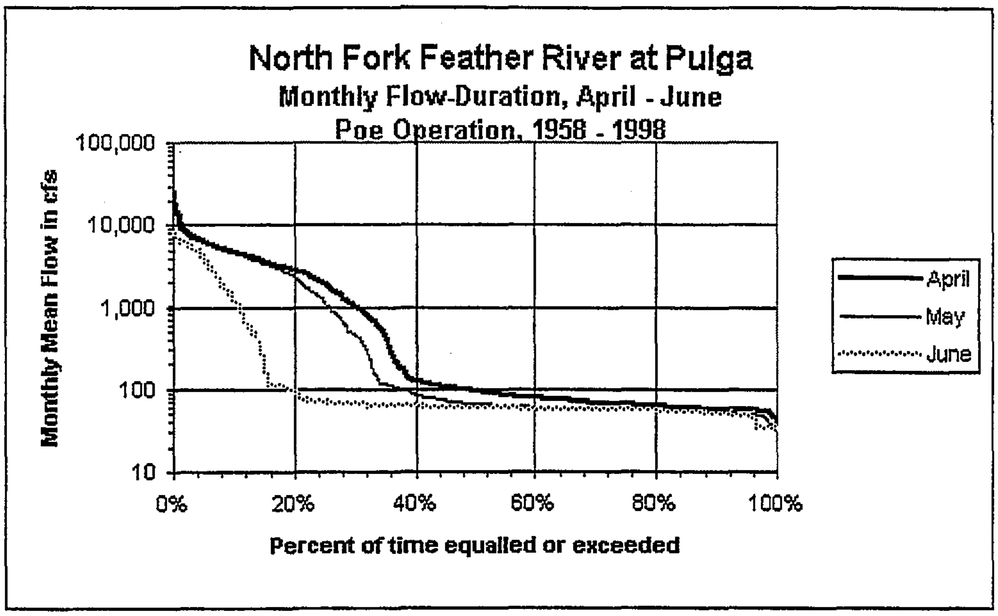


Project operation, January-March

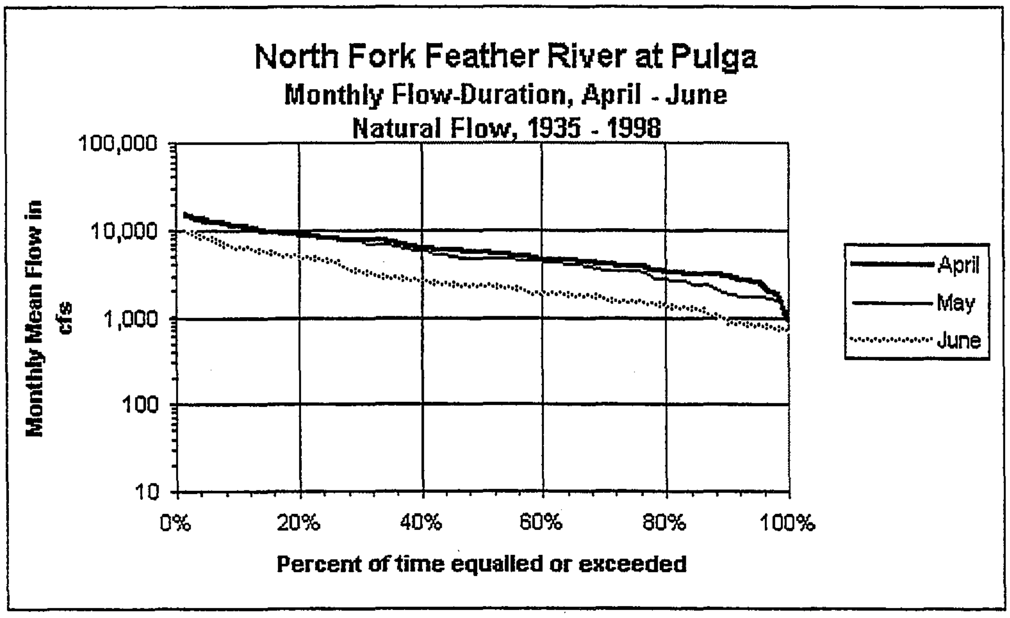


Natural flow, January-March

Appendix E2-5
(continued)

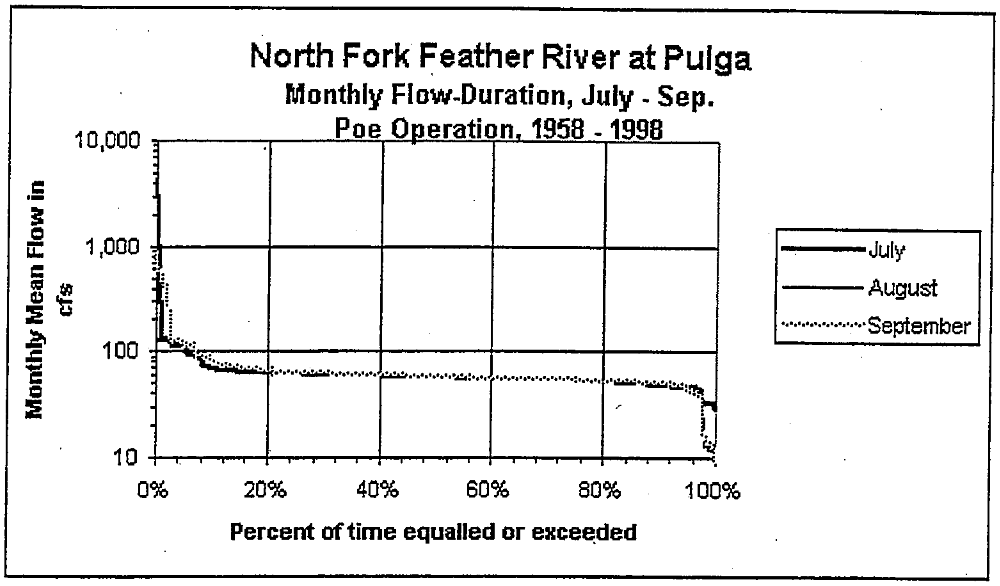


Project operation, April-June

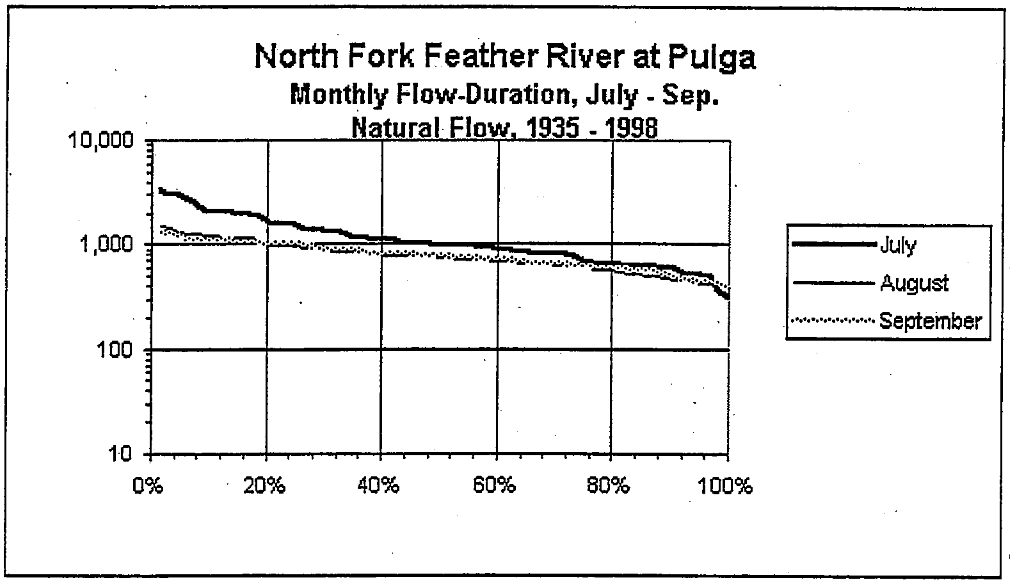


Natural flow, April-June

Appendix E2-5
(continued)

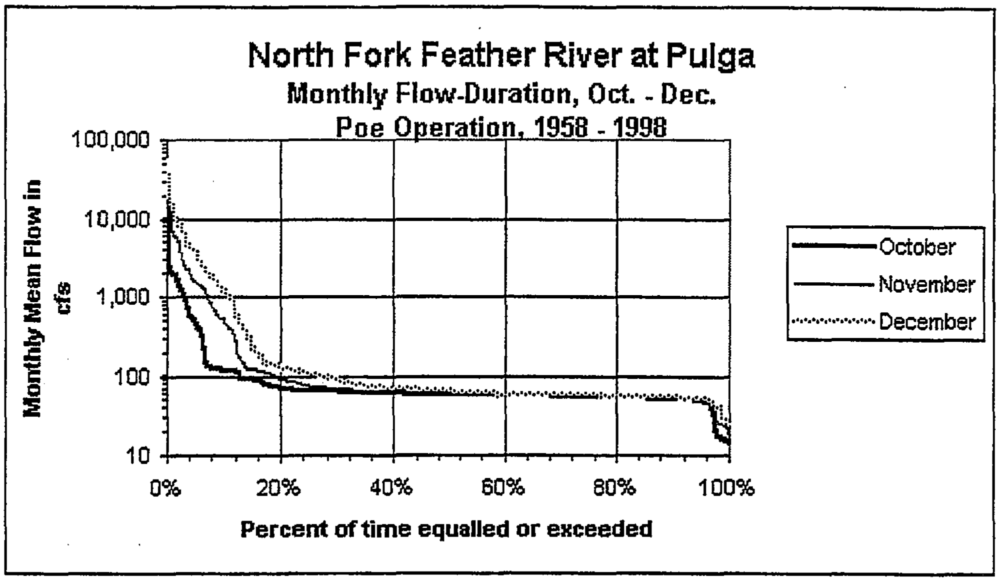


Project operation, July-September

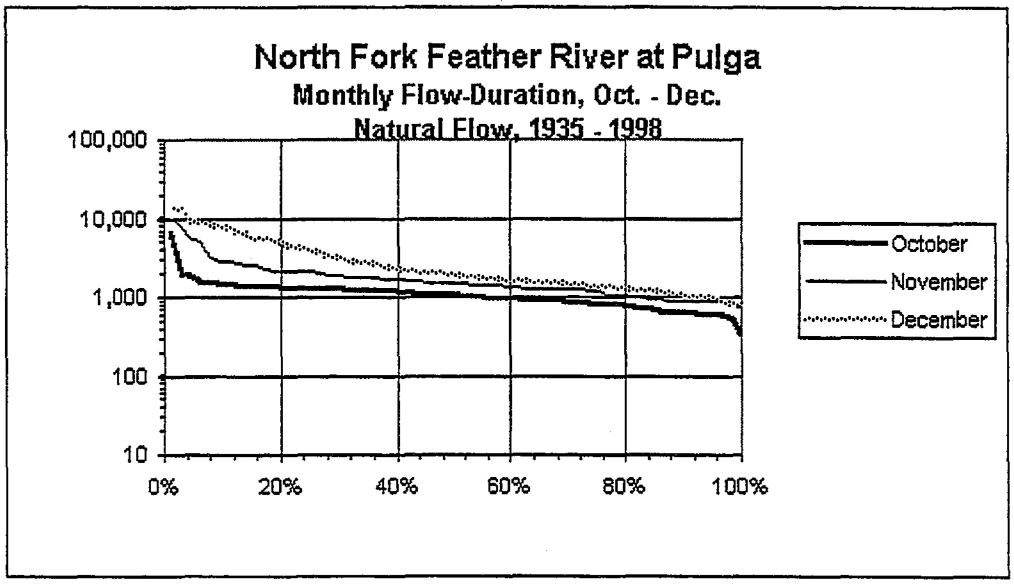


Natural flow, July-September

Appendix E2-5
(continued)



Project operation, October-December



Natural flow, October-December

POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX E2-6

Characterization of Erosion
At Bardee's Bar Tunnel Spoil Pile

CHARACTERIZATION OF EROSION AT BARDEE'S BAR TUNNEL SPOIL PILE

North Fork Feather River

Butte County, California

Prepared for:

Pacific Gas and Electric Company
245 Market Street
San Francisco, CA 94177

February 2001

Project No. 6777

T

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FIGURES

CHARACTERIZATION OF EROSION AT BARDEE'S BAR TUNNEL SPOIL PILE

North Fork Feather River
Butte County, California

1.0 INTRODUCTION

This report summarizes the results of our study of erosion features at the Bardee's Bar Tunnel Spoil Pile. Erosion features in this area are being studied as part of the Poe Project (FERC 2107) re-licensing effort. Specifically, this work encompasses Study 29 – Bardee's Bar Tunnel Spoil Pile Remediation Study. The Bardee's Bar Tunnel Spoil is located along the North Fork Feather River above Lake Oroville in Butte County, California (Figure 1).

The purpose of this study is to assess the erosion potential and feasibility of remedial measures for erosion features at the spoil pile located at the Poe Tunnel Adit No. 1, across the North Fork Feather River from Bardee's Bar (Figure 1). The study was conducted using existing data and by performing reconnaissance field investigations of the spoil pile. Geomatrix performed the following tasks: (a) review of published geologic reports of Hietanen (1973, 1977); (b) review of Exhibit K-2 and Engineering Drawings 416736 (Change 2) and 416737 (Change 4) made available by Pacific Gas and Electric Company; (c) review of aerial photographs (CXW 18-103 and 104, and 4-75 taken on October 13, 1941; F16-PL01-06007-0172-68 to 70 taken on May 29, 1972; USDA-F-16-615110-787-60 to 64 taken on July 12, 1987; and USDA-FS-16-615110-297-181 to 186 taken on August 11, 1997) on file at the offices of the Plumas National Forest in Oroville, California; (d) field reconnaissance mapping of the Tunnel Spoil Pile using a 1:4,800-scale orthophoto and topographic base map provided by Pacific Gas and Electric Company; (e) evaluation of the findings and identifying conceptual level measures for repairing erosion features; and (f) preparation of this report.

The conclusions and recommendations presented in this report are based upon the data reviewed and reconnaissance mapping of available surface outcrops. No subsurface exploration and laboratory testing were performed as part of this evaluation.

This work was completed under the direction of Ken Leung (Engineer at Pacific Gas and Electric Company) and Faiz Makdisi (Engineer at Geomatrix Consultants). Todd Crampton and John Wesling (Engineering Geologists at Geomatrix Consultants) conducted field studies on 11 to 13 October 2000. An additional field visit was made on 5 December 2000 by Ken

Leung, Tom Carrier (Pacific Gas and Electric Company), and John Wesling. James Ott and Jerry Gott (U.S. Department of Agriculture National Forest Service) provided access to aerial photographs at Forest Service offices in Oroville, California.

2.0 GEOLOGY AND EROSION FEATURES

The purpose of this study is to assess the erosion potential and feasibility of remedial measures for the spoil pile located at the Poe Tunnel Adit No. 1 across the North Fork Feather River from Bardee's Bar (Figures 1 and 2). The spoil pile was placed along the approximately 800-foot-long outside part of a meander bend; water flow is from north to south along this part of the river (Figures 2 and 3). The top of the spoil pile is about 100 to 150 feet above the river level, and the slope face of the pile slopes steeply (i.e., about 30° to 40°) down to the river level. The upper surface of the spoil pile has been graded, and a shallow, unlined drainage ditch parallels the slope face along the outer edge in the central part of the spoil pile (Figures 2 and 3). This drainage appears to direct runoff from the top of the spoil pile onto the slope face of the pile.

The northern part of the toe of the spoil pile is located approximately 150 feet from the edge of the low flow channel of the river, and the horizontal distance between the river channel and spoil pile decreases to about 20 to 30 feet in the middle and southern parts of the spoil pile. The toe of the spoil pile was locally coated with gunite (Figure 2) that evidently was placed in 1997 by the Union Pacific Railroad (Ken Leung, pers. comm., 2000). The extent of the 1997 gunite application is not known. High water marks (trim lines and scour features) from the river were evident on the toe of the spoil pile.

Available gully exposures indicate that the spoil pile consists of well-graded angular gravel to boulders with sand, and well-graded sand with angular gravel and boulders. Comparison of pre-spoil pile topography with existing topography (U.S. Geological Survey 7.5 Minute Digital Elevation Model) indicates that there are 500,000 to 600,000 cubic yards of tunnel muck contained within the spoil pile. Bedrock underlying the spoil pile and surrounding site area consists of Jurassic serpentine and ultramafic rocks (Hietanen, 1973).

Erosion gullies occur on the slope face of the spoil pile, and the toe of the spoil pile is slightly eroded where the river impinges against it (Figures 2 and 3). Gullies are evident on the slope face of the spoil pile on the 1972 through 1997 aerial photographs; however, the scale of the photographs is too small to meaningfully evaluate changes in gully number and size over time. Larger gullies are concentrated along the northern part of the slope face and at the northernmost margin of the spoil pile where surface drainage is directed from the top of the pile. Larger debris fans are deposited at the base of the spoil pile below these gullies.

Smaller gullies shown on Figures 2 and 3 occur on the middle and southern part of the spoil pile slope face. No surface runoff appears to be concentrated onto the slope face from the top of the spoil pile above these gullies. Instead, they appear to have formed directly through runoff generated from rainfall, from seeps of shallow groundwater (i.e., rainwater introduced along unlined drainage ditch, surface of pile, and/or along back edge of spoil pile), and/or from sloughing of loose materials comprising the slope face of the spoil pile. An alternate explanation may be that these gullies were formed from runoff from the top of the spoil pile prior to regrading and establishment of the ditch in 1997.

The spoil pile toe has been slightly eroded by the river along the middle and southern part of the spoil pile (Figure 2). Gunite placed along the toe of the spoil pile, presumably to protect it from erosion, has been partially eroded by the river at the location where the river directly impinges against the spoil pile. This erosion has resulted in small sediment input to the river, and has left a small, steep cut face near the bottom of the spoil pile.

3.0 SUMMARY AND RECOMMENDATIONS

The primary erosion features evident on the spoil pile are gullies that have formed on the slope face of the pile, and a small steep cutbank at the toe of the pile along the North Fork Feather River (Figure 2). Larger gullies on the slope face of the spoil pile appear to be caused by concentrated surface runoff from ditches along the top of the pile, whereas, smaller gullies appear to be the result of direct rainfall and runoff and sloughing of weak surface materials. The toe of the spoil pile is slightly undercut by high flows along the river. No evidence of large-scale, deep-seated sliding of the spoil pile was observed in the field and on aerial photographs.

The spoil pile is stable and has experienced minor to moderate gradual erosion along the slope face and along the toe. Given the present conditions on the spoil pile and its position directly adjacent to the river, it is our judgement that the pile is susceptible to future erosion where the river impinges along its toe and where surface runoff is directed onto the slope face without adequate erosion protection. We anticipate that the amount of erosion will be relatively small during water years having "average" size storms. There is no immediate significant erosion or stability concern at the spoil pile. However, the spoil pile may be susceptible to more severe erosion during intense winter storms such as those that occurred during 1997. We recommend that Pacific Gas and Electric Company consider the following long-term strategy to improve erosion protection of the spoil pile.

Strategies for erosion mitigation of the pile should consider surface water runoff and protection of the toe from high flows along the river. Consideration should include the following:

- Modify surface drainage on top of spoil pile (e.g., line and extend ditch) and effectively transition surface water off of the pile (e.g., pipe with energy dissipater);

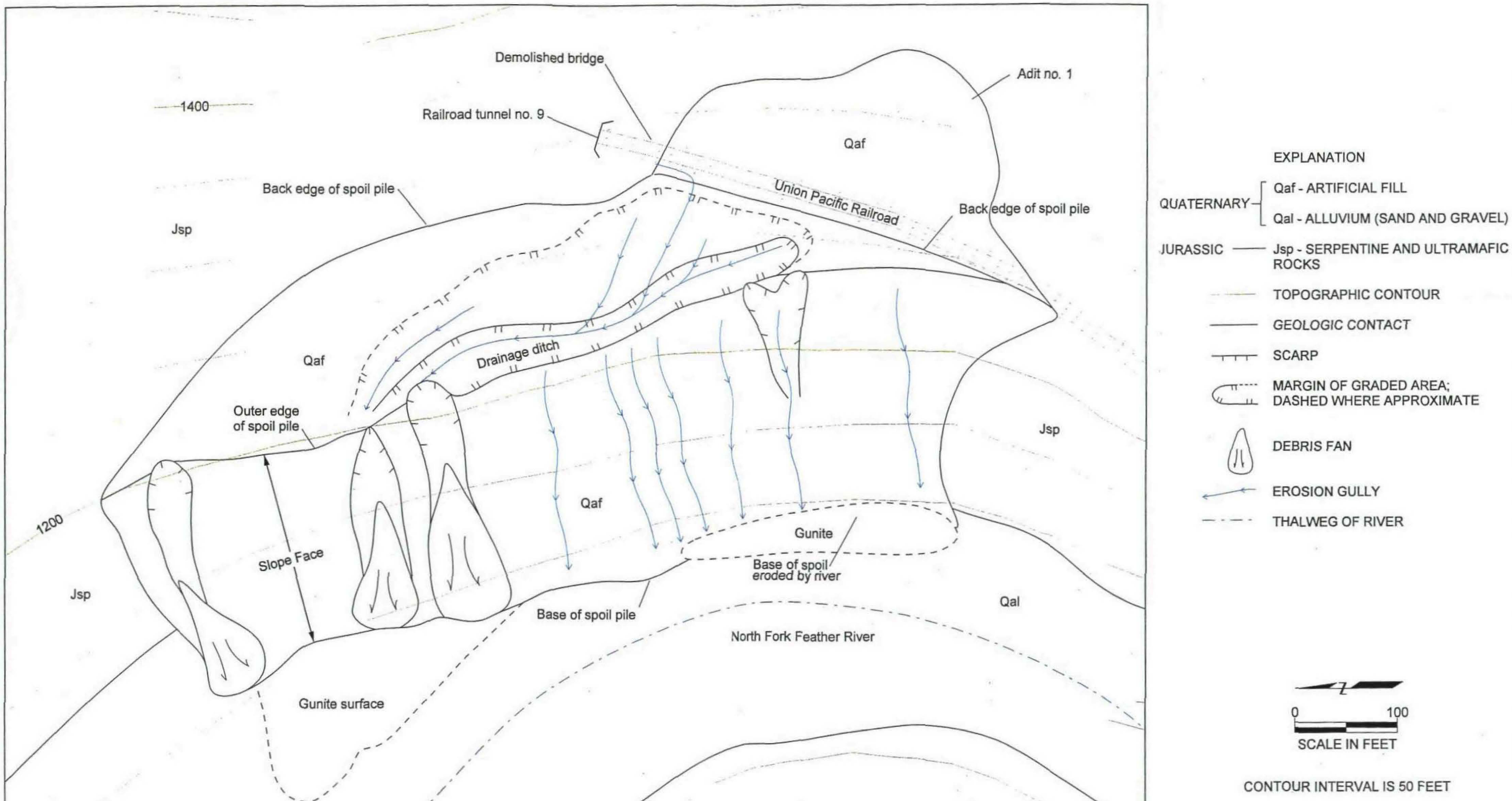
- Armor area of toe that is susceptible to undercutting by the river.

- Monitor erosion: establish a baseline survey of existing conditions to monitor rate and level of erosion after significant storms.

4.0 REFERENCES CITED

Hietanen, Anna, 1973, Geology of the Pulga and Bucks Lake Quadrangles, Butte and Plumas Counties, California: U.S. Geological Survey Professional Paper 731, scale 1:48,000.

Hietanen, Anna, 1977, Paleozoic-Mesozoic boundary in the Berry Creek quadrangle, northwestern Sierra Nevada, California: U.S. Geological Survey Professional Paper 1027, scale 1:48,000.



GEOLOGY AND EROSION FEATURES AT BARDEE'S BAR SPOIL PILE

PG&E Poe Project

Butte County, California

GEOMATRIX	Project No. 6777	Figure 2

Non-GDS

GEOMATRIX

BARDEE'S BAR SPOIL PILE
North Fork Feather River
Butte County, California

Project No.
6777
Figure
3

[Put Drawing No. and Plotting Information Here]

POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX E2-7

Water Quality Protection Plan

Poe Hydroelectric Project
FERC No. 2107
Water Quality Protection Plan

This plan summarizes the operating plans, practices, and procedures used by Licensee to protect water quality as part of its operation of the Poe Project.

Reservoir Releases and Gate Operation

<u>Poe Diversion Dam</u>

Poe Diversion Dam has four large radial gates and two smaller radial gates. In addition, a 36 inch bypass pipe is installed on the Highway 70 side of the dam. The FERC has set minimum instream flow release requirements for the protection on the aquatic resources downstream of the dam. Instream flow releases would typically be made through the 36 inch pipe. However, current leakage through the radial gates is in excess of the minimum instream flow release requirement and the valves on the 36 inch bypass pipe are currently closed. In the event flow in the NFFR exceeds the capability of the powerhouse diversion (approximately 3,700 cfs), the small radial gate located on the highway 70 side of the dam is opened to spill water. This gate will handle flows up to approximately 4000 cfs. If spill above this amount is required, one of the large flood gates is opened as needed. During very high flood events (over 45,000 cfs) all radial gates are opened completely, the intake to the tunnel closed and the powerhouse shut down to avoid damage. As a result of this mode of operation, sediment and debris carried by these large flows pass through Poe Reservoir and are released through the gates. Some sediment and debris may accumulate behind the gate between flood events, however, this volume is minor. Sluicing operation of gates is not performed. FERC requires that each gate be tested each year. This test involves the lifting of the gates a small distance, resulting in a small release of water. This testing is typically performed during the spill season. If gate maintenance is required, project specific measures to control any potential release of sediments will be prepared.

<u>Big Bend Dam</u>

Big Bend Dam is a static structure with no gates or other operating mechanisms. All flows in the NFFR flow over the top of the dam. The structure is constructed entirely of concrete, is stable and has no erosion or other concerns that could impact water quality.

Operation and Powerhouse Releases

<u>Turbine Discharge</u>

Except for small cooling water flows (discussed below), flow diverted at the Poe Diversion Dam flows through the turbines and is released into a short tailrace channel before returning to the NFFR. The tunnel and penstock leading to the powerhouse are underground. At certain times of the year the underground temperature is likely lower than the temperature of the water. However, due to the large volume of water passing through the tunnel it is unlikely that any significant cooling occurs or that the character of the water is changed in any other way. The tailrace channel is stable and not subject to erosion concerns.

Powerhouse Bearing Cooling Discharge

Turbine and Generator Bearings contain lubricating oil which is cooled using water taken from the penstock and run through cooling coils placed in an oil reservoir. A total flow of approximately 100 gpm (for each unit) is used for oil cooling purposes. The volumes of oil in any single lubricating oil system is approximately 260 gallons. The cooling water is discharged into the tailrace channel. The pressure in the cooling water system is higher than that in the lubricating oil system. Although a leak in the cooling coils typically results in water entering the oil reservoir (rather than oil being released to the water), some minor releases of oil have recently occurred from cooling water systems at PG&E Powerhouses in Northern California. As a result, PG&E is studying ways to make these systems more fail-safe and will implement changes as determined appropriate.

Generator Cooling

Water for generator cooling purposes is taken from the penstock upstream of the turbine, run through generator air cooler and then discharged to the tailrace. This water system is enclosed at all times and the maximum flow rate is 900 gpm (for each unit). This process increases the temperature of the cooling water. However, the volume of water involved is very small (1800 gpm maximum for both units) relative the flow through the turbines (3700 cfs or 2,390 million gpm) and this heating has no detectable impact on water released from the tailrace.

TRANSFORMER COOLING

Water for cooling the main transformer for each unit is also taken from the penstock upstream of the turbine. This cooling system has a total rated capacity of 170 gpm for each transformer. However, actual usage is currently considerably less. The water is run through heat exchangers on each transformer and then discharged into the tailrace. The heat exchangers are equipped with double wall design as a protection against leaks.

Sump Systems

Floor drains within the powerhouse drain to a large sump, which is pumped to the tailrace. The sump contains an electronic probe capable of sensing the presence of oil which will maintain approximately 1 ½ feet of water over the pump intake at all times. Any petroleum spill made within the powerhouse that reaches the sump would be contained in the sump until it is cleaned-up.

Powerhouse and Switchyard run-off

The outdoor areas of the Poe Powerhouse and Switchyard generally drain to a catch basin that eventually flows to the NFFR. The catch basin is bermed and drain pipes from the catch basin to the river contain valves that are kept normally closed. Run-off is released by manually opening the valve after visual inspection to ensure that no water quality concerns exist.

SPCC Plan

PG&E maintains an SPCC Plan for the Poe Powerhouse and Switchyard. This plan contains detailed information on the facility features and PG&E practices and procedure to prevent spills and respond to spill incidents. A Hazardous Material Release Response Plan is also prepared for Poe Powerhouse and filed with Butte County.

Sanitary Waste System

Waste from the restroom at the powerhouse is collected in the toilet sump and pumped to a septic tank.

Water Temperature Concerns

The operation of Licensees hydroelectric developments on the NFFR have altered flow patterns from historic conditions. While Licensee believes that any resulting changes in water quality are minor and beneficial uses provided for under the Basin Plan are not adversely impacted, Licensee has an extension program to study, enhance and protect the cold water resource of the NFFR. This effort includes commitments to a temperature control structure at the Prattville Intake at Lake Almanor made under a Settlement Agreement under Project No. 1962 and continuing study efforts associated with several other projects. The Poe Project reservoirs are relatively small in volume compared to the normal flow levels and heating in the reservoirs is very minor. Impacts associated with the minimum instream flow releases level below Poe Diversion Dam are being studied as part of the relicensing of the Poe Project and will be mitigated as determined by conditions of the new license.

Best Management Practices

The Licensee has an established best management practices in the form of guidelines to ensure that environmental and regulatory requirements, including agency notifications and consultations, are consistently met during construction, maintenance and operation activities.

POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX E3-1

Poe Snorkeling Surveys - October 1992, 1999, 2000

Appendix 3-1. Poe Snorkeling Fish Survey - Octo' 1992, July 1999, October 1999, and June 2000

OCT	1992				HH	HH	HH	HH	ALL	All Sizes	PM	PM	PM	PM	ALL	All Sizes
Month	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
OCT	1992	1	RUN	61	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	1	LGR	318	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	1	LSP-BO	89	0	0	0	0	0	0.0	0	0	11	11	11	12.4
OCT	1992	1	LSP-BO	217	0	0	3	3	3	1.4	0	0	18	18	18	8.3
OCT	1992	1	LGR	57	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	1	RUN	43	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	1	POOL-MC	161	0	0	0	0	0	0.0	0	0	1	1	1	0.6
OCT	1992	1	RUN	27	0	0	0	0	0	0.0	0	0	0	0	0	0.0
				973	0	0	3	3	3	0.3	0	0	30	30	30	3.1
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
	1992	1	POOLS	467	0.0	0.0	0.6	0.6	0.6	0.0	0.0	0.0	6.4	6.4	6.4	0.0
	1992	1	RUNS	131	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0.0	0.0	0.0	0.0	A&J
	1992	1	RIFFLES	375	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	3.1
		REACH														
OCT	1992	2	POOL-LSB	680	0	0	0	0	0	0.0	0	0	5	5	5	0.7
OCT	1992	2	POW	106	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	2	RUN	54	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	2	POOL-MC	756	0	0	0	0	0	0.0	0	1	24	25	25	3.3
OCT	1992	2	RUN	70	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	2	LGR	21	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	2	GLIDE	80	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	2	POOL-LSB/MC	328	0	0	0	0	0	0.0	0	0	4	4	4	1.2
				2095	0	0	0	0	0	0.0	0	1	33	34	34	1.6
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
	1992	2	POOLS	1764	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.9	1.9	1.9	0.0
	1992	2	POW	106	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0	0	0.0	0	A&J
	1992	2	RUNS/GLIDES	204	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0	1.6
	1992	2	RIFFLES	21	0.0	0.0	0.0	0.0	0.0		0.0	0	0	0.0	0	

Appendix 3-1. Poe Snorkeling Fish Survey - Octol 1992, July 1999, October 1999, and June 2000

MONTH	YEAR	REACH	TYPE	LENGTH	HH YOY	HH JUV	HH AD	HH A&J	ALL SIZES	/100 ft	PM YOY	PM JUV	PM AD	PM A&J	ALL SIZES	/100 ft
OCT	1992	3	RUN	24	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	3	POOL-LSB	124	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	3	POW	33	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	3	POOL-PLUNGE	45	0	0	0	0	0	0.0	0	1	0	1	1	2.2
OCT	1992	3	RUN	40	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	3	POOL	50	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	3	POW	100	0	0	0	0	0	0.0	0	0	0	0	0	0.0
				416	0	0	0	0	0	0.0	0	1	0	1	1	0.2
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
	1992	3	POOLS	219	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.5	0.5	0.0
	1992	3	RUNS	64	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0.0	0.0	0.0	0.0	A&J
	1992	3	POW	133	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
OCT	1992	4	POOL-LSB	102	0	0	0	0	0	0.0	0	0	1	1	1	1.0
OCT	1992	4	RUN	20	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	RUN	73	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	POW	289	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	POOL-LSB	78	0	0	0	0	0	0.0	45	0	0	0	45	57.7
OCT	1992	4	LGR	80	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	RUN	109	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	POOL-MC	59	0	0	0	0	0	0.0	10	0	0	0	10	16.9
OCT	1992	4	POW	147	0	0	0	0	0	0.0	0	0	0	0	0	0.0
				957	0	0	0	0	0	0.0	55	0	1	1	56	5.9
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
	1992	4	POOLS	239	0.0	0.0	0.0	0.0	0.0	0.0	23.0	0.0	0.4	0.4	23.4	5.7
	1992	4	RUNS	202	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0.0	0.0	0.0	0.0	A&J
	1992	4	POW	436	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	1992	4	RIFFLES	80	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	

Appendix 3-1. Poe Snorkeling Fish Survey - Octo 1992, July 1999, October 1999, and June 2000

JULY	1999				HH	HH	HH	HH	ALL		PM	PM	PM	PM	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
JULY	1999	1	RUN	165	0	0	0	0	0	0.0	5	0	0	0	5	3.0
JULY	1999	1	POOL	119	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JULY	1999	1	RIFFLE	58	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JULY	1999	1	POOL	127	0	0	3	3	3	2.4	0	0	4	4	4	3.1
JULY	1999	1	RIFFLE	80	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JULY	1999	1	RUN	97	0	0	0	0	0	0.0	0	0	1	1	1	1.0
JULY	1999	1	RUN	120	0	0	0	0	0	0.0	5	0	0	0	5	4.2
JULY	1999	1	POOL	258	0	0	4	4	4	1.6	0	0	20	20	20	7.8
				1024	0	0	7	7	7	0.7	10	0	25	25	35	3.4
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
	1999	1	POOLS	504	0.0	0.0	1.4	1.4	1.4	0.0	0.0	0.0	4.8	4.8	4.8	1.0
	1999	1	RUNS	382	0.0	0.0	0.0	0.0	0.0	A&J	2.6	0.0	0.3	0.3	2.9	A&J
	1999	1	RIFFLES	138	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	2.4
		REACH														
JULY	1999	2	POOL	239	0	0	4	4	4	1.7	1	0	5	5	6	2.5
JULY	1999	2	POW	60	0	0	0	0	0	0.0	0	0	2	2	2	3.3
JULY	1999	2	RUN	87	0	0	2	2	2	2.3	0	0	3	3	3	3.4
JULY	1999	2	RUN	85	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JULY	1999	2	POOL	53	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JULY	1999	2	RIFFLE	52	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JULY	1999	2	RUN	36	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JULY	1999	2	POOL	172	0	0	4	4	4	2.3	0	0	6	6	6	3.5
				784	0	0	10	10	10	1.3	1	0	16	16	17	2.2
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
	1999	2	POOLS	464	0.0	0.0	1.7	1.7	1.7	0.0	0.2	0.0	2.4	2.4	2.6	0.1
	1999	2	RUNS	208	0.0	0.0	1.0	1.0	1.0	A&J	0.0	0.0	1.4	1.4	1.4	A&J
	1999	2	POW	60	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	3.3	3.3	3.3	2.0
	1999	2	RIFFLES	52	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	

					HH	HH	HH	HH	ALL		PM	PM	PM	PM	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
JULY	1999	3	POOL	49	0	0	1	1	1	2.0	0	3	1	4	4	8.2
JULY	1999	3	RUN	59	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JULY	1999	3	RUN	29	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JULY	1999	3	POOL	74	0	1	0	1	1	1.4	0	0	1	1	1	1.4
JULY	1999	3	POW	87	0	0	0	0	0	0.0	0	0	3	3	3	3.4
JULY	1999	3	POOL	116	0	0	1	1	1	0.9	0	0	1	1	1	0.9
JULY	1999	3	POW	86	0	0	0	0	0	0.0	0	0	1	1	1	1.2
				500	0	1	2	3	3	0.6	0	3	7	10	10	2.0
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
	1999	3	POOLS	239	0.0	0.4	0.8	1.3	1.3	0.0	0.0	1.3	1.3	2.5	2.5	0.0
	1999	3	RUNS	88	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0.0	0.0	0.0	0.0	A&J
	1999	3	POW	173	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	2.3	2.3	2.3	2.0
		REACH														
JULY	1999	4	POOL	253	0	0	1	1	1	0.4	2	0	13	13	15	5.9
JULY	1999	4	RUN	87	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JULY	1999	4	POW	54	0	0	2	2	2	3.7	1	0	0	0	1	1.9
JULY	1999	4	POOL	56	2	3	4	7	9	16.1	0	0	0	0	0	0.0
JULY	1999	4	RUN	74	0	6	0	6	6	8.1	0	0	0	0	0	0.0
JULY	1999	4	POW	100	0	0	0	0	0	0.0	0	0	7	7	7	7.0
JULY	1999	4	POOL	82	0	0	0	0	0	0.0	0	0	3	3	3	3.7
JULY	1999	4	RUN	80	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JULY	1999	4	RIFFLE	62	0	0	0	0	0	0.0	0	8	0	8	8	12.9
				848	2	9	7	16	18	2.1	3	8	23	31	34	4.0
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
	1999	4	POOLS	391	0.5	0.8	1.3	2.0	2.6	0.2	0.5	0.0	4.1	4.1	4.6	0.4
	1999	4	RUNS	241	0.0	2.5	0.0	2.5	2.5	A&J	0.0	0.0	0.0	0.0	0.0	A&J
	1999	4	POW	154	0.0	0.0	1.3	1.3	1.3	1.9	0.6	0.0	4.5	4.5	5.2	3.7
	1999	4	RIFFLES	62	0.0	0.0	0.0	0.0	0.0		0.0	12.9	0.0	12.9	12.9	

Appendix 3-1. Poe Snorkeling Fish Survey - Octol 1992, July 1999, October 1999, and June 2000

OCT	1999				HH	HH	HH	HH	ALL		PM	PM	PM	PM	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
OCT	1999	1	RUN	177	23	0	0	0	23	13.0	0	0	0	0	0	0.0
OCT	1999	1	POOL	127	17	0	0	0	17	13.4	0	8	4	12	12	9.4
OCT	1999	1	RIFFLE	43	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	1	POOL	158	7	0	0	0	7	4.4	0	100	6	106	106	67.1
OCT	1999	1	RIFFLE	68	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	1	RUN	132	0	0	0	0	0	0.0	18	0	0	0	18	13.6
OCT	1999	1	RUN	135	0	0	0	0	0	0.0	0	0	3	3	3	2.2
OCT	1999	1	POOL	282	3	0	3	3	6	2.1	2	0	4	4	6	2.1
				1122	50	0	3	3	53	4.7	20	108	17	125	145	12.9
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
	1999	1	POOLS	567	4.8	0.0	0.5	0.5	5.3	4.5	0.4	19.0	2.5	21.5	21.9	1.8
	1999	1	RUNS	444	5.2	0.0	0.0	0.0	5.2	A&J	4.1	0.0	0.7	0.7	4.7	A&J
	1999	1	RIFFLES	111	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	11.1
		REACH														
OCT	1999	2	POOL	298	0	0	0	0	0	0.0	0	0	2	2	2	0.7
OCT	1999	2	POW	61	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	2	RUN	91	0	0	0	0	0	0.0	0	0	1	1	1	1.1
OCT	1999	2	RUN	85	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	2	POOL	60	0	0	0	0	0	0.0	1	0	0	0	1	1.7
OCT	1999	2	RIFFLE	52	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	2	RUN	36	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	2	POOL	172	0	0	1	1	1	0.6	0	0	1	1	1	0.6
				855	0	0	1	1	1	0.1	1	0	4	4	5	0.6
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
	1999	2	POOLS	530	0.0	0.0	0.2	0.2	0.2	0.0	0.2	0.0	0.6	0.6	0.8	0.1
	1999	2	RUNS	212	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0.0	0.5	0.5	0.5	A&J
	1999	2	POW	61	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.5
	1999	2	RIFFLES	52	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	

Appendix.3-1. Poe Snorkeling Fish Survey - Octo[illegible] 1992, July 1999, October 1999, and June 2000

MONTH	YEAR	REACH	TYPE	LENGTH	HH YOY	HH JUV	HH AD	HH A&J	ALL SIZES	/100 ft	PM YOY	PM JUV	PM AD	PM A&J	ALL SIZES	/100 ft
OCT	1999	3	POOL	58	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	3	RUN	60	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	3	RUN	29	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	3	POOL	76	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	3	POW	57	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	3	POOL	116	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	3	POW	108	0	0	0	0	0	0.0	0	0	0	0	0	0.0
				504	0	0	0	0	0	0.0	0	0	0	0	0	0.0
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
	1999	3	POOLS	250	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1999	3	RUNS	89	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0.0	0.0	0.0	0.0	A&J
	1999	3	POW	165	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		REACH														
OCT	1999	4	POOL	269	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	RUN	81	0	0	0	0	0	0.0	4	0	0	0	4	4.9
OCT	1999	4	POW	64	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	POOL	55	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	RUN	70	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	POW	103	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	POOL	82	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	RUN	103	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	RIFFLE	60	0	0	0	0	0	0.0	0	0	1	1	1	1.7
				887	0	0	0	0	0	0.0	4	0	1	1	5	0.6
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
	1999	4	POOLS	406	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
	1999	4	RUNS	254	0.0	0.0	0.0	0.0	0.0	A&J	1.6	0.0	0.0	0.0	1.6	A&J
	1999	4	POW	167	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	1999	4	RIFFLES	60	0.0	0.0	0.0	0.0	0.0		0.0	0.0	1.7	1.7	1.7	

Appendix 3-1. Poe Snorkeling Fish Survey - Octol 1992, July 1999, October 1999, and June 2000

JUNE	2000				HH	HH	HH	HH	ALL		PM	PM	PM	PM	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
JUNE	2000	1	RUN	165	0	0	1	1	1	0.6	0	1	2	3	3	1.8
JUNE	2000	1	POOL	119	0	0	0	0	0	0.0	0	0	2	2	2	1.7
JUNE	2000	1	RIFFLE	58	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	1	POOL	215	0	0	0	0	0	0.0	0	1	0	1	1	0.5
JUNE	2000	1	RIFFLE	80	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	1	RUN	134	0	0	0	0	0	0.0	0	0	2	2	2	1.5
JUNE	2000	1	RUN	120	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	1	POOL	258	0	0	1	1	1	0.4	0	0	3	3	3	1.2
				1149	0	0	2	2	2	0.2	0	2	9	11	11	1.0
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
JUNE	2000	1	POOLS	592	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.2	0.8	1.0	1.0	0.0
JUNE	2000	1	RUNS	419	0.0	0.0	0.2	0.2	0.2	A&J	0.0	0.2	1.0	1.2	1.2	A&J
JUNE	2000	1	RIFFLES	138	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	1.0
		REACH														
JUNE	2000	2	POOL	239	0	0	0	0	0	0.0	0	1	2	3	3	1.3
JUNE	2000	2	POW	60	0	0	0	0	0	0.0	0	0	7	7	7	11.7
JUNE	2000	2	RUN	87	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	2	RUN	85	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	2	POOL	53	0	0	0	0	0	0.0	0	0	2	2	2	3.8
JUNE	2000	2	RIFFLE	52	0	0	0	0	0	0.0	0	1	0	1	1	1.9
JUNE	2000	2	RUN	36	0	0	1	1	1	2.8	0	0	0	0	0	0.0
JUNE	2000	2	POOL	172	0	0	1	1	1	0.6	0	0	5	5	5	2.9
				784	0	0	2	2	2	0.3	0	2	16	18	18	2.3
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
JUNE	2000	2	POOLS	464	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.2	1.9	2.2	2.2	0.0
JUNE	2000	2	RUNS	208	0.0	0.0	0.5	0.5	0.5	A&J	0.0	0.0	0.0	0.0	0.0	A&J
JUNE	2000	2	POW	60	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	11.7	11.7	11.7	2.3
JUNE	2000	2	RIFFLES	52	0.0	0.0	0.0	0.0	0.0		0.0	1.9	0.0	1.9	1.9	

					HH	HH	HH	HH	ALL		PM	PM	PM	PM	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
JUNE	2000	3	POOL	49	0	0	0	0	0	0.0	0	0	1	1	1	2.0
JUNE	2000	3	RUN	59	0	0	0	0	0	0.0	0	0	3	3	3	5.1
JUNE	2000	3	RUN	29	0	0	0	0	0	0.0	0	0	1	1	1	3.4
JUNE	2000	3	POOL	74	0	0	0	0	0	0.0	0	1	2	3	3	4.1
JUNE	2000	3	POW	87	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	3	POOL	116	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	3	POW	86	0	0	0	0	0	0.0	0	3	0	3	3	3.5
				500	0	0	0	0	0	0.0	0	4	7	11	11	2.2
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
JUNE	2000	3	POOLS	239	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.3	1.7	1.7	0.0
JUNE	2000	3	RUNS	88	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0.0	4.5	4.5	4.5	A&J
JUNE	2000	3	POW	173	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	1.7	1.7	2.2
		REACH														
JUNE	2000	4	POOL	253	0	0	1	1	1	0.4	0	0	10	10	10	4.0
JUNE	2000	4	RUN	87	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	4	POW	54	0	0	0	0	0	0.0	0	1	1	2	2	3.7
JUNE	2000	4	POOL	56	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	4	RUN	74	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	4	POW	100	0	0	1	1	1	1.0	0	2	3	5	5	5.0
JUNE	2000	4	POOL	82	0	0	0	0	0	0.0	0	0	6	6	6	7.3
JUNE	2000	4	RUN	80	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	4	RIFFLE	62	0	0	0	0	0	0.0	0	2	2	4	4	6.5
				848	0	0	2	2	2	0.2	0	5	22	27	27	3.2
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
JUNE	2000	4	POOLS	391	0.0	0.0	0.3	0.3	0.3	0.0	0.0	0.0	4.1	4.1	4.1	0.0
JUNE	2000	4	RUNS	241	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0.0	0.0	0.0	0.0	A&J
JUNE	2000	4	POW	154	0.0	0.0	0.6	0.6	0.6	0.2	0.0	1.9	2.6	4.5	4.5	3.2
JUNE	2000	4	RIFFLES	62	0.0	0.0	0.0	0.0	0.0		0.0	3.2	3.2	6.5	6.5	

Appendix 3-1. Poe Snorkeling Fish Survey - Octo[illegible] 1992, July 1999, October 1999, and June 2000

MONTH	YEAR	REACH	TYPE	LENGTH	SKR YOY	SKR JUV	SKR AD	SKR A&J	ALL SIZES	All Sizes /100 ft	RBT YOY	RBT JUV	RBT AD	RBT A&J	ALL SIZES	All Sizes /100 ft
OCT	1992	1	RUN	61	0	0	0	0	0	0.0	0	0	1	1	1	1.6
OCT	1992	1	LGR	318	0	0	0	0	0	0.0	0	0	1	1	1	0.3
OCT	1992	1	LSP-BO	89	0	0	3	3	3	3.4	0	0	0	0	0	0.0
OCT	1992	1	LSP-BO	217	0	0	16	16	16	7.4	0	0	0	0	0	0.0
OCT	1992	1	LGR	57	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	1	RUN	43	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	1	POOL-MC	161	0	0	3	3	3	1.9	0	0	1	1	1	0.6
OCT	1992	1	RUN	27	0	0	1	1	1	3.7	0	0	1	1	1	3.7
				973	0	0	23	23	23	2.4	0	0	4	4	4	0.4
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		1	POOLS	467	0.0	0.0	4.7	4.7	4.7	0.0	0.0	0.0	0.2	0.2	0.2	0.0
		1	RUNS	131	0.0	0.0	0.8	0.8	0.8	A&J	0.0	0.0	1.5	1.5	1.5	A&J
		1	RIFFLES	375	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.3	0.3	0.3	0.4
OCT	1992	2	POOL-LSB	680	0	0	8	8	8	1.2	0	0	0	0	0	0.0
OCT	1992	2	POW	106	0	0	10	10	10	9.4	0	0	3	3	3	2.8
OCT	1992	2	RUN	54	0	0	20	20	20	37.0	0	0	2	2	2	3.7
OCT	1992	2	POOL-MC	756	0	0	47	47	47	6.2	0	0	1	1	1	0.1
OCT	1992	2	RUN	70	0	0	16	16	16	22.9	0	2	6	8	8	11.4
OCT	1992	2	LGR	21	0	0	1	1	1	4.8	0	0	1	1	1	4.8
OCT	1992	2	GLIDE	80	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	2	POOL-LSB/MC	328	0	0	24	24	24	7.3	0	0	0	0	0	0.0
					0	0	126	126	126	6.0	0	2	13	15	15	0.7
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		2	POOLS	1764	0.0	0.0	4.5	4.5	4.5	0.0	0.0	0.0	0.1	0.1	0.1	0.0
		2	POW	106	0.0	0.0	9.4	9.4	9.4	A&J	0.0	0.0	2.8	2.8	2.8	A&J
		2	RUNS/GLIDES	204	0.0	0.0	10.3	10.3	10.3	6.0	0.0	0.0	1.5	1.5	1.5	0.7
		2	RIFFLES	21	0.0	0.0	4.8	4.8	4.8		0.0	0.0	4.8	4.8	4.8	

					SKR	SKR	SKR	SKR	ALL		RBT	RBT	RBT	RBT	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
OCT	1992	3	RUN	24	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	3	POOL-LSB	124	0	0	17	17	17	13.7	0	0	1	1	1	0.8
OCT	1992	3	POW	33	0	0	0	0	0	0.0	0	0	1	1	1	3.0
OCT	1992	3	POOL-PLUNGE	45	0	0	2	2	2	4.4	0	0	1	1	1	2.2
OCT	1992	3	RUN	40	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	3	POOL	50	0	0	0	0	0	0.0	0	0	1	1	1	2.0
OCT	1992	3	POW	100	0	0	5	5	5	5.0	0	5	3	8	8	8.0
					0	0	24	24	24	5.8	0	5	7	12	12	2.9
		REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		3	POOLS	219	0.0	0.0	8.7	8.7	8.7	0.0	0.0	0.0	1.4	1.4	1.4	0.0
		3	RUNS	64	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0.0	0.0	0.0	0.0	A&J
		3	POW	133	0.0	0.0	3.8	3.8	3.8	5.8	0.0	3.8	3.0	6.8	6.8	2.9
OCT	1992	4	POOL-LSB	102	0	0	5	5	5	4.9	0	0	0	0	0	0.0
OCT	1992	4	RUN	20	0	0	1	1	1	5.0	0	0	0	0	0	0.0
OCT	1992	4	RUN	73	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	POW	289	0	0	5	5	5	1.7	0	4	6	10	10	3.5
OCT	1992	4	POOL-LSB	78	0	0	7	7	7	9.0	0	0	0	0	0	0.0
OCT	1992	4	LGR	80	0	0	1	1	1	1.3	0	2	1	3	3	3.8
OCT	1992	4	RUN	109	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	POOL-MC	59	0	0	6	6	6	10.2	0	2	2	4	4	6.8
OCT	1992	4	POW	147	0	0	0	0	0	0.0	0	0	0	0	0	0.0
					0	0	25	25	25	2.6	0	8	9	17	17	1.8
		REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		4	POOLS	239	0.0	0.0	7.5	7.5	7.5	0.0	0.0	0.8	0.8	1.7	1.7	0.0
		4	RUNS	202	0.0	0.0	0.5	0.5	0.5	A&J	0.0	0.0	0.0	0.0	0.0	A&J
		4	POW	436	0.0	0.0	1.1	1.1	1.1	2.6	0.0	0.9	1.4	2.3	2.3	1.8
		4	RIFFLES	80	0.0	0.0	1.3	1.3	1.3		0.0	2.5	1.3	3.8	3.8	

Appendix 3-1. Poe Snorkeling Fish Survey - Octo[illegible] 1992, July 1999, October 1999, and June 2000

					SKR	SKR	SKR	SKR	ALL		RBT	RBT	RBT	SKR	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
JULY	1999	1	RUN	165	3	1	0	1	4	2.4	0	0	9	9	9	5.5
JULY	1999	1	POOL	119	0	0	18	18	18	15.1	0	1	8	9	9	7.6
JULY	1999	1	RIFFLE	58	0	0	0	0	0	0.0	1	2	6	8	9	15.5
JULY	1999	1	POOL	127	0	0	36	36	36	28.3	0	4	6	10	10	7.9
JULY	1999	1	RIFFLE	80	0	6	0	6	6	7.5	2	2	0	2	4	5.0
JULY	1999	1	RUN	97	2	1	14	15	17	17.5	1	1	7	8	9	9.3
JULY	1999	1	RUN	120	0	0	9	9	9	7.5	0	3	12	15	15	12.5
JULY	1999	1	POOL	258	1	0	23	23	24	9.3	0	3	8	11	11	4.3
					6	8	100	108	114	11.1	4	16	56	72	76	7.4
		REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		1	POOLS	504	0.2	0.0	15.3	15.3	15.5	0.6	0.0	1.6	4.4	6.0	6.0	0.4
		1	RUNS	382	1.3	0.5	6.0	6.5	7.9	A&J	0.3	1.0	7.3	8.4	8.6	A&J
		1	RIFFLES	138	0.0	4.3	0.0	4.3	4.3	10.5	2.2	2.9	4.3	7.2	9.4	7.0
JULY	1999	2	POOL	239	0	0	34	34	34	14.2	0	1	7	8	8	3.3
JULY	1999	2	POW	60	0	2	1	3	3	5.0	0	3	9	12	12	20.0
JULY	1999	2	RUN	87	2	0	41	41	43	49.4	0	2	19	21	21	24.1
JULY	1999	2	RUN	85	3	0	10	10	13	15.3	0	5	4	9	9	10.6
JULY	1999	2	POOL	53	1	0	13	13	14	26.4	0	1	9	10	10	18.9
JULY	1999	2	RIFFLE	52	0	2	6	8	8	15.4	0	2	3	5	5	9.6
JULY	1999	2	RUN	36	0	0	3	3	3	8.3	0	3	6	9	9	25.0
JULY	1999	2	POOL	172	2	0	39	39	41	23.8	0	1	12	13	13	7.6
					8	4	147	151	159	20.3	0	18	69	87	87	11.1
		REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		2	POOLS	464	0.6	0.0	18.5	18.5	19.2	1.0	0.0	0.6	6.0	6.7	6.7	0.0
		2	RUNS	208	2.4	0.0	26.0	26.0	28.4	A&J	0.0	4.8	13.9	18.8	18.8	A&J
		2	POW	60	0.0	3.3	1.7	5.0	5.0	19.3	0.0	5.0	15.0	20.0	20.0	11.1
		2	RIFFLES	52	0.0	3.8	11.5	15.4	15.4		0.0	3.8	5.8	9.6	9.6	

					SKR	SKR	SKR	SKR	ALL		RBT	RBT	RBT	RBT	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
JULY	1999	3	POOL	49	3	0	21	21	24	49.0	0	0	2	2	2	4.1
JULY	1999	3	RUN	59	15	1	3	4	19	32.2	4	1	4	5	9	15.3
JULY	1999	3	RUN	29	3	1	8	9	12	41.4	3	0	1	1	4	13.8
JULY	1999	3	POOL	74	20	1	12	13	33	44.6	0	3	5	8	8	10.8
JULY	1999	3	POW	87	3	3	12	15	18	20.7	1	1	6	7	8	9.2
JULY	1999	3	POOL	116	35	0	1	1	36	31.0	1	0	1	1	2	1.7
JULY	1999	3	POW	86	27	1	45	46	73	84.9	1	1	4	5	6	7.0
					106	7	102	109	215	43.0	10	6	23	29	39	7.8
		REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		3	POOLS	239	24.3	0.4	14.2	14.6	38.9	21.2	0.4	1.3	3.3	4.6	5.0	2.0
		3	RUNS	88	20.5	2.3	12.5	14.8	35.2	A&J	8.0	1.1	5.7	6.8	14.8	A&J
		3	POW	173	17.3	2.3	32.9	35.3	52.6	21.8	1.2	1.2	5.8	6.9	8.1	5.8
JULY	1999	4	POOL	253	298	3	10	13	311	122.9	6	1	7	8	14	5.5
JULY	1999	4	RUN	87	154	22	0	22	176	202.3	12	10	0	10	22	25.3
JULY	1999	4	POW	54	58	8	9	17	75	138.9	2	2	7	9	11	20.4
JULY	1999	4	POOL	56	97	10	2	12	109	194.6	4	1	5	6	10	17.9
JULY	1999	4	RUN	74	66	23	3	26	92	124.3	7	7	4	11	18	24.3
JULY	1999	4	POW	100	178	14	0	14	192	192.0	2	2	4	6	8	8.0
JULY	1999	4	POOL	82	134	0	1	1	135	164.6	1	0	3	3	4	4.9
JULY	1999	4	RUN	80	65	23	1	24	89	111.3	19	4	9	13	32	40.0
JULY	1999	4	RIFFLE	62	21	12	0	12	33	53.2	6	4	1	5	11	17.7
					1071	115	26	141	1212	142.9	59	31	40	71	130	15.3
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		4	POOLS	391	135.3	3.3	3.3	6.6	141.9	126.3	2.8	0.5	3.8	4.3	7.2	7.0
		4	RUNS	241	118.3	28.2	1.7	29.9	148.1	A&J	15.8	8.7	5.4	14.1	29.9	A&J
		4	POW	154	153.2	14.3	5.8	20.1	173.4	16.6	2.6	2.6	7.1	9.7	12.3	8.4
		4	RIFFLES	62	33.9	19.4	0.0	19.4	53.2		9.7	6.5	1.6	8.1	17.7	

Appendix 3-1. Poe Snorkeling Fish Survey - Octo 1992, July 1999, October 1999, and June 2000

					SKR	SKR	SKR	SKR	ALL		RBT	RBT	RBT	RBT	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
OCT	1999	1	RUN	177	2	0	0	0	2	1.1	0	0	4	4	4	2.3
OCT	1999	1	POOL	127	0	3	45	48	48	37.8	0	0	15	15	15	11.8
OCT	1999	1	RIFFLE	43	0	0	0	0	0	0.0	0	1	4	5	5	11.6
OCT	1999	1	POOL	158	0	0	29	29	29	18.4	0	0	5	5	5	3.2
OCT	1999	1	RIFFLE	68	0	0	3	3	3	4.4	0	5	0	5	5	7.4
OCT	1999	1	RUN	132	0	0	16	16	16	12.1	0	0	6	6	6	4.5
OCT	1999	1	RUN	135	0	0	6	6	6	4.4	0	0	12	12	12	8.9
OCT	1999	1	POOL	282	0	1	35	36	36	12.8	0	0	2	2	2	0.7
				1122	2	4	134	138	140	12.5	0	6	48	54	54	4.8
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		1	POOLS	567	0.0	0.7	19.2	19.9	19.9	0.2	0.0	0.0	3.9	3.9	3.9	0.0
		1	RUNS	444	0.5	0.0	5.0	5.0	5.4	A&J	0.0	0.0	5.0	5.0	5.0	A&J
		1	RIFFLES	111	0.0	0.0	2.7	2.7	2.7	12.3	0.0	5.4	3.6	9.0	9.0	4.8
OCT	1999	2	POOL	298	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	2	POW	61	0	0	6	6	6	9.8	0	1	7	8	8	13.1
OCT	1999	2	RUN	91	0	0	30	30	30	33.0	0	0	4	4	4	4.4
OCT	1999	2	RUN	85	0	0	12	12	12	14.1	0	1	5	6	6	7.1
OCT	1999	2	POOL	60	0	0	19	19	19	31.7	0	0	7	7	7	11.7
OCT	1999	2	RIFFLE	52	0	0	2	2	2	3.8	0	0	0	0	0	0.0
OCT	1999	2	RUN	36	0	0	2	2	2	5.6	0	4	1	5	5	13.9
OCT	1999	2	POOL	172	0	0	18	18	18	10.5	0	0	2	2	2	1.2
				855	0	0	89	89	89	10.4	0	6	26	32	32	3.7
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		2	POOLS	530	0.0	0.0	7.0	7.0	7.0	0.0	0.0	0.0	1.7	1.7	1.7	0.0
		2	RUNS	212	0.0	0.0	20.8	20.8	20.8	A&J	0.0	2.4	4.7	7.1	7.1	A&J
		2	POW	61	0.0	0.0	9.8	9.8	9.8	10.4	0.0	1.6	11.5	13.1	13.1	3.7
		2	RIFFLES	52	0.0	0.0	3.8	3.8	3.8		0.0	0.0	0.0	0.0	0.0	

					SKR	SKR	SKR	SKR	ALL		RBT	RBT	RBT	RBT	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
OCT	1999	3	POOL	58	0	0	1	1	1	1.7	0	0	0	0	0	0.0
OCT	1999	3	RUN	60	0	0	1	1	1	1.7	0	1	0	1	1	1.7
OCT	1999	3	RUN	29	0	0	2	2	2	6.9	0	1	0	1	1	3.4
OCT	1999	3	POOL	76	0	0	8	8	8	10.5	0	0	0	0	0	0.0
OCT	1999	3	POW	57	0	0	3	3	3	5.3	0	0	0	0	0	0.0
OCT	1999	3	POOL	116	0	0	21	21	21	18.1	0	0	0	0	0	0.0
OCT	1999	3	POW	108	0	0	4	4	4	3.7	0	0	0	0	0	0.0
				504	0	0	40	40	40	7.9	0	2	0	2	2	0.4
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		3	POOLS	250	0.0	0.0	12.0	12.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		3	RUNS	89	0.0	0.0	3.4	3.4	3.4	A&J	0.0	2.2	0.0	2.2	2.2	A&J
		3	POW	165	0.0	0.0	4.2	4.2	4.2	7.9	0.0	0.0	0.0	0.0	0.0	0.4
OCT	1999	4	POOL	269	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	RUN	81	0	3	1	4	4	4.9	0	0	1	1	1	1.2
OCT	1999	4	POW	64	0	0	1	1	1	1.6	0	0	3	3	3	4.7
OCT	1999	4	POOL	55	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	RUN	70	0	1	1	2	2	2.9	0	0	1	1	1	1.4
OCT	1999	4	POW	103	0	0	7	7	7	6.8	0	0	1	1	1	1.0
OCT	1999	4	POOL	82	1	0	3	3	4	4.9	0	0	2	2	2	2.4
OCT	1999	4	RUN	103	7	1	3	4	11	10.7	0	0	3	3	3	2.9
OCT	1999	4	RIFFLE	60	0	0	0	0	0	0.0	0	1	0	1	1	1.7
				887	8	5	16	21	29	3.3	0	1	11	12	12	1.4
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		4	POOLS	406	0.2	0.0	0.7	0.7	1.0	0.9	0.0	0.0	0.5	0.5	0.5	0.0
		4	RUNS	254	2.8	2.0	2.0	3.9	6.7	A&J	0.0	0.0	2.0	2.0	2.0	A&J
		4	POW	167	0.0	0.0	4.8	4.8	4.8	2.4	0.0	0.0	2.4	2.4	2.4	1.4
		4	RIFFLES	60	0.0	0.0	0.0	0.0	0.0		0.0	1.7	0.0	1.7	1.7	

Appendix 3-1. Poe Snorkeling Fish Survey - Octo 1992, July 1999, October 1999, and June 2000

JUNE	2000				SKR	SKR	SKR	SKR	ALL		RBT	RBT	RBT	RBT	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
JUNE	2000	1	RUN	165	0	0	1	1	1	0.6	0	0	4	4	4	2.4
JUNE	2000	1	POOL	119	0	0	30	30	30	25.2	0	1	5	6	6	5.0
JUNE	2000	1	RIFFLE	58	0	0	0	0	0	0.0	0	7	3	10	10	17.2
JUNE	2000	1	POOL	215	0	0	17	17	17	7.9	0	7	6	13	13	6.0
JUNE	2000	1	RIFFLE	80	0	0	1	1	1	1.3	0	4	0	4	4	5.0
JUNE	2000	1	RUN	134	0	0	30	30	30	22.4	0	0	2	2	2	1.5
JUNE	2000	1	RUN	120	0	0	2	2	2	1.7	0	2	18	20	20	16.7
JUNE	2000	1	POOL	258	0	0	24	24	24	9.3	0	0	3	3	3	1.2
				1149	0	0	105	105	105	9.1	0	21	41	62	62	5.4
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
JUNE	2000	1	POOLS	592	0.0	0.0	12.0	12.0	12.0	0.0	0.0	1.4	2.4	3.7	3.7	0.0
JUNE	2000	1	RUNS	419	0.0	0.0	7.9	7.9	7.9	A&J	0.0	0.5	5.7	6.2	6.2	A&J
JUNE	2000	1	RIFFLES	138	0.0	0.0	0.7	0.7	0.7	9.1	0.0	8.0	2.2	10.1	10.1	5.4
JUNE	2000	2	POOL	239	0	0	19	19	19	7.9	0	0	11	11	11	4.6
JUNE	2000	2	POW	60	0	0	13	13	13	21.7	0	1	6	7	7	11.7
JUNE	2000	2	RUN	87	0	0	24	24	24	27.6	0	0	14	14	14	16.1
JUNE	2000	2	RUN	85	0	0	16	16	16	18.8	0	1	15	16	16	18.8
JUNE	2000	2	POOL	53	0	1	18	19	19	35.8	0	1	12	13	13	24.5
JUNE	2000	2	RIFFLE	52	0	0	2	2	2	3.8	3	1	2	3	6	11.5
JUNE	2000	2	RUN	36	0	0	8	8	8	22.2	0	5	4	9	9	25.0
JUNE	2000	2	POOL	172	0	1	42	43	43	25.0	0	4	19	23	23	13.4
				784	0	2	142	144	144	18.4	3	13	83	96	99	12.6
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
JUNE	2000	2	POOLS	464	0.0	0.4	17.0	17.5	17.5	0.0	0.0	1.1	9.1	10.1	10.1	0.4
JUNE	2000	2	RUNS	208	0.0	0.0	23.1	23.1	23.1	A&J	0.0	2.9	15.9	18.8	18.8	A&J
JUNE	2000	2	POW	60	0.0	0.0	21.7	21.7	21.7	18.4	0.0	1.7	10.0	11.7	11.7	12.2
JUNE	2000	2	RIFFLES	52	0.0	0.0	3.8	3.8	3.8		5.8	1.9	3.8	5.8	11.5	

					SKR	SKR	SKR	SKR	ALL		RBT	RBT	RBT	RBT	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
JUNE	2000	3	POOL	49	0	0	29	29	29	59.2	0	0	1	1	1	2.0
JUNE	2000	3	RUN	59	0	0	54	54	54	91.5	0	1	2	3	3	5.1
JUNE	2000	3	RUN	29	0	0	6	6	6	20.7	0	0	4	4	4	13.8
JUNE	2000	3	POOL	74	0	1	27	28	28	37.8	0	2	12	14	14	18.9
JUNE	2000	3	POW	87	0	0	5	5	5	5.7	0	1	2	3	3	3.4
JUNE	2000	3	POOL	116	0	0	21	21	21	18.1	3	1	23	24	27	23.3
JUNE	2000	3	POW	86	0	1	24	25	25	29.1	0	6	7	13	13	15.1
				500	0	2	166	168	168	33.6	3	11	51	62	65	13.0
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
JUNE	2000	3	POOLS	239	0.0	0.4	32.2	32.6	32.6	0.0	1.3	1.3	15.1	16.3	17.6	0.6
JUNE	2000	3	RUNS	88	0.0	0.0	68.2	68.2	68.2	A&J	0.0	1.1	6.8	8.0	8.0	A&J
JUNE	2000	3	POW	173	0.0	0.6	16.8	17.3	17.3	33.6	0.0	4.0	5.2	9.2	9.2	12.4
JUNE	2000	4	POOL	253	0	12	20	32	32	12.6	11	3	13	16	27	10.7
JUNE	2000	4	RUN	87	0	1	5	6	6	6.9	113	2	0	2	115	132.2
JUNE	2000	4	POW	54	0	2	14	16	16	29.6	37	4	15	19	56	103.7
JUNE	2000	4	POOL	56	1	0	1	1	2	3.6	19	5	9	14	33	58.9
JUNE	2000	4	RUN	74	0	4	8	12	12	16.2	22	4	4	8	30	40.5
JUNE	2000	4	POW	100	6	8	39	47	53	53.0	31	8	13	21	52	52.0
JUNE	2000	4	POOL	82	20	2	13	15	35	42.7	36	2	10	12	48	58.5
JUNE	2000	4	RUN	80	4	16	6	22	26	32.5	235	11	9	20	255	318.8
JUNE	2000	4	RIFFLE	62	0	3	1	4	4	6.5	67	5	1	6	73	117.7
				848	31	48	107	155	186	21.9	571	44	74	118	689	81.3
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
JUNE	2000	4	POOLS	391	5.4	3.6	8.7	12.3	17.6	3.7	16.9	2.6	8.2	10.7	27.6	67.3
JUNE	2000	4	RUNS	241	1.7	8.7	7.9	16.6	18.3	A&J	153.5	7.1	5.4	12.4	166.0	A&J
JUNE	2000	4	POW	154	3.9	6.5	34.4	40.9	44.8	18.3	44.2	7.8	18.2	26.0	70.1	13.9
JUNE	2000	4	RIFFLES	62	0.0	4.8	1.6	6.5	6.5		108.1	8.1	1.6	9.7	117.7	

Appendix 3-1. Poe Snorkeling Fish Survey - Octob 992, July 1999, October 1999, and June 2000

					SMB	SMB	SMB	SMB	ALL	All Sizes	OTHER	OTHER	OTHER	OTHER	ALL	All Sizes
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
OCT	1992	1	RUN	61	0	0	1	1	1	1.6	0	0	0	0	0	0.0
OCT	1992	1	LGR	318	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	1	LSP-BO	89	1	3	3	6	7	7.9	0	0	0	0	0	0.0
OCT	1992	1	LSP-BO	217	0	20	80	100	100	46.1	0	0	0	0	0	0.0
OCT	1992	1	LGR	57	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	1	RUN	43	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	1	POOL-MC	161	0	20	20	40	40	24.8	0	0	0	0	0	0.0
OCT	1992	1	RUN	27	1	9	5	14	15	55.6	0	0	0	0	0	0.0
				973	2	52	109	161	163	16.8	0	0	0	0	0	0.0
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		1	POOLS	467	0.2	9.2	22.1	31.3	31.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0
		1	RUNS	131	0.8	6.9	4.6	11.5	12.2	A&J	0.0	0.0	0.0	0.0	0.0	A&J
		1	RIFFLES	375	0.0	0.0	0.0	0.0	0.0	16.5	0.0	0.0	0.0	0.0	0.0	0.0
OCT	1992	2	POOL-LSB	680	0	11	16	27	27	4.0	0	0	0	0	0	0.0
OCT	1992	2	POW	106	0	3	2	5	5	4.7	0	0	0	0	0	0.0
OCT	1992	2	RUN	54	0	1	4	5	5	9.3	0	0	0	0	0	0.0
OCT	1992	2	POOL-MC	756	0	2	20	22	22	2.9	0	0	0	0	0	0.0
OCT	1992	2	RUN	70	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	2	LGR	21	0	1	0	1	1	4.8	0	0	0	0	0	0.0
OCT	1992	2	GLIDE	80	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	2	POOL-LSB/MC	328	0	12	5	17	17	5.2	0	0	0	0	0	0.0
					0	30	47	77	77	3.7	0	0	0	0	0	0.0
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		2	POOLS	1764	0.0	1.4	2.3	3.7	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		2	POW	106	0.0	2.8	1.9	4.7	4.7	A&J	0.0	0.0	0.0	0.0	0.0	A&J
		2	RUNS/GLIDES	204	0.0	1.0	2.0	2.9	2.9	3.7	0.0	0.0	0.0	0.0	0.0	0.0
		2	RIFFLES	21	0.0	4.8	0.0	4.8	4.8		0.0	0.0	0.0	0.0	0.0	

					SMB	SMB	SMB	SMB	ALL		OTHER	OTHER	OTHER	OTHER	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
OCT	1992	3	RUN	24	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	3	POOL-LSB	124	0	0	1	1	1	0.8	0	0	0	0	0	0.0
OCT	1992	3	POW	33	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	3	POOL-PLUNGE	45	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	3	RUN	40	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	3	POOL	50	0	0	0	0	0	0.0	0	0	3	3	3	6.0
OCT	1992	3	POW	100	0	0	0	0	0	0.0	0	0	0	0	0	0.0
					0	0	1	1	1	0.2	0	0	3	3	3	0.7
		REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		3	POOLS	219	0.0	0.0	0.5	0.5	0.5	0.0	0.0	0.0	1.4	1.4	1.4	0.0
		3	RUNS	64	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0.0	0.0	0.0	0.0	A&J
		3	POW	133	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.7
OCT	1992	4	POOL-LSB	102	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	RUN	20	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	RUN	73	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	POW	289	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	POOL-LSB	78	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	LGR	80	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	RUN	109	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	POOL-MC	59	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1992	4	POW	147	0	0	0	0	0	0.0	0	0	0	0	0	0.0
					0	0	0	0	0	0.0	0	0	0	0	0	0.0
		REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		4	POOLS	239	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		4	RUNS	202	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0.0	0.0	0.0	0.0	A&J
		4	POW	436	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		4	RIFFLES	80	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	

Appendix 3-1. Poe Snorkeling Fish Survey - Octob 992, July 1999, October 1999, and June 2000

					SMB	SMB	SMB	SKR	ALL		OTHER	OTHER	OTHER	SKR	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
JULY	1999	1	RUN	165	0	0	0	0	0	0.0	2000	0	0	0	2000	1212.1
JULY	1999	1	POOL	119	0	0	1	1	1	0.8	200	0	0	0	200	168.1
JULY	1999	1	RIFFLE	58	0	0	0	0	0	0.0	75	0	0	0	75	129.3
JULY	1999	1	POOL	127	0	0	3	3	3	2.4	400	0	0	0	400	315.0
JULY	1999	1	RIFFLE	80	0	0	0	0	0	0.0	10	0	0	0	10	12.5
JULY	1999	1	RUN	97	0	0	1	1	1	1.0	187	0	0	0	187	192.8
JULY	1999	1	RUN	120	0	0	5	5	5	4.2	740	0	0	0	740	616.7
JULY	1999	1	POOL	258	0	0	4	4	4	1.6	640	0	0	0	640	248.1
					0	0	14	14	14	1.4	4252	0	0	0	4252	415.2
		REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		1	POOLS	504	0.0	0.0	1.6	1.6	1.6	0.0	246.0	0.0	0.0	0.0	246.0	415.2
		1	RUNS	382	0.0	0.0	1.6	1.6	1.6	A&J	766.2	0.0	0.0	0.0	766.2	A&J
		1	RIFFLES	138	0.0	0.0	0.0	0.0	0.0	1.4	61.6	0.0	0.0	0.0	61.6	0.0
JULY	1999	2	POOL	239	0	0	18	18	18	7.5	1000	0	0	0	1000	418.4
JULY	1999	2	POW	60	0	0	0	0	0	0.0	125	0	0	0	125	208.3
JULY	1999	2	RUN	87	0	0	2	2	2	2.3	563	0	0	0	563	647.1
JULY	1999	2	RUN	85	0	0	0	0	0	0.0	47	0	0	0	47	55.3
JULY	1999	2	POOL	53	0	0	0	0	0	0.0	88	0	0	0	88	166.0
JULY	1999	2	RIFFLE	52	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JULY	1999	2	RUN	36	0	0	0	0	0	0.0	6	0	0	0	6	16.7
JULY	1999	2	POOL	172	0	1	0	1	1	0.6	1231	0	0	0	1231	715.7
					0	1	20	21	21	2.7	3060	0	0	0	3060	390.3
		REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		2	POOLS	464	0.0	0.2	3.9	4.1	4.1	0.0	499.8	0.0	0.0	0.0	499.8	390.3
		2	RUNS	208	0.0	0.0	1.0	1.0	1.0	A&J	296.2	0.0	0.0	0.0	296.2	A&J
		2	POW	60	0.0	0.0	0.0	0.0	0.0	2.7	208.3	0.0	0.0	0.0	208.3	0.0
		2	RIFFLES	52	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	

					SMB	SMB	SMB	SMB	ALL		OTHER	OTHER	OTHER	OTHER	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
JULY	1999	3	POOL	49	0	0	0	0	0	0.0	575	0	0	0	575	1173.5
JULY	1999	3	RUN	59	0	0	0	0	0	0.0	20	0	0	0	20	33.9
JULY	1999	3	RUN	29	0	0	0	0	0	0.0	10	0	0	0	10	34.5
JULY	1999	3	POOL	74	0	0	0	0	0	0.0	244	0	0	0	244	329.7
JULY	1999	3	POW	87	0	0	0	0	0	0.0	39	0	0	0	39	44.8
JULY	1999	3	POOL	116	0	0	0	0	0	0.0	1851	0	0	0	1851	1595.7
JULY	1999	3	POW	86	0	0	0	0	0	0.0	1405	0	0	0	1405	1633.7
					0	0	0	0	0	0.0	4144	0	0	0	4144	828.8
		REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		3	POOLS	239	0.0	0.0	0.0	0.0	0.0	0.0	1117.2	0.0	0.0	0.0	1117.2	828.8
		3	RUNS	88	0.0	0.0	0.0	0.0	0.0	A&J	34.1	0.0	0.0	0.0	34.1	A&J
		3	POW	173	0.0	0.0	0.0	0.0	0.0	0.0	834.7	0.0	0.0	0.0	834.7	0.0
JULY	1999	4	POOL	253	0	0	0	0	0	0.0	1193	0	0	0	1193	471.5
JULY	1999	4	RUN	87	0	0	0	0	0	0.0	320	0	0	0	320	367.8
JULY	1999	4	POW	54	0	0	0	0	0	0.0	120	0	0	0	120	222.2
JULY	1999	4	POOL	56	0	0	0	0	0	0.0	390	0	0	0	390	696.4
JULY	1999	4	RUN	74	0	0	0	0	0	0.0	150	0	0	0	150	202.7
JULY	1999	4	POW	100	0	0	0	0	0	0.0	361	0	0	0	361	361.0
JULY	1999	4	POOL	82	0	0	0	0	0	0.0	81	0	0	0	81	98.8
JULY	1999	4	RUN	80	0	0	0	0	0	0.0	60	0	0	0	60	75.0
JULY	1999	4	RIFFLE	62	0	0	0	0	0	0.0	7	0	0	0	7	11.3
					0	0	0	0	0	0.0	2682	0	0	0	2682	316.3
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		4	POOLS	391	0.0	0.0	0.0	0.0	0.0	0.0	425.6	0.0	0.0	0.0	425.6	316.3
		4	RUNS	241	0.0	0.0	0.0	0.0	0.0	A&J	219.9	0.0	0.0	0.0	219.9	A&J
		4	POW	154	0.0	0.0	0.0	0.0	0.0	0.0	312.3	0.0	0.0	0.0	312.3	0.0
		4	RIFFLES	62	0.0	0.0	0.0	0.0	0.0		11.3	0.0	0.0	0.0	11.3	

Appendix 3-1. Poe Snorkeling Fish Survey - Octob 992, July 1999, October 1999, and June 2000

					SMB	SMB	SMB	SMB	ALL		OTHER	OTHER	OTHER	OTHER	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
OCT	1999	1	RUN	177	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	1	POOL	127	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	1	RIFFLE	43	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	1	POOL	158	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	1	RIFFLE	68	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	1	RUN	132	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	1	RUN	135	0	0	1	1	1	0.7	0	0	0	0	0	0.0
OCT	1999	1	POOL	282	0	0	0	0	0	0.0	1	0	0	0	1	0.4
				1122	0	0	1	1	1	0.1	1	0	0	0	1	0.1
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		1	POOLS	567	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.1
		1	RUNS	444	0.0	0.0	0.2	0.2	0.2	A&J	0.0	0.0	0.0	0.0	0.0	A&J
		1	RIFFLES	111	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
OCT	1999	2	POOL	298	0	0	0	0	0	0.0	0	0	1	1	1	0.3
OCT	1999	2	POW	61	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	2	RUN	91	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	2	RUN	85	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	2	POOL	60	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	2	RIFFLE	52	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	2	RUN	36	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	2	POOL	172	0	0	0	0	0	0.0	0	0	0	0	0	0.0
				855	0	0	0	0	0	0.0	0	0	1	1	1	0.1
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		2	POOLS	530	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.0
		2	RUNS	212	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0.0	0.0	0.0	0.0	A&J
		2	POW	61	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
		2	RIFFLES	52	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	

					SMB	SMB	SMB	SMB	ALL		OTHER	OTHER	OTHER	OTHER	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
OCT	1999	3	POOL	58	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	3	RUN	60	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	3	RUN	29	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	3	POOL	76	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	3	POW	57	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	3	POOL	116	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	3	POW	108	0	0	0	0	0	0.0	0	0	0	0	0	0.0
				504	0	0	0	0	0	0.0	0	0	0	0	0	0.0
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		3	POOLS	250	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		3	RUNS	89	0.0	0.0	0.0	0.0	0.0	A&J	0.0	0.0	0.0	0.0	0.0	A&J
		3	POW	165	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OCT	1999	4	POOL	269	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	RUN	81	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	POW	64	0	0	0	0	0	0.0	2	0	0	0	2	3.1
OCT	1999	4	POOL	55	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	RUN	70	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	POW	103	0	0	0	0	0	0.0	0	0	0	0	0	0.0
OCT	1999	4	POOL	82	0	0	0	0	0	0.0	1	0	0	0	1	1.2
OCT	1999	4	RUN	103	0	0	0	0	0	0.0	41	0	0	0	41	39.8
OCT	1999	4	RIFFLE	60	0	0	0	0	0	0.0	7	0	0	0	7	11.7
				887	0	0	0	0	0	0.0	51	0	0	0	51	5.7
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
		4	POOLS	406	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2	5.7
		4	RUNS	254	0.0	0.0	0.0	0.0	0.0	A&J	16.1	0.0	0.0	0.0	16.1	A&J
		4	POW	167	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	1.2	0.0
		4	RIFFLES	60	0.0	0.0	0.0	0.0	0.0		11.7	0.0	0.0	0.0	11.7	

Appendix 3-1. Poe Snorkeling Fish Survey - Octob 992, July 1999, October 1999, and June 2000

JUNE	2000				SMB	SMB	SMB	SMB	ALL		OTHER	OTHER	OTHER	OTHER	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
JUNE	2000	1	RUN	165	0	0	0	0	0	0.0	95	0	0	0	95	57.6
JUNE	2000	1	POOL	119	0	0	0	0	0	0.0	5	0	0	0	5	4.2
JUNE	2000	1	RIFFLE	58	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	1	POOL	215	0	0	0	0	0	0.0	250	0	0	0	250	116.3
JUNE	2000	1	RIFFLE	80	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	1	RUN	134	0	0	0	0	0	0.0	98	0	0	0	98	73.1
JUNE	2000	1	RUN	120	0	0	0	0	0	0.0	310	0	0	0	310	258.3
JUNE	2000	1	POOL	258	0	0	1	1	1	0.4	230	0	0	0	230	89.1
				1149	0	0	1	1	1	0.1	988	0	0	0	988	86.0
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
JUNE	2000	1	POOLS	592	0.0	0.0	0.2	0.2	0.2	0.0	81.9	0.0	0.0	0.0	81.9	86.0
JUNE	2000	1	RUNS	419	0.0	0.0	0.0	0.0	0.0	A&J	120.0	0.0	0.0	0.0	120.0	A&J
JUNE	2000	1	RIFFLES	138	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
JUNE	2000	2	POOL	239	0	3	6	9	9	3.8	375	0	0	0	375	156.9
JUNE	2000	2	POW	60	0	0	2	2	2	3.3	7	0	0	0	7	11.7
JUNE	2000	2	RUN	87	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	2	RUN	85	0	0	1	1	1	1.2	0	0	0	0	0	0.0
JUNE	2000	2	POOL	53	0	0	0	0	0	0.0	7	0	0	0	7	13.2
JUNE	2000	2	RIFFLE	52	0	0	0	0	0	0.0	3	0	0	0	3	5.8
JUNE	2000	2	RUN	36	0	0	0	0	0	0.0	17	0	0	0	17	47.2
JUNE	2000	2	POOL	172	0	0	0	0	0	0.0	300	0	0	0	300	174.4
				784	0	3	9	12	12	1.5	709	0	0	0	709	90.4
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
JUNE	2000	2	POOLS	464	0.0	0.6	1.3	1.9	1.9	0.0	147.0	0.0	0.0	0.0	147.0	90.4
JUNE	2000	2	RUNS	208	0.0	0.0	0.5	0.5	0.5	A&J	8.2	0.0	0.0	0.0	8.2	A&J
JUNE	2000	2	POW	60	0.0	0.0	3.3	3.3	3.3	1.5	11.7	0.0	0.0	0.0	11.7	0.0
JUNE	2000	2	RIFFLES	52	0.0	0.0	0.0	0.0	0.0		5.8	0.0	0.0	0.0	5.8	

					SMB	SMB	SMB	SMB	ALL		OTHER	OTHER	OTHER	OTHER	ALL	
MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft	YOY	JUV	AD	A&J	SIZES	/100 ft
JUNE	2000	3	POOL	49	0	0	0	0	0	0.0	46	0	0	0	46	93.9
JUNE	2000	3	RUN	59	0	0	0	0	0	0.0	134	0	0	0	134	227.1
JUNE	2000	3	RUN	29	0	0	0	0	0	0.0	120	0	0	0	120	413.8
JUNE	2000	3	POOL	74	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	3	POW	87	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	3	POOL	116	0	0	1	1	1	0.9	50	0	0	0	50	43.1
JUNE	2000	3	POW	86	0	0	0	0	0	0.0	70	0	0	0	70	81.4
				500	0	0	1	1	1	0.2	420	0	0	0	420	84.0
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
JUNE	2000	3	POOLS	239	0.0	0.0	0.4	0.4	0.4	0.0	40.2	0.0	0.0	0.0	40.2	84.0
JUNE	2000	3	RUNS	88	0.0	0.0	0.0	0.0	0.0	A&J	288.6	0.0	0.0	0.0	288.6	A&J
JUNE	2000	3	POW	173	0.0	0.0	0.0	0.0	0.0	0.2	40.5	0.0	0.0	0.0	40.5	0.0
JUNE	2000	4	POOL	253	0	0	0	0	0	0.0	800	0	0	0	800	316.2
JUNE	2000	4	RUN	87	0	0	0	0	0	0.0	530	0	0	0	530	609.2
JUNE	2000	4	POW	54	0	0	0	0	0	0.0	150	0	0	0	150	277.8
JUNE	2000	4	POOL	56	0	0	0	0	0	0.0	0	0	0	0	0	0.0
JUNE	2000	4	RUN	74	0	0	0	0	0	0.0	75	0	0	0	75	101.4
JUNE	2000	4	POW	100	0	0	0	0	0	0.0	85	0	0	0	85	85.0
JUNE	2000	4	POOL	82	0	0	0	0	0	0.0	1500	0	0	0	1500	1829.3
JUNE	2000	4	RUN	80	0	0	0	0	0	0.0	500	0	0	0	500	625.0
JUNE	2000	4	RIFFLE	62	0	0	0	0	0	0.0	200	0	0	0	200	322.6
				848	0	0	0	0	0	0.0	3840	0	0	0	3840	452.8
		REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY
JUNE	2000	4	POOLS	391	0.0	0.0	0.0	0.0	0.0	0.0	588.2	0.0	0.0	0.0	588.2	452.8
JUNE	2000	4	RUNS	241	0.0	0.0	0.0	0.0	0.0	A&J	458.5	0.0	0.0	0.0	458.5	A&J
JUNE	2000	4	POW	154	0.0	0.0	0.0	0.0	0.0	0.0	152.6	0.0	0.0	0.0	152.6	0.0
JUNE	2000	4	RIFFLES	62	0.0	0.0	0.0	0.0	0.0		322.6	0.0	0.0	0.0	322.6	

Appendix 3-1. Poe Snorkeling Fish Survey - Octob 1992, July 1999, October 1999, and June 2000

						CARP	CARP	CARP	CARP	ALL	All Sizes		DACE	All Sizes	CULPIN	All Sizes
	MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft		All Sizes	/100 ft	L SIZES	/100 ft
	OCT	1992	1	RUN	61	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	1	LGR	318	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	1	LSP-BO	89	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	1	LSP-BO	217	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	1	LGR	57	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	1	RUN	43	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	1	POOL-MC	161	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	1	RUN	27	0	0	0	0	0	0.0		0	0.0	0	0.0
					973	0	0	0	0	0	0.0		0	0.0	0	0.0
			REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
			1	POOLS	467	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
			1	RUNS	131	0.0	0.0	0.0	0.0	0.0	A&J		0.0		0.0	
			1	RIFFLES	375	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
	OCT	1992	2	POOL-LSB	680	0	0	2	2	2	0.3		0	0.0	0	0.0
	OCT	1992	2	POW	106	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	2	RUN	54	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	2	POOL-MC	756	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	2	RUN	70	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	2	LGR	21	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	2	GLIDE	80	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	2	POOL-LSB/MC	328	0	0	0	0	0	0.0		0	0.0	0	0.0
						0	0	2	2	2	0.1		0	0.0	0	0.0
			REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
			2	POOLS	1764	0.0	0.0	0.1	0.1	0.1	0.0		0.0		0.0	
			2	POW	106	0.0	0.0	0.0	0.0	0.0	A&J		0.0		0.0	
			2	RUNS/GLIDES	204	0.0	0.0	0.0	0.0	0.0	0.1		0.0		0.0	
			2	RIFFLES	21	0.0	0.0	0.0	0.0	0.0			0.0		0.0	

						CARP	CARP	CARP	CARP	ALL			DACE		SCULPIN	
	MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft		ALL.SIZES	/100 ft	L SIZES	/100 ft
	OCT	1992	3	RUN	24	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	3	POOL-LSB	124	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	3	POW	33	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	3	POOL-PLUNGE	45	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	3	RUN	40	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	3	POOL	50	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	3	POW	100	0	0	0	0	0	0.0		0	0.0	0	0.0
						0	0	0	0	0	0.0		0	0.0	0	0.0
			REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
			3	POOLS	219	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
			3	RUNS	64	0.0	0.0	0.0	0.0	0.0	A&J		0.0		0.0	
			3	POW	133	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
	OCT	1992	4	POOL-LSB	102	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	4	RUN	20	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	4	RUN	73	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	4	POW	289	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	4	POOL-LSB	78	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	4	LGR	80	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	4	RUN	109	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	4	POOL-MC	59	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1992	4	POW	147	0	0	0	0	0	0.0		0	0.0	0	0.0
						0	0	0	0	0	0.0		0	0.0	0	0.0
			REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
			4	POOLS	239	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
			4	RUNS	202	0.0	0.0	0.0	0.0	0.0	A&J		0.0		0.0	
			4	POW	436	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
			4	RIFFLES	80	0.0	0.0	0.0	0.0	0.0			0.0		0.0	

Appendix 3-1. Poe Snorkeling Fish Survey - Octot 1992, July 1999, October 1999, and June 2000

						CARP	CARP	CARP	SKR	ALL			DACE		SCULPIN	
	MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft		ALL SIZES	/100 ft	L SIZES	/100 ft
	JULY	1999	1	RUN	165	0	0	0	0	0	0.0		13	7.9	0	0.0
	JULY	1999	1	POOL	119	0	0	0	0	0	0.0		6	5.0	0	0.0
	JULY	1999	1	RIFFLE	58	0	0	0	0	0	0.0		1	1.7	0	0.0
	JULY	1999	1	POOL	127	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	1	RIFFLE	80	0	0	0	0	0	0.0		4	5.0	0	0.0
	JULY	1999	1	RUN	97	0	0	0	0	0	0.0		0	0.0	1	1.0
	JULY	1999	1	RUN	120	0	0	0	0	0	0.0		5	4.2	0	0.0
	JULY	1999	1	POOL	258	0	0	1	1	1	0.4		1	0.4	0	0.0
						0	0	1	1	1	0.1		30	2.9	1	0.1
			REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
			1	POOLS	504	0.0	0.0	0.2	0.2	0.2	0.0		1.4		0.0	
			1	RUNS	382	0.0	0.0	0.0	0.0	0.0	A&J		4.7		0.3	
			1	RIFFLES	138	0.0	0.0	0.0	0.0	0.0	0.1		3.6		0.0	
	JULY	1999	2	POOL	239	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	2	POW	60	0	0	0	0	0	0.0		6	10.0	0	0.0
	JULY	1999	2	RUN	87	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	2	RUN	85	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	2	POOL	53	0	0	0	0	0	0.0		1	1.9	0	0.0
	JULY	1999	2	RIFFLE	52	0	0	0	0	0	0.0		1	1.9	0	0.0
	JULY	1999	2	RUN	36	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	2	POOL	172	0	0	1	1	1	0.6		0	0.0	0	0.0
						0	0	1	1	1	0.1		8	1.0	0	0.0
			REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
			2	POOLS	464	0.0	0.0	0.2	0.2	0.2	0.0		0.2		0.0	
			2	RUNS	208	0.0	0.0	0.0	0.0	0.0	A&J		0.0		0.0	
			2	POW	60	0.0	0.0	0.0	0.0	0.0	0.1		10.0		0.0	
			2	RIFFLES	52	0.0	0.0	0.0	0.0	0.0			1.9		0.0	

						CARP	CARP	CARP	CARP	ALL			DACE		SCULPIN	
	MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft		ALL SIZES	/100 ft	L SIZES	/100 ft
	JULY	1999	3	POOL	49	0	0	0	0	0	0.0		3	6.1	0	0.0
	JULY	1999	3	RUN	59	0	0	0	0	0	0.0		1	1.7	0	0.0
	JULY	1999	3	RUN	29	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	3	POOL	74	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	3	POW	87	0	0	0	0	0	0.0		1	1.1	0	0.0
	JULY	1999	3	POOL	116	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	3	POW	86	0	0	0	0	0	0.0		0	0.0	0	0.0
						0	0	0	0	0	0.0		5	1.0	0	0.0
			REACH			#/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
			3	POOLS	239	0.0	0.0	0.0	0.0	0.0	0.0		1.3		0.0	
			3	RUNS	88	0.0	0.0	0.0	0.0	0.0	A&J		1.1		0.0	
			3	POW	173	0.0	0.0	0.0	0.0	0.0	0.0		0.6		0.0	
	JULY	1999	4	POOL	253	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	4	RUN	87	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	4	POW	54	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	4	POOL	56	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	4	RUN	74	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	4	POW	100	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	4	POOL	82	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	4	RUN	80	0	0	0	0	0	0.0		0	0.0	0	0.0
	JULY	1999	4	RIFFLE	62	0	0	0	0	0	0.0		0	0.0	0	0.0
						0	0	0	0	0	0.0		0	0.0	0	0.0
			REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
			4	POOLS	391	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
			4	RUNS	241	0.0	0.0	0.0	0.0	0.0	A&J		0.0		0.0	
			4	POW	154	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
			4	RIFFLES	62	0.0	0.0	0.0	0.0	0.0			0.0		0.0	

Appendix 3-1. Poe Snorkeling Fish Survey - Octob 992, July 1999, October 1999, and June 2000

						CARP	CARP	CARP	CARP	ALL			DACE		SCULPIN	
	MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft		ALL SIZES	/100 ft	L SIZES	/100 ft
	OCT	1999	1	RUN	177	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	1	POOL	127	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	1	RIFFLE	43	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	1	POOL	158	0	0	0	0	0	0.0		2	1.3	0	0.0
	OCT	1999	1	RIFFLE	68	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	1	RUN	132	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	1	RUN	135	0	0	0	0	0	0.0		0	0.0	2	1.5
	OCT	1999	1	POOL	282	0	0	0	0	0	0.0		0	0.0	0	0.0
					1122	0	0	0	0	0	0.0		2	0.2	2	0.2
			REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
			1	POOLS	567	0.0	0.0	0.0	0.0	0.0	0.0		0.4		0.0	
			1	RUNS	444	0.0	0.0	0.0	0.0	0.0	A&J		0.0		0.5	
			1	RIFFLES	111	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
	OCT	1999	2	POOL	298	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	2	POW	61	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	2	RUN	91	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	2	RUN	85	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	2	POOL	60	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	2	RIFFLE	52	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	2	RUN	36	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	2	POOL	172	0	0	0	0	0	0.0		0	0.0	0	0.0
					855	0	0	0	0	0	0.0		0	0.0	0	0.0
			REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
			2	POOLS	530	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
			2	RUNS	212	0.0	0.0	0.0	0.0	0.0	A&J		0.0		0.0	
			2	POW	61	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
			2	RIFFLES	52	0.0	0.0	0.0	0.0	0.0			0.0		0.0	

						CARP	CARP	CARP	CARP	ALL			DACE		SCULPIN	
	MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft		ALL SIZES	/100 ft	L SIZES	/100 ft
	OCT	1999	3	POOL	58	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	3	RUN	60	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	3	RUN	29	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	3	POOL	76	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	3	POW	57	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	3	POOL	116	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	3	POW	108	0	0	0	0	0	0.0		0	0.0	0	0.0
					504	0	0	0	0	0	0.0		0	0.0	0	0.0
			REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
			3	POOLS	250	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
			3	RUNS	89	0.0	0.0	0.0	0.0	0.0	A&J		0.0		0.0	
			3	POW	165	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
	OCT	1999	4	POOL	269	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	4	RUN	81	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	4	POW	64	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	4	POOL	55	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	4	RUN	70	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	4	POW	103	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	4	POOL	82	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	4	RUN	103	0	0	0	0	0	0.0		0	0.0	0	0.0
	OCT	1999	4	RIFFLE	60	0	0	0	0	0	0.0		0	0.0	0	0.0
					887	0	0	0	0	0	0.0		0	0.0	0	0.0
			REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
			4	POOLS	406	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
			4	RUNS	254	0.0	0.0	0.0	0.0	0.0	A&J		0.0		0.0	
			4	POW	167	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
			4	RIFFLES	60	0.0	0.0	0.0	0.0	0.0			0.0		0.0	

Appendix 3-1. Poe Snorkeling Fish Survey - Octob 992, July 1999, October 1999, and June 2000

	JUNE	2000				CARP	CARP	CARP	CARP	ALL			DACE		BASS	
	MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft		ALL SIZES	/100 ft	L SIZES	/100 ft
	JUNE	2000	1	RUN	165	0	0	0	0	0	0.0		3	1.8	0	0.0
	JUNE	2000	1	POOL	119	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	1	RIFFLE	58	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	1	POOL	215	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	1	RIFFLE	80	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	1	RUN	134	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	1	RUN	120	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	1	POOL	258	0	0	0	0	0	0.0		0	0.0	0	0.0
					1149	0	0	0	0	0	0.0		3	0.3	0	0.0
			REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
	JUNE	2000	1	POOLS	592	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
	JUNE	2000	1	RUNS	419	0.0	0.0	0.0	0.0	0.0	A&J		0.7		0.0	
	JUNE	2000	1	RIFFLES	138	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
	JUNE	2000	2	POOL	239	0	0	0	0	0	0.0		0	0.0	1	0.4
	JUNE	2000	2	POW	60	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	2	RUN	87	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	2	RUN	85	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	2	POOL	53	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	2	RIFFLE	52	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	2	RUN	36	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	2	POOL	172	0	0	4	4	4	2.3		0	0.0	0	0.0
					784	0	0	4	4	4	0.5		0	0.0	1	0.1
			REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
	JUNE	2000	2	POOLS	464	0.0	0.0	0.9	0.9	0.9	0.0		0.0		0.2	
	JUNE	2000	2	RUNS	208	0.0	0.0	0.0	0.0	0.0	A&J		0.0		0.0	
	JUNE	2000	2	POW	60	0.0	0.0	0.0	0.0	0.0	0.5		0.0		0.0	
	JUNE	2000	2	RIFFLES	52	0.0	0.0	0.0	0.0	0.0			0.0		0.0	

						CARP	CARP	CARP	CARP	ALL			DACE		SCULPIN	
	MONTH	YEAR	REACH	TYPE	LENGTH	YOY	JUV	AD	A&J	SIZES	/100 ft		ALL SIZES	/100 ft	L SIZES	/100 ft
	JUNE	2000	3	POOL	49	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	3	RUN	59	0	0	0	0	0	0.0		1	1.7	0	0.0
	JUNE	2000	3	RUN	29	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	3	POOL	74	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	3	POW	87	0	0	0	0	0	0.0		1	1.1	0	0.0
	JUNE	2000	3	POOL	116	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	3	POW	86	0	0	0	0	0	0.0		0	0.0	0	0.0
					500	0	0	0	0	0	0.0		2	0.4	0	0.0
			REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
	JUNE	2000	3	POOLS	239	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
	JUNE	2000	3	RUNS	88	0.0	0.0	0.0	0.0	0.0	A&J		1.1		0.0	
	JUNE	2000	3	POW	173	0.0	0.0	0.0	0.0	0.0	0.0		0.6		0.0	
	JUNE	2000	4	POOL	253	0	0	0	0	0	0.0		5	2.0	0	0.0
	JUNE	2000	4	RUN	87	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	4	POW	54	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	4	POOL	56	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	4	RUN	74	0	0	0	0	0	0.0		1	1.4	0	0.0
	JUNE	2000	4	POW	100	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	4	POOL	82	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	4	RUN	80	0	0	0	0	0	0.0		0	0.0	0	0.0
	JUNE	2000	4	RIFFLE	62	0	0	0	0	0	0.0		0	0.0	0	0.0
					848	0	0	0	0	0	0.0		6	0.7	0	0.0
			REACH		LENGTH	/100 ft	/100 ft	/100 ft	/100 ft	/100 ft	YOY		#/100 ft		#/100 ft	
	JUNE	2000	4	POOLS	391	0.0	0.0	0.0	0.0	0.0	0.0		1.3		0.0	
	JUNE	2000	4	RUNS	241	0.0	0.0	0.0	0.0	0.0	A&J		0.4		0.0	
	JUNE	2000	4	POW	154	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	
	JUNE	2000	4	RIFFLES	62	0.0	0.0	0.0	0.0	0.0			0.0		0.0	

POE HYDROELECTRIC PROJECT

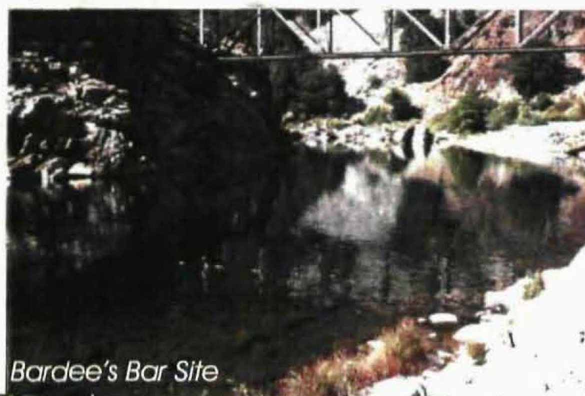
FERC NO. 2107

APPENDIX E3-2

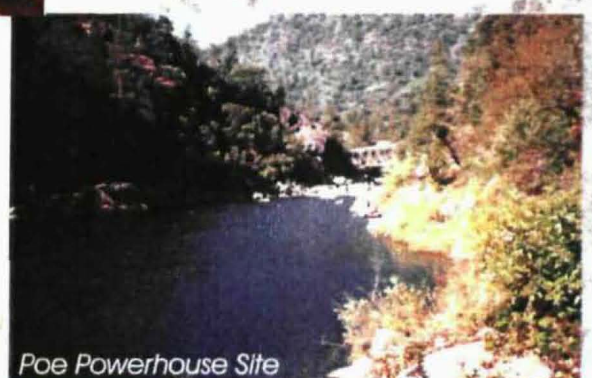
Poe Project River Pool Fisheries Survey
North Fork Feather River

PG&E Poe Project
River Pool Fisheries Survey
North Fork Feather River


Mill Creek Confluence Site


Bardee's Bar Site


Common Carp


Poe Powerhouse Site

October 2000

Prepared for:

Pacific Gas and Electric Company
Technical and Ecological Services
3400 Crow Canyon Road
San Ramon, California 94583

Prepared by:

EA Engineering, Science, and Technology
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EA Engineering, Science, and Technology, Inc.

POE PROJECT RIVER POOL FISHERIES SURVEY

Prepared for:
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October 2000

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ACKNOWLEDGMENTS

Many individuals contributed to this investigation of fish populations in pools of the Poe Project bypass reach on the Upper North Fork Feather River. Pacific Gas and Electric Company's project manager was Stuart Moock. EA field crew members included Wayne Swaney, Regina Argo, Coralie Dayde, Susan Palmer and Aurelien Dayde. Susan Palmer and Regina Argo provided data analysis and report preparation assistance. Scott Wilcox was the principal investigator and project manager.

1. INTRODUCTION

PG&E is in the process of relicensing the Poe Project on the Upper North Fork Feather River. As part of relicensing under the Federal Energy Regulatory Commission (FERC), technical studies are required for a variety of resource areas which are potentially affected by hydroelectric project operations. Due to the effects of the hydroelectric project on the aquatic environment, PG&E is conducting a fisheries survey to satisfy the requirements of FERC and various resource agencies such as the U.S. Fish and Wildlife Service (USFWS), U.S. Forest Service (USFS), and California Department of Fish and Game (CDFG).

While previous surveys have assessed the fish species composition and population characteristics of the Poe Project bypass reach, this report details the methods used and presents the sampling results for a study of selected large, deep pools in the reach. The additional information from this study of large pools is important for a better understanding of fish population dynamics in the bypass reach, and the possible influence of different flow or water temperature regimes on aquatic resources.

2. METHODS

2.1 SURVEY AREAS

The survey areas consisted of three large pools located near the Mill Creek Confluence, at Bardee's Bar, and above the Poe Powerhouse on the North Fork Feather River (Table 2-1). Estimated flows at the time of sampling were 120 cfs. Topographic maps with more detailed site locations are provided in Appendix A.

Table 2-1. Fish Population Survey Site Locations

Site	Township Range Section
Mill Creek Confluence	T23N R5E S32
Bardee's Bar	T22N R5E S7
Poe Powerhouse	T22N R4E S36

Within each site, the sampled pool was segmented into three or four areas (numbered downstream to upstream) of varying depth and width, and partitioned with gill nets (Table 2-2). The length of each sampling segment was measured along the thalweg or river's edge to the nearest foot, and ranged from 60 to 176 feet. The width of each sampling segment was measured across the wetted channel, and ranged from 90 to 201 feet. The approximate maximum depth of the segment was recorded up to 15 feet. Substrate and fish cover types were visually estimated at each site. Each sampling site was photographed to allow future sampling at the same location.

Table 2-2. Fish Population Survey Site Dimensions.

NORTH FORK FEATHER RIVER POE BYPASS REACH				
Location	Segment	Width (feet)	Length (feet)	Max. Depth (feet)
Mill Creek Confluence	1	150	120	11
	2	145	133.5	13.2
	3	134	176	8.2
Bardee's Bar	1	112	60	>15
	2	91	70	14
	3	67	82	>15
	4	116	78	13
Poe Powerhouse	1	172	61	11
	2	166	78	>15
	3	179	95	>15
	4	201	76	>15

2.2 SAMPLING METHODOLOGY

EA conducted fish sampling using a combination of boat electrofishing from a raft/barge platform and closely monitored gill netting. Each sampled river reach was partitioned into 3-4 segments with 4-5 100-foot long variable mesh gill nets. Mesh sizes ranged from 0.75 to 2.0 inches. The nets were stretched across the river, perpendicular to the thalweg, with the smaller mesh sizes in the shallower areas. In some cases, the nets spanned the river from bank to bank, but in most cases one side of the river was not blocked off.

A team of four people on the raft platform maneuvered a barge mounted Coffelt model VVP electrofisher systematically throughout the segment in order to thoroughly sample the area. Fish were captured either by stunning them directly with the electric field, or by herding or spooking them into the gill nets. Two anode pole operators used 8 foot and 11 foot long anode poles to stun and capture fish. The floating platform and long anode poles allowed for deeper sampling, in many cases extending to the bottom of the river. Deep and shallow bank areas were sampled from the "water side" of the segment, and fish were captured both along the banks and in mid-channel areas. The maximum depth for capture of fish was approximately 12 feet, although many more fish were captured in shallower areas with cover along the banks than in mid-channel areas.

Gill nets were checked repeatedly throughout the day, in order to minimize mortality of captured fish.

Each captured fish was identified to species, measured to the nearest millimeter total length, weighed to the nearest tenth of a gram, and returned to the stream outside of the sampling area.

2.3 SURVEY SCHEDULE

The fish population surveys were conducted according to the schedule in Table 2-3. Each pool was sampled in a one-day effort, which included daylight and twilight sampling. The daylight sampling effort was conducted from late morning to mid afternoon, and the twilight sampling effort was conducted from late afternoon to early evening. The final check of the gill nets began at approximately 6pm. The timing of the daylight and twilight sampling efforts was an effort to capture both daylight and twilight active species.

Table 2-3. Fish Population Survey Schedule. Daylight and Twilight Electrofishing in the North Fork Feather River Poe Bypass Reach.

Site	Date	Daylight Sampling	Twilight Sampling
Mill Creek Confluence	9/26/00	10:40am – 4:03pm	4:50pm – 6:30pm
Bardee's Bar	9/27/00	11:25am – 3:50pm	4:25pm – 5:50pm
Poe Powerhouse	9/28/00	11:26am – 4:37pm	4:44pm – 6:16pm

3. RESULTS

3.1 SPECIES COMPOSITION

Sacramento sucker, smallmouth bass, hardhead, Sacramento pikeminnow and riffle sculpin were captured at all three sampling sites within the Poe Project bypass reach on the North Fork Feather River in September 2000. Additionally, common carp and a rainbow trout were captured at Bardee's Bar, and common carp were captured at the Poe Powerhouse site. Sacramento sucker and hardhead were the dominant species near the Mill Creek Confluence and at Bardee's Bar; however, smallmouth bass was the dominant species at Poe Powerhouse (Figure 3.1-1). Crayfish were present at all three sites, though for the purposes of this study were not sampled.

For all species except riffle sculpin, individuals were classified as juvenile if their total length was less than 200 mm, or adult if their total length was greater than 200 mm. Riffle sculpin were classified as juvenile if their total length was less than 75 mm, or adult if their total length was greater than 75 mm. In terms of species numbers, at the Mill Creek Confluence, Sacramento sucker was the dominant adult species (Figure 3.1-2), while hardhead was the dominant juvenile species (Figure 3.1-3). This same pattern was also observed at Bardee's Bar; Sacramento sucker was the dominant adult species (Figure 3.1-4), and hardhead was the dominant juvenile species (Figure 3.1-5). Additionally, at Poe Powerhouse, Sacramento sucker was the dominant adult species (Figure 3.1-6); however, smallmouth bass was the dominant juvenile species (Figure 3.1-7).

3.2 ELECTROFISHING VERSUS GILL NETTING

At all sites, the majority of fish sampled were collected by stunning fish directly with the electrofisher and collecting them with dip nets (Figures 3.2-1 to 3.2-6); however, the species composition and size differed depending on the capture method. Sacramento sucker was the dominant species caught in the gill nets at all three sites: 82% at Mill Creek Confluence, 67% at Bardee's Bar and 69% at Poe Powerhouse (Figures 3.2-1 to 3.2-3). Hardhead was the dominant species caught by electrofishing at Mill Creek Confluence (44%) and Bardee's Bar (66%), though smallmouth bass (76%) was the dominant species caught at Poe Powerhouse. Histograms of the species' total length and method of capture show the general predominance of juveniles being caught by electrofishing and adults being caught in the gill nets; however, many adult Sacramento suckers and all three adult common carp were caught by electrofishing.

3.3 DAYLIGHT VERSUS TWILIGHT SAMPLING

Length frequency histograms by time of sampling were produced for all three sites. The daylight and twilight sampling efforts captured similar species and sizes for the Mill Creek Confluence and Poe Powerhouse sites; however, there was a decrease in the number of smallmouth bass caught at Bardee's Bar during the twilight sampling (Figures

3.3-1 to 3.3-3). At all three sites, a large proportion of the fish were captured during the daylight sampling. However, it should be noted that the daylight sampling was of longer duration than the twilight sampling, and that may account for much of the difference in results.

3.4 LENGTH-WEIGHT RELATIONSHIPS

All individuals were weighed to the nearest tenth of a gram, and measured to the nearest millimeter in total length. The total length-to-weight relationship was calculated and graphed for the most abundant species: hardhead, Sacramento pikeminnow, Sacramento sucker, smallmouth bass and sculpin (Figures 3.4-2 to 3.4-5). A polynomial regression and R^2 value of total length to weight was calculated for each species.

4. DISCUSSION

The use of electrofishers, gill nets, daylight and twilight sampling efforts had different effects on species capture in the Poe Project bypass reach on the North Fork Feather River.

Electrofishing was most effective in the shallower areas near the bank where there was sufficient cover. With the exception of a school of adult Sacramento suckers found at the Mill Creek Confluence site and several adult fish at Bardee's Bar, few fish were captured directly out of the deeper section of the pools. However, the larger fish may have been spooked into the gill nets by the electrofishing activity. The use of gill nets increased the numbers of adult fish caught, especially of Sacramento suckers.

The additional twilight sampling effort increased the total number of fish caught; however, daylight sampling appeared to be adequate to collect a range of species and size classes.

The sampling methods appeared to be effective for capturing a significant number of fish of varying species and size classes, from different types of habitat within the large pools. Estimates of species composition at different sites are considered fairly reliable (although no effort was made to capture all young-of-the-year hardhead along some of the river margins). Overall, numbers of captured fish at a site (adjusted for sampling time and area) may be indicative of relative population levels between sites, but the lack of any controlled depletion of fish in the segments (and the inability to sample the deepest areas) would make any population estimates speculative.

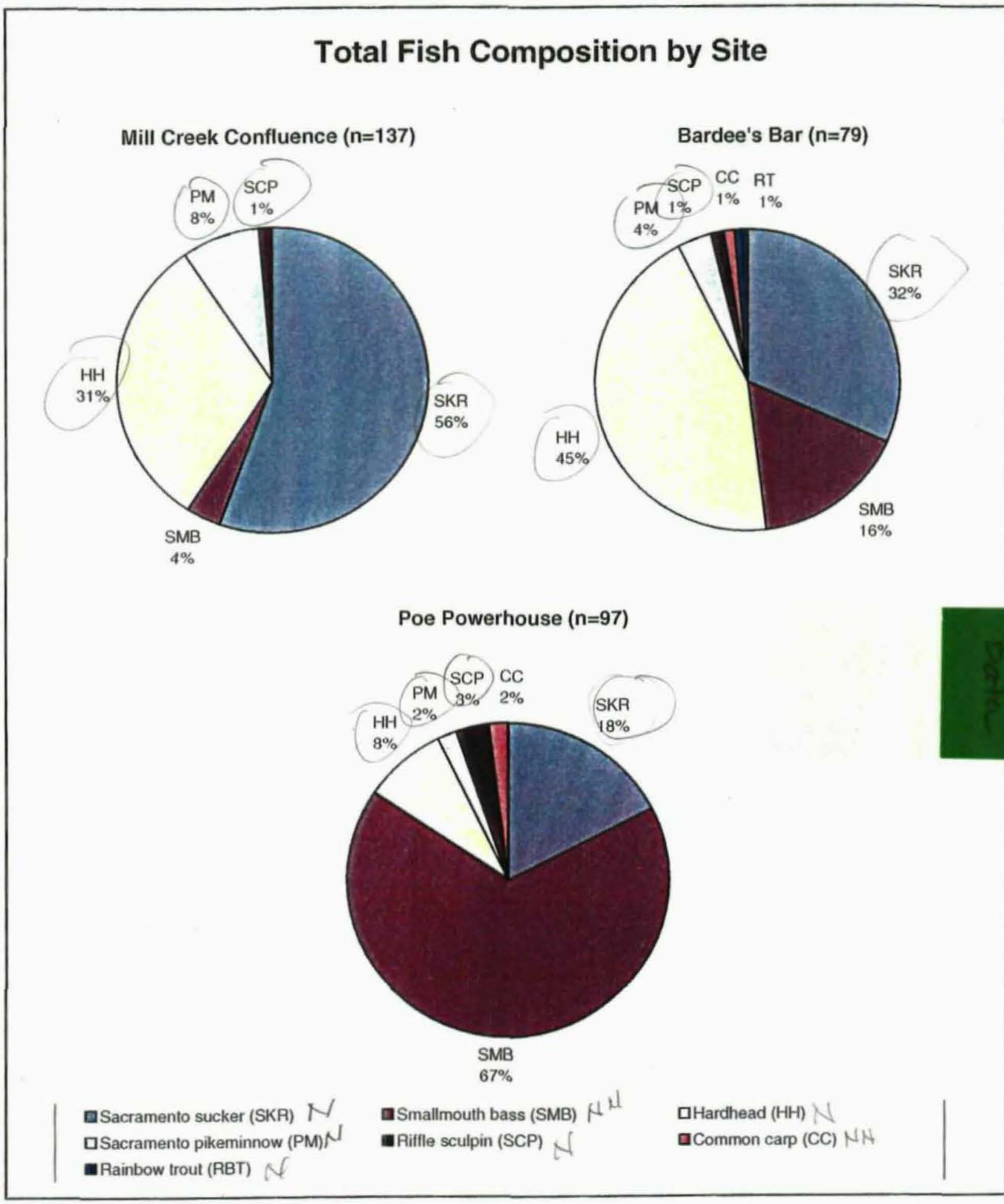


Figure 3.1-1: North Fork Feather River. Total fish composition by site (Mill Creek Confluence, Bardee's Bar, Poe Powerhouse).

No Rainbow T.

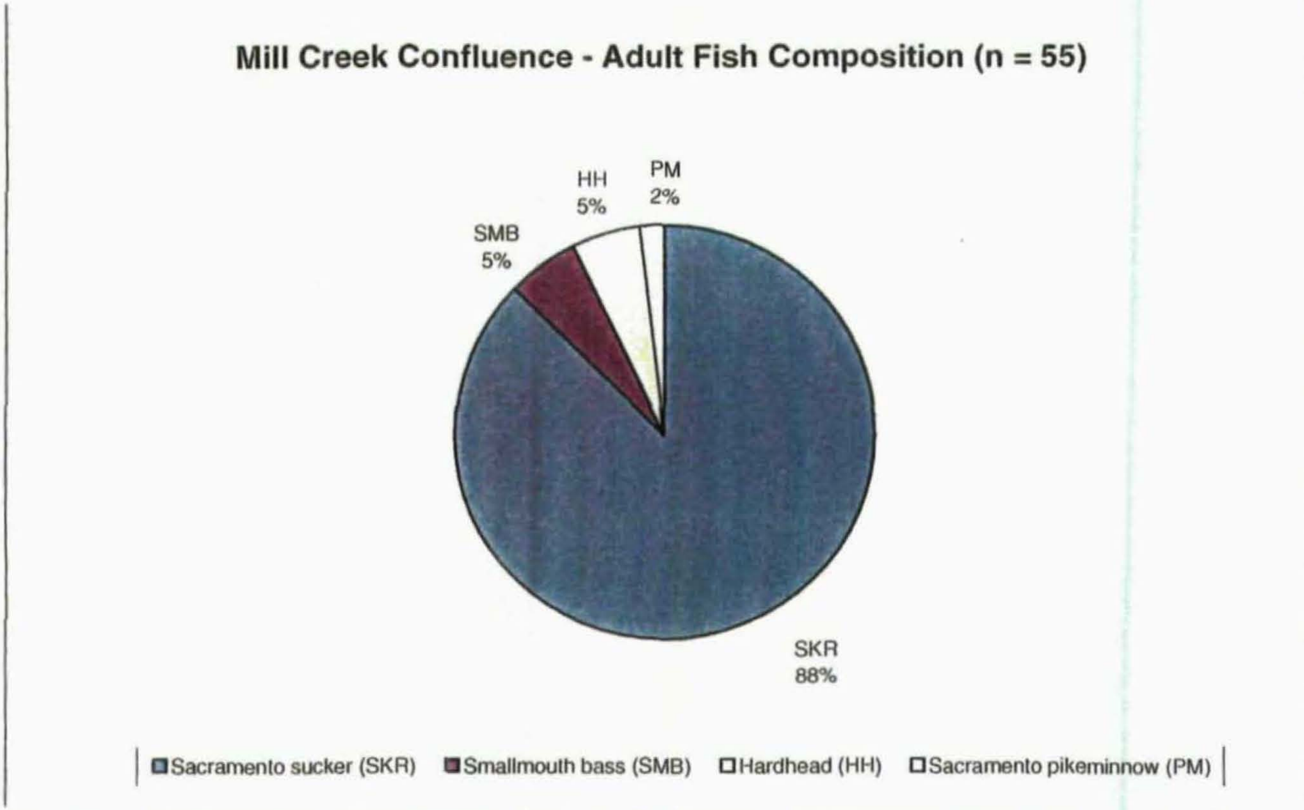


Figure 3.1-2: North Fork Feather River at Mill Creek Confluence. Adult fish composition by species. (Total length > 200mm).

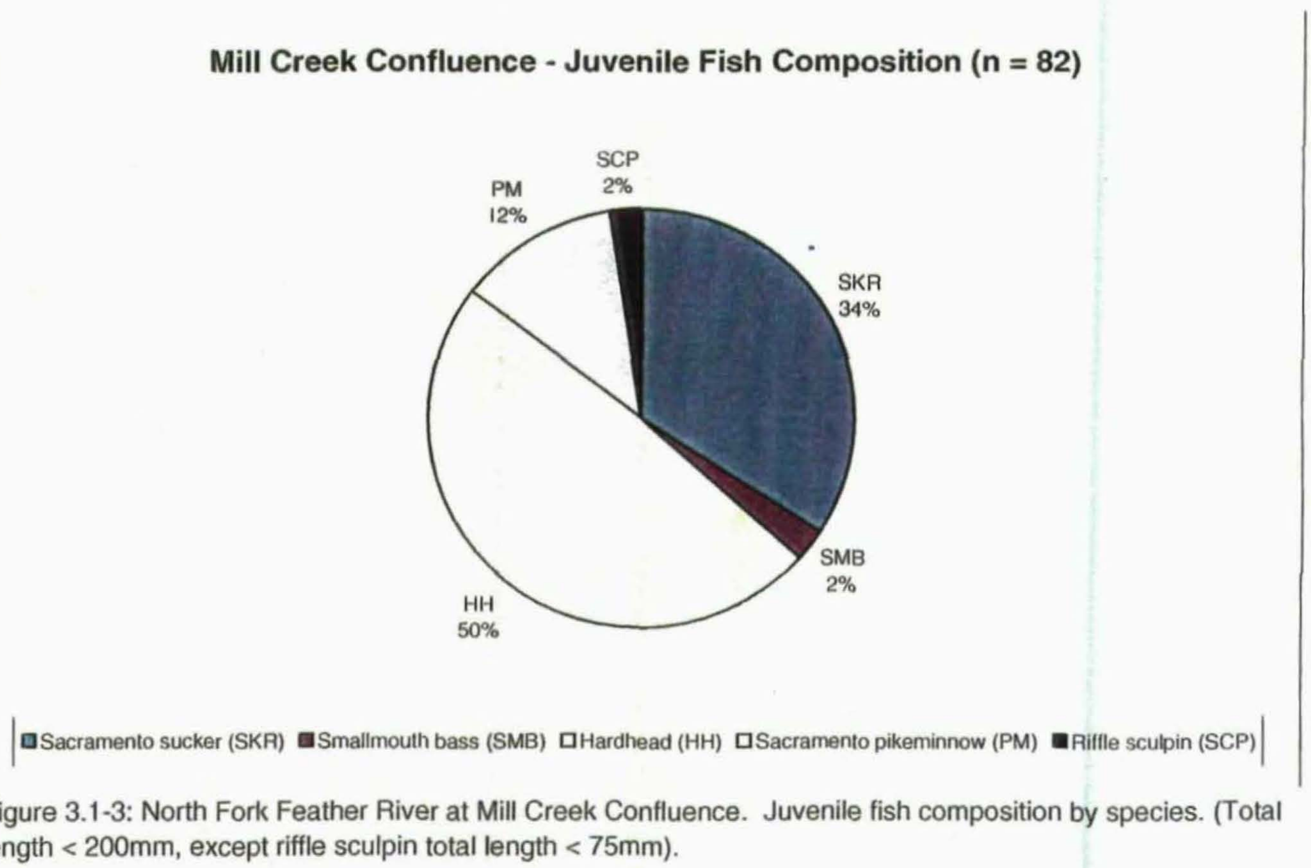


Figure 3.1-3: North Fork Feather River at Mill Creek Confluence. Juvenile fish composition by species. (Total length < 200mm, except riffle sculpin total length < 75mm).

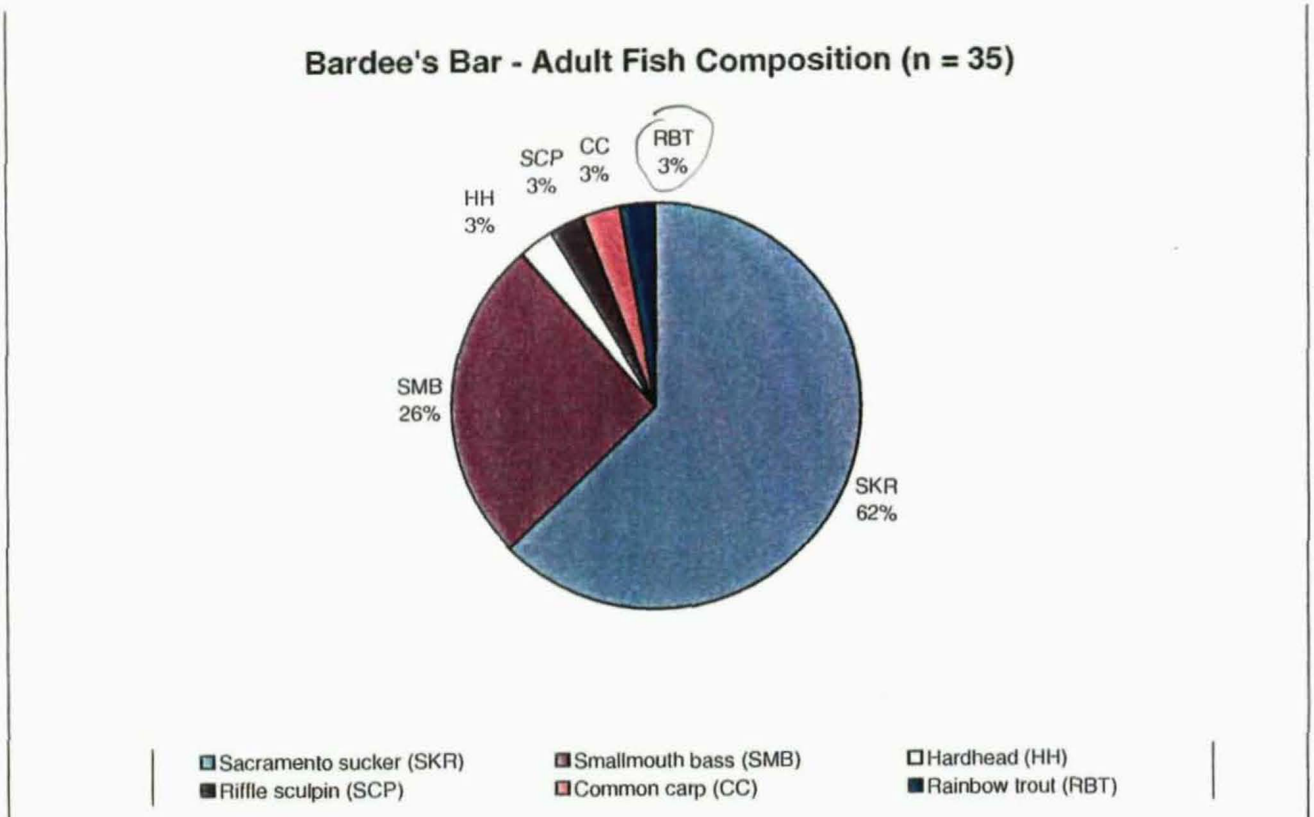


Figure 3.1-4: North Fork Feather River at Bardee's Bar. Adult fish composition by species. (Total length > 200mm, except riffle sculpin total length > 75mm).

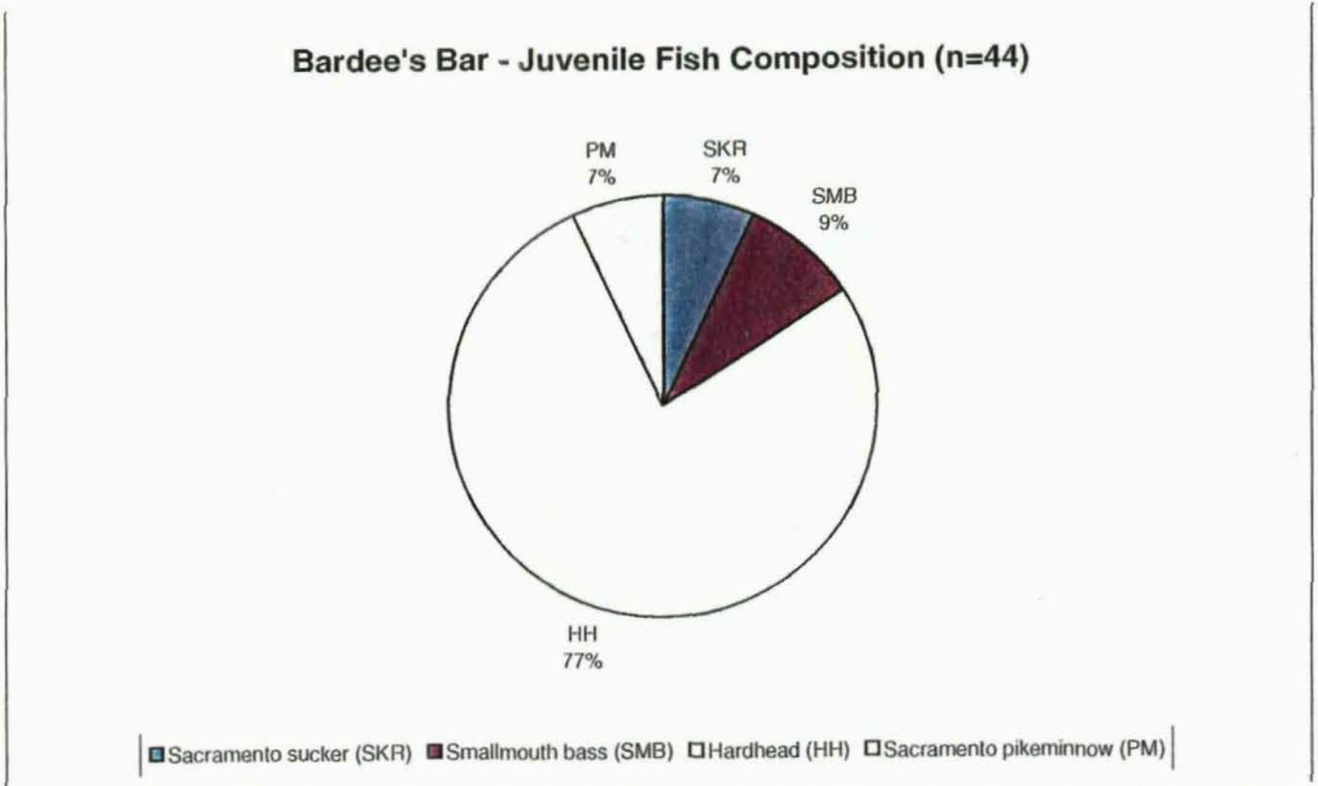


Figure 3.1-5: North Fork Feather River at Bardee's Bar. Juvenile fish composition by species. (Total length < 200mm).

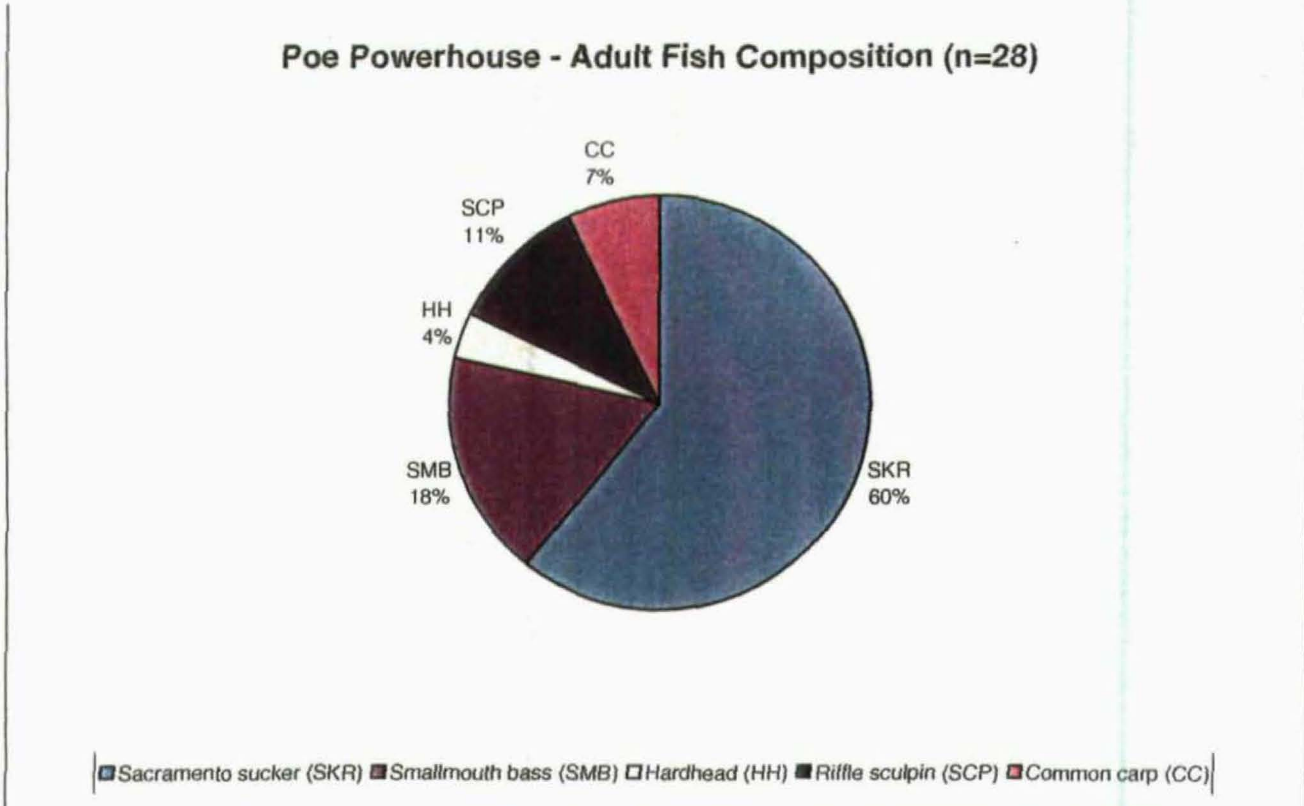


Figure 3.1-6: North Fork Feather River at Poe Powerhouse. Adult fish composition by species. (Total length > 200mm, except riffle sculpin total length > 75mm).

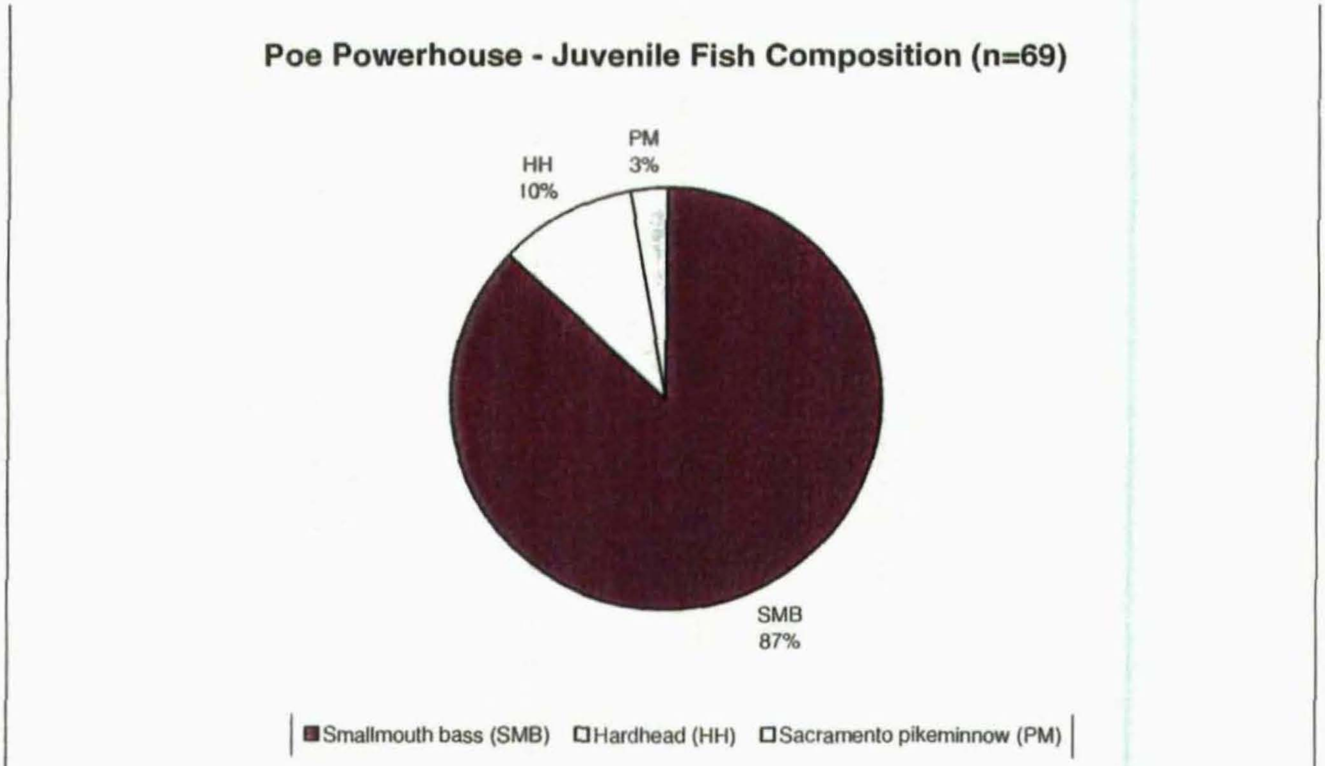


Figure 3.1-7: North Fork Feather River at Poe Powerhouse. Juvenile fish composition by species. (Total length < 200mm).

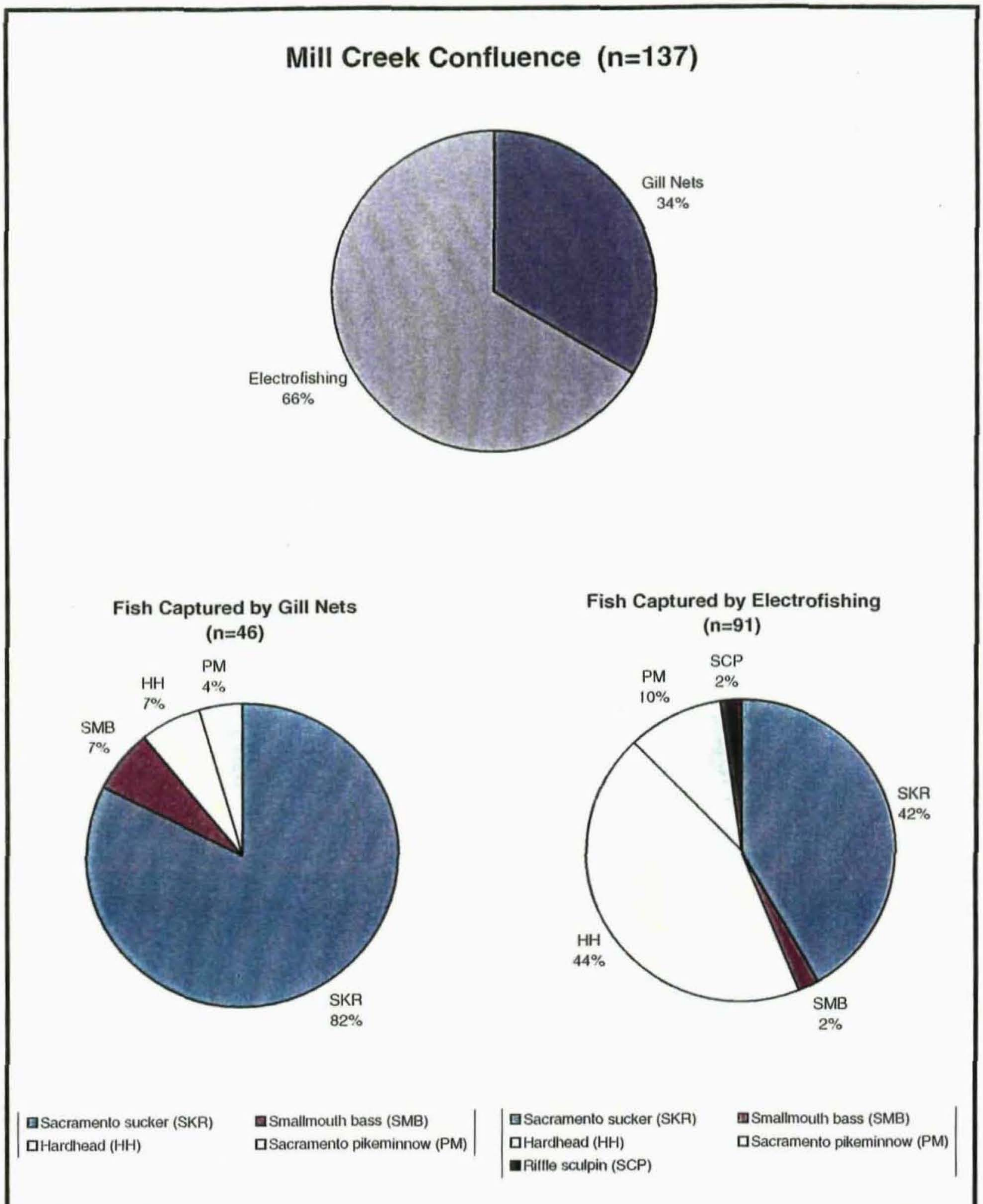


Figure 3.2-1: North Fork Feather River at Mill Creek Confluence. Species composition by method of capture (gill nets and electrofishing).

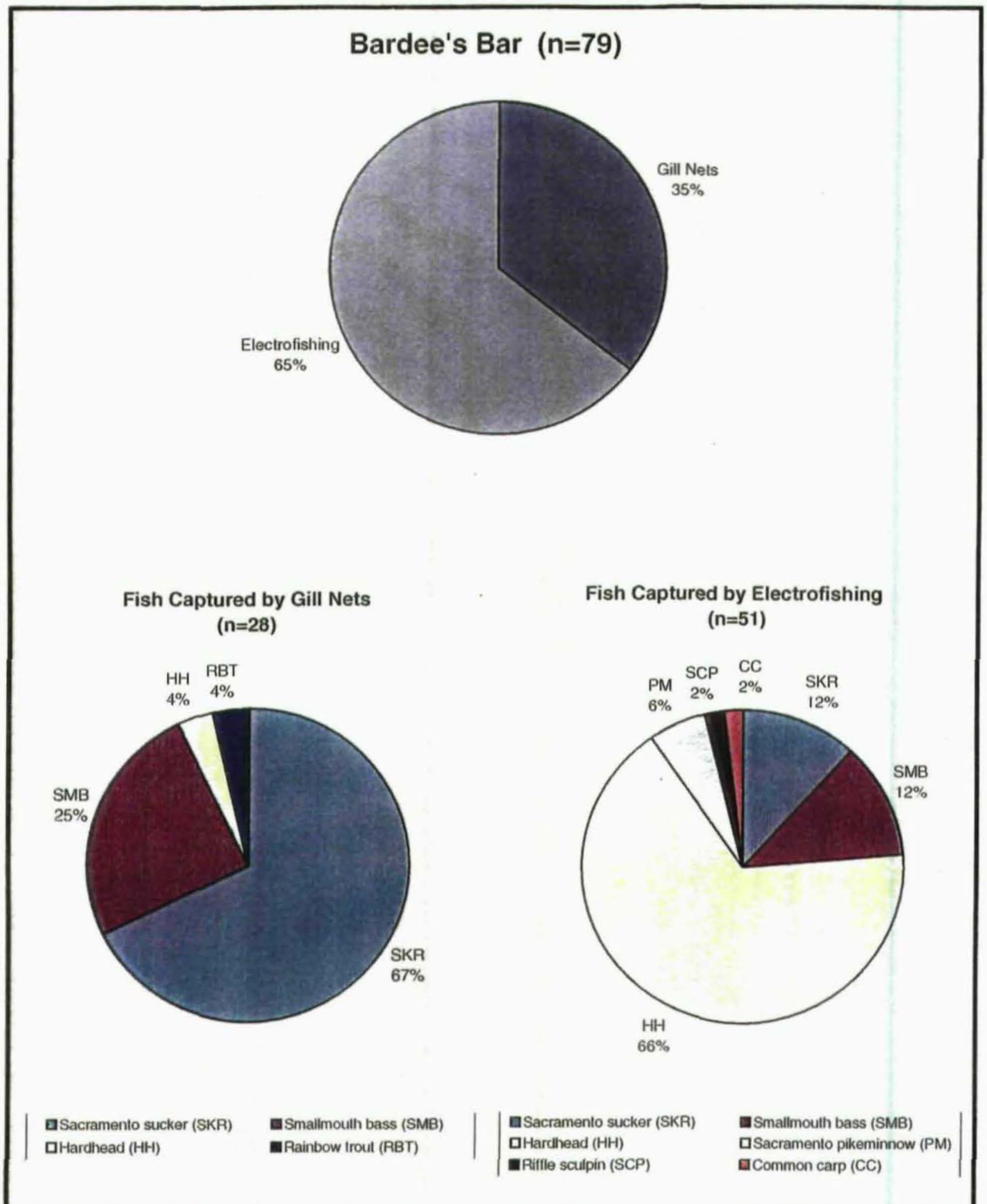


Figure 3.2-2: North Fork Feather River at Bardee's Bar. Species composition by method of capture (gill nets and electrofishing).

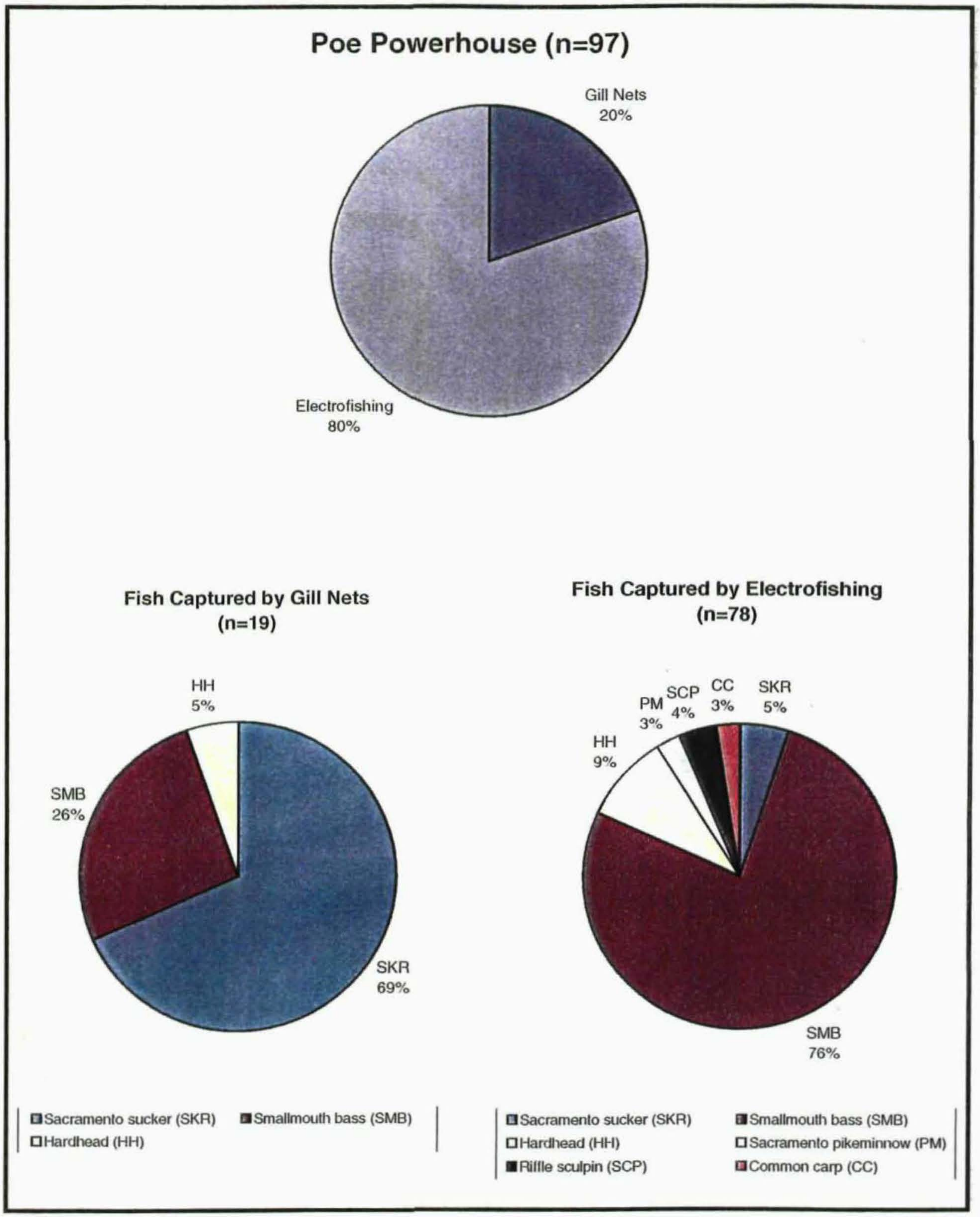


Figure 3.2-3: North Fork Feather River at Poe Powerhouse. Species composition by method of capture (gill nets and electrofishing).

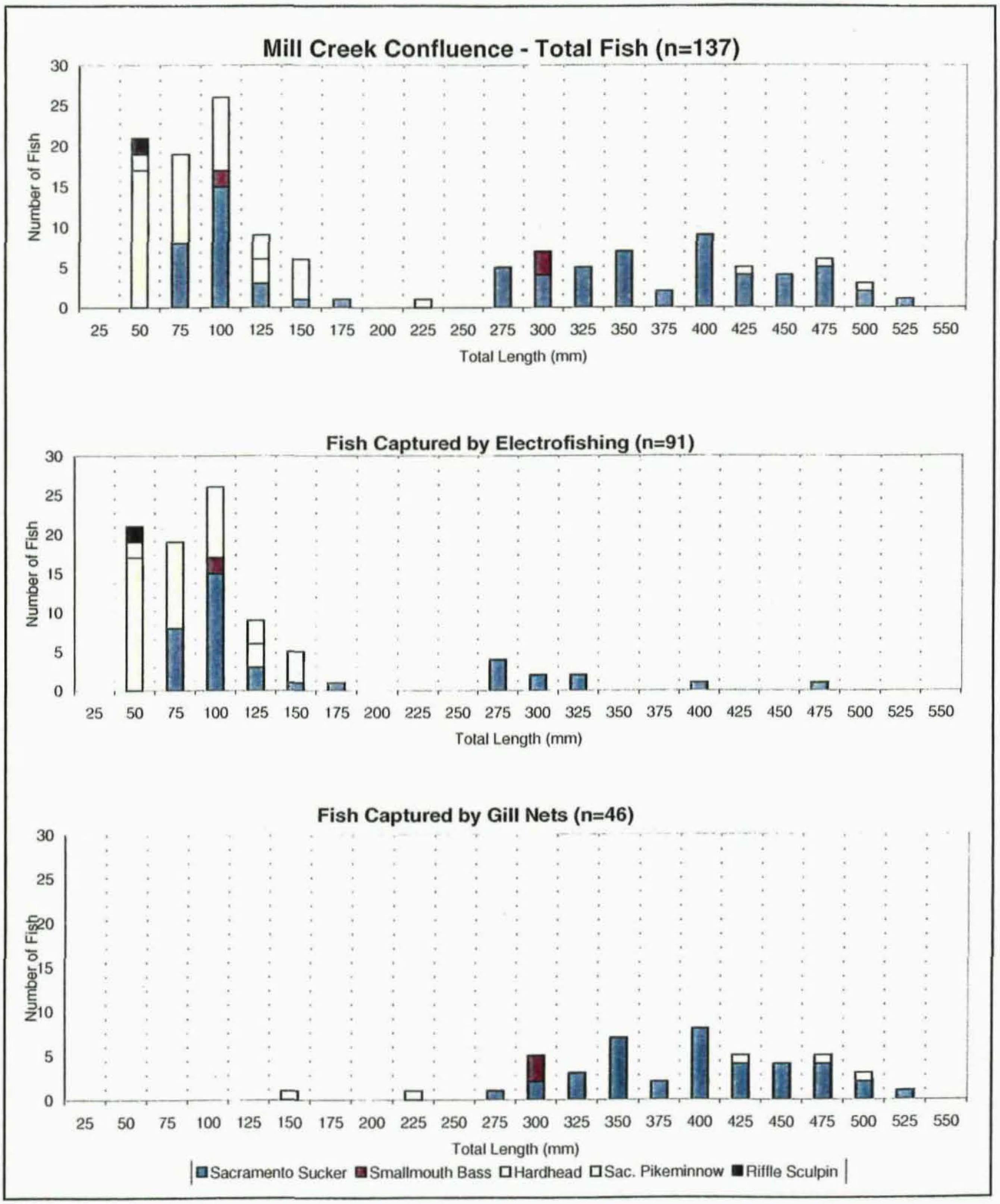


Figure 3.2-4: North Fork Feather River at Mill Creek Confluence: length frequency histograms.

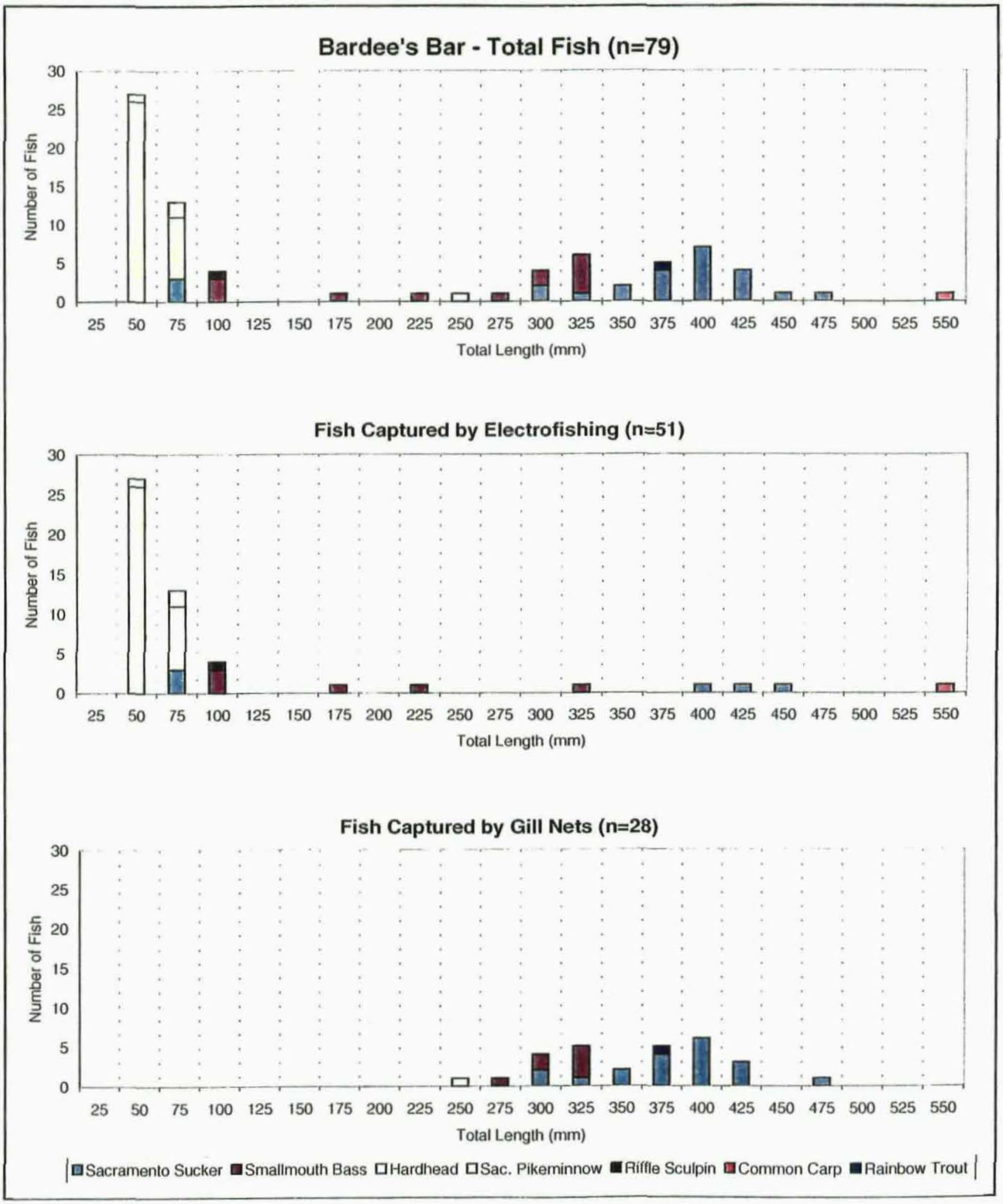


Figure 3.2-5: North Fork Feather River at Bardee's Bar: length frequency histograms.

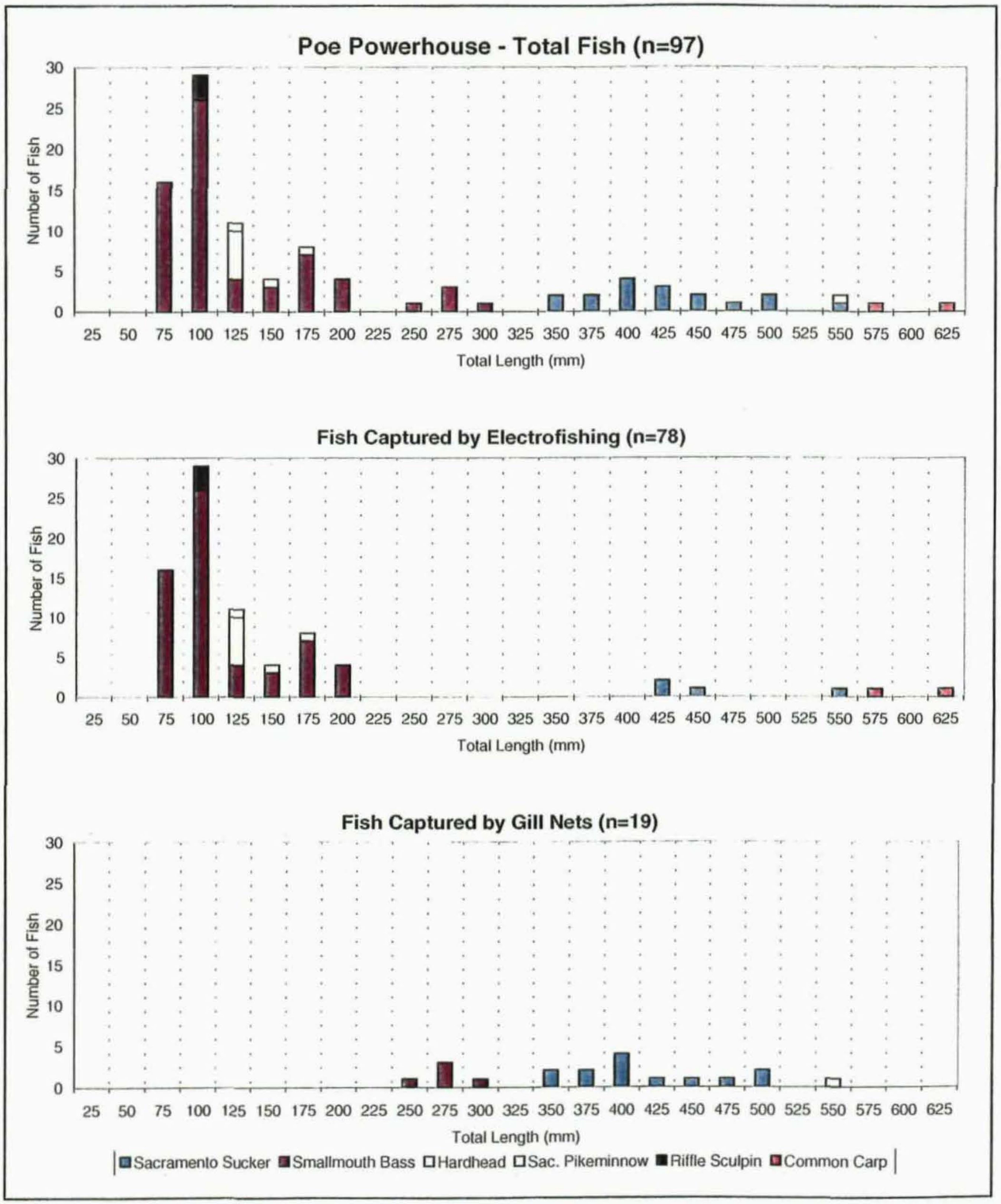


Figure 3.2-6: North Fork Feather River at Poe Powerhouse: length frequency histograms.

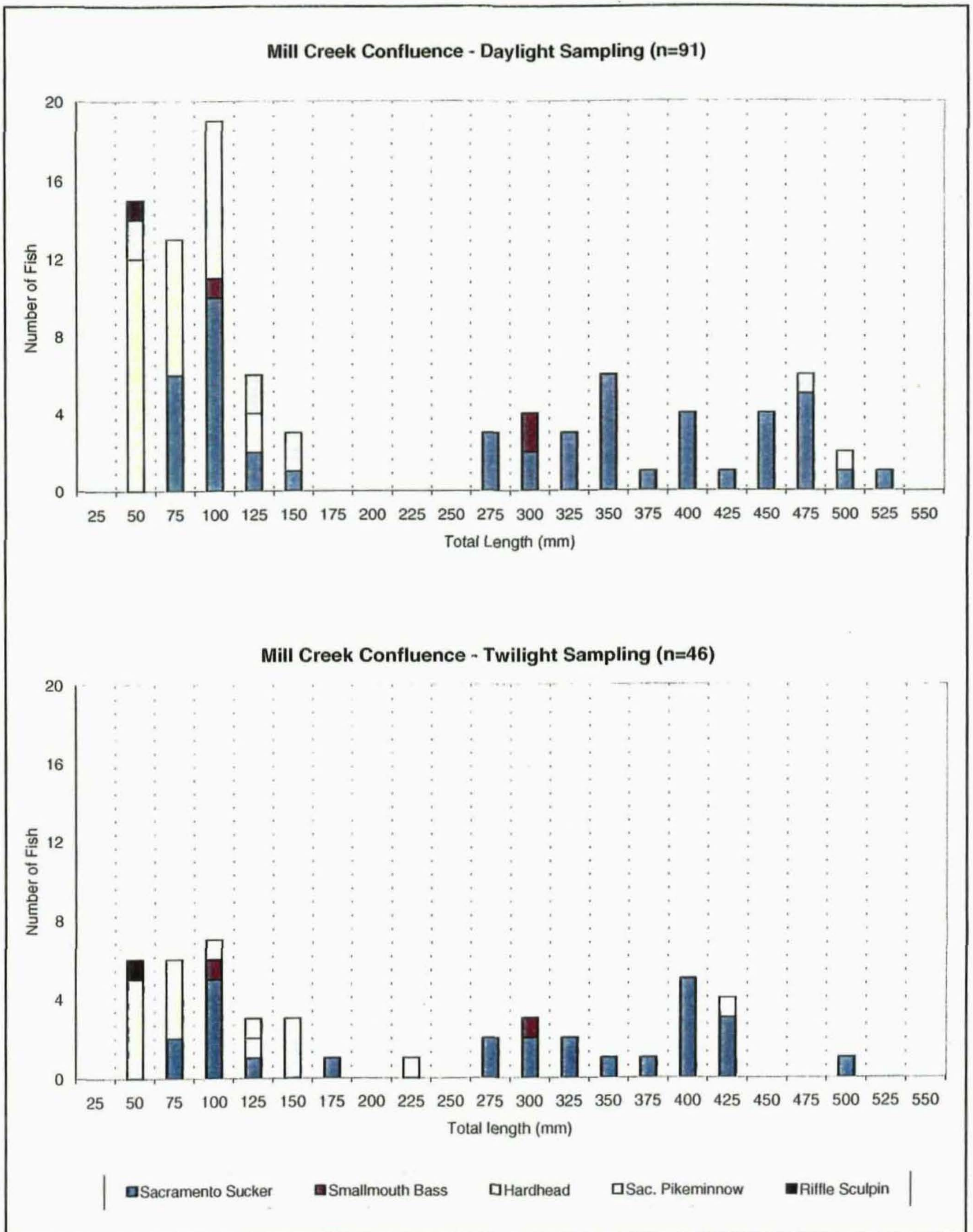


Figure 3.3-1: North Fork Feather River at Mill Creek Confluence. Fish captured in daylight versus twilight sampling.

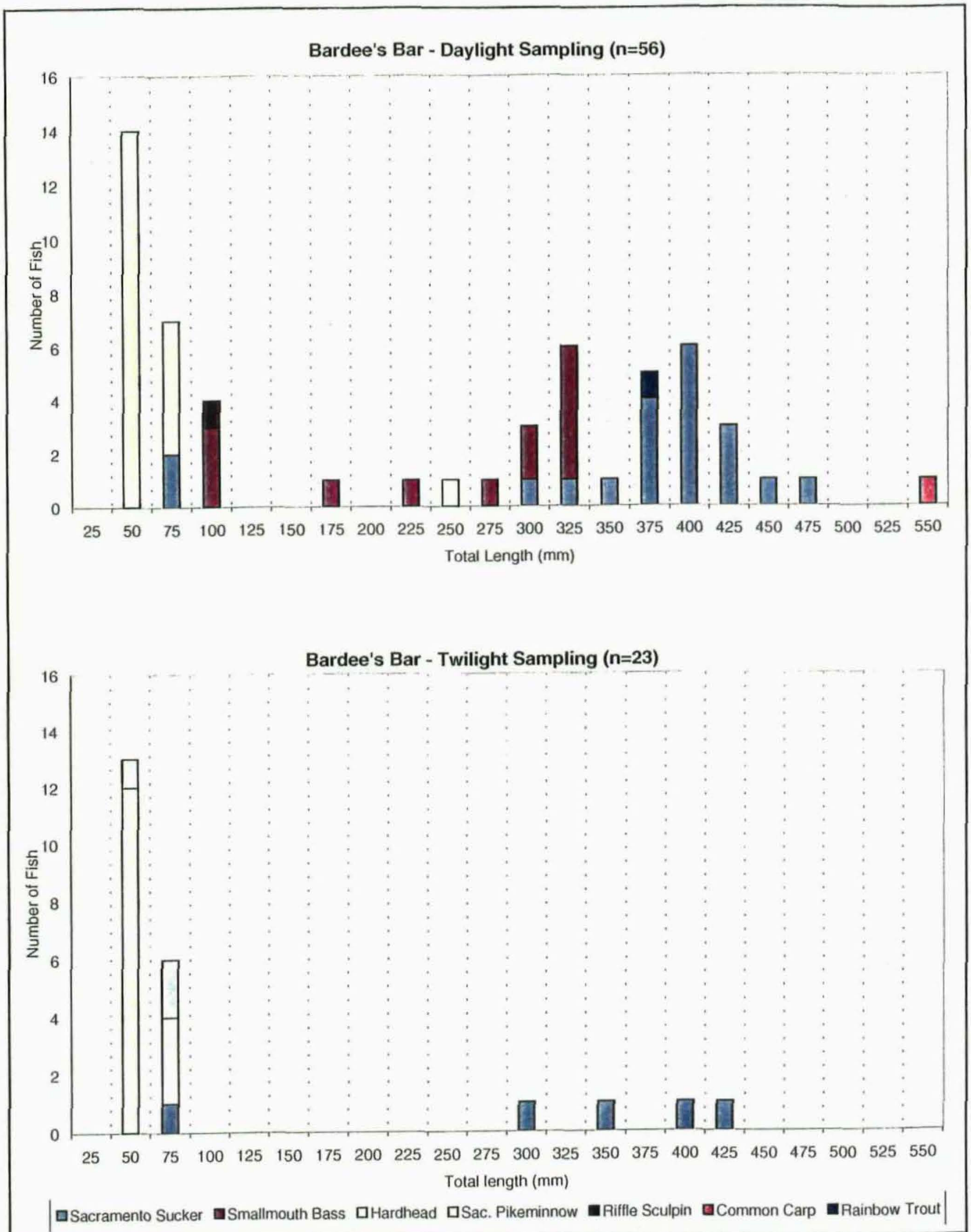


Figure 3.3-2: North Fork Feather River at Bardee's Bar. Fish captured in daylight versus twilight sampling.

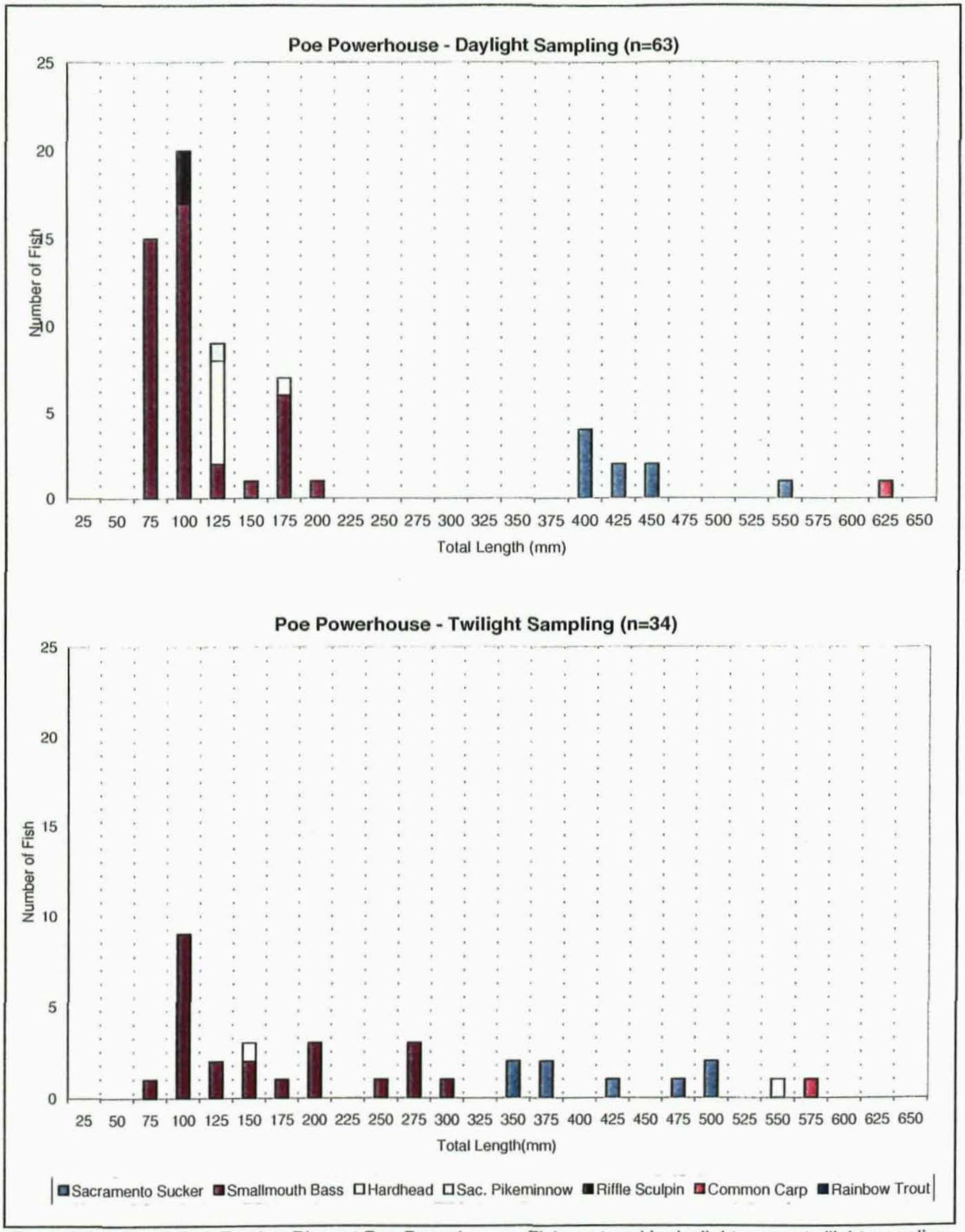


Figure 3.3-3: North Fork Feather River at Poe Powerhouse. Fish captured in daylight versus twilight sampling.

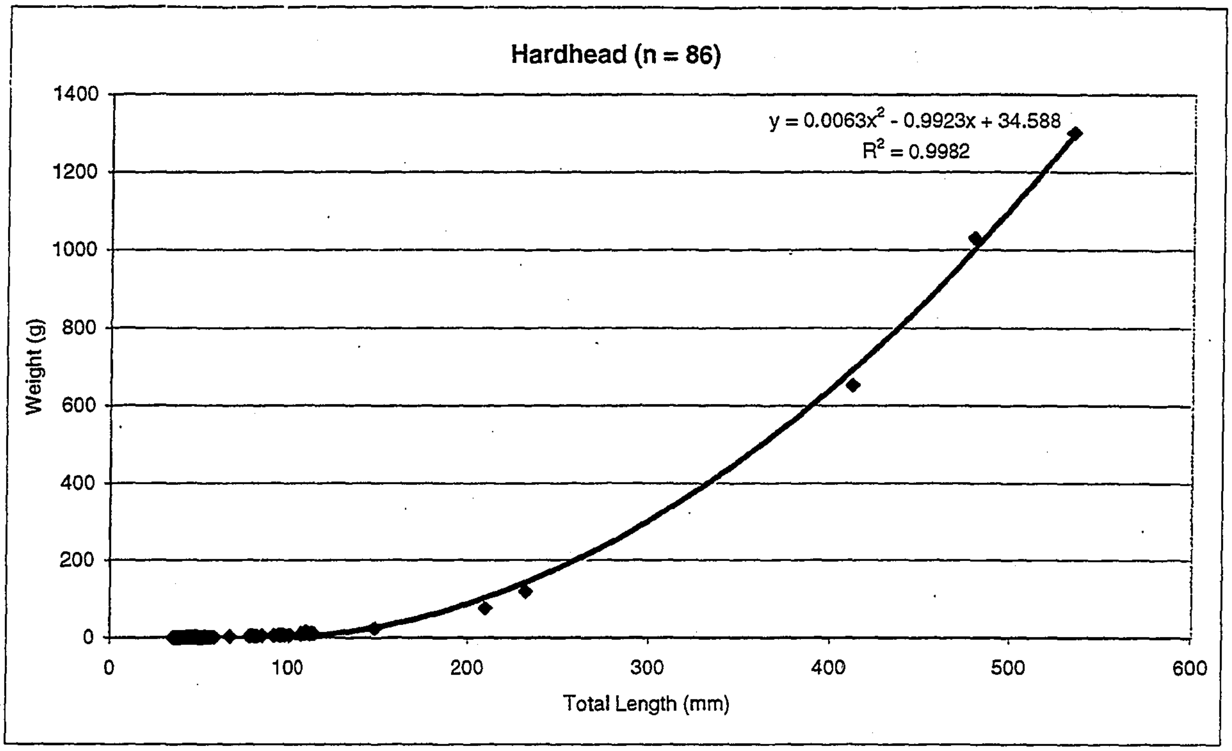


Figure 3.4-1: Total length-to-weight regression for hardhead at 3 sites (Mill Creek Confluence, Bardee's Bar, Poe Powerhouse) on the North Fork Feather River.

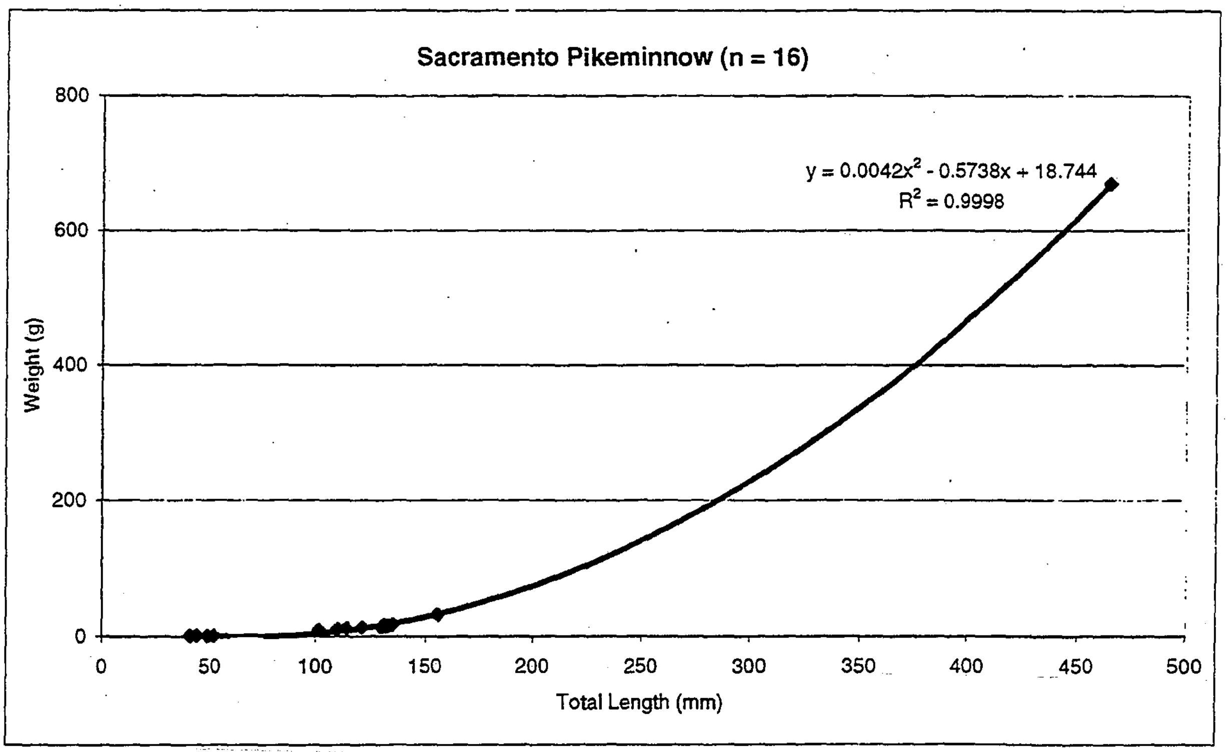


Figure 3.4-2: Total length-to-weight regression for Sacramento pikeminnow at 3 sites (Mill Creek Confluence, Bardee's Bar, Poe Powerhouse) on the North Fork Feather River.

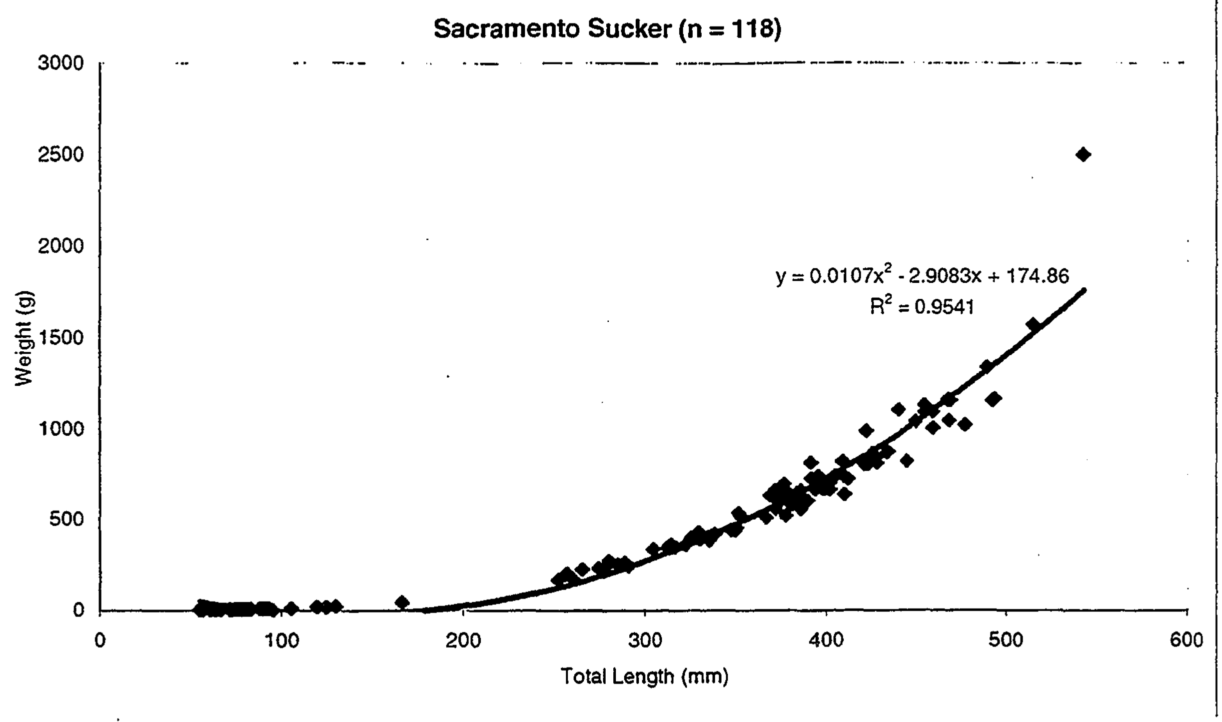


Figure 3.4-3: Total length-to-weight regression for Sacramento sucker at 3 sites (Mill Creek Confluence, Bardee's Bar, Poe Powerhouse) on the North Fork Feather River.

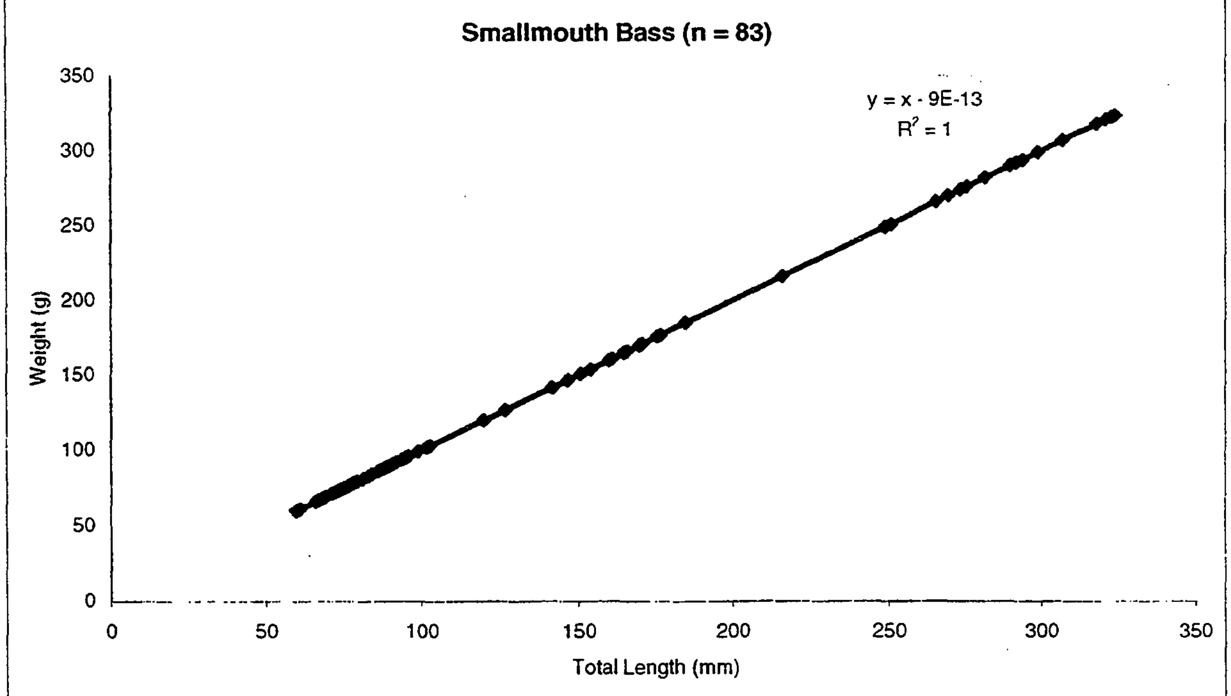


Figure 3.4-4: Total length-to-weight regression for smallmouth bass at 3 sites (Mill Creek Confluence, Bardee's Bar, Poe Powerhouse) on the North Fork Feather River.

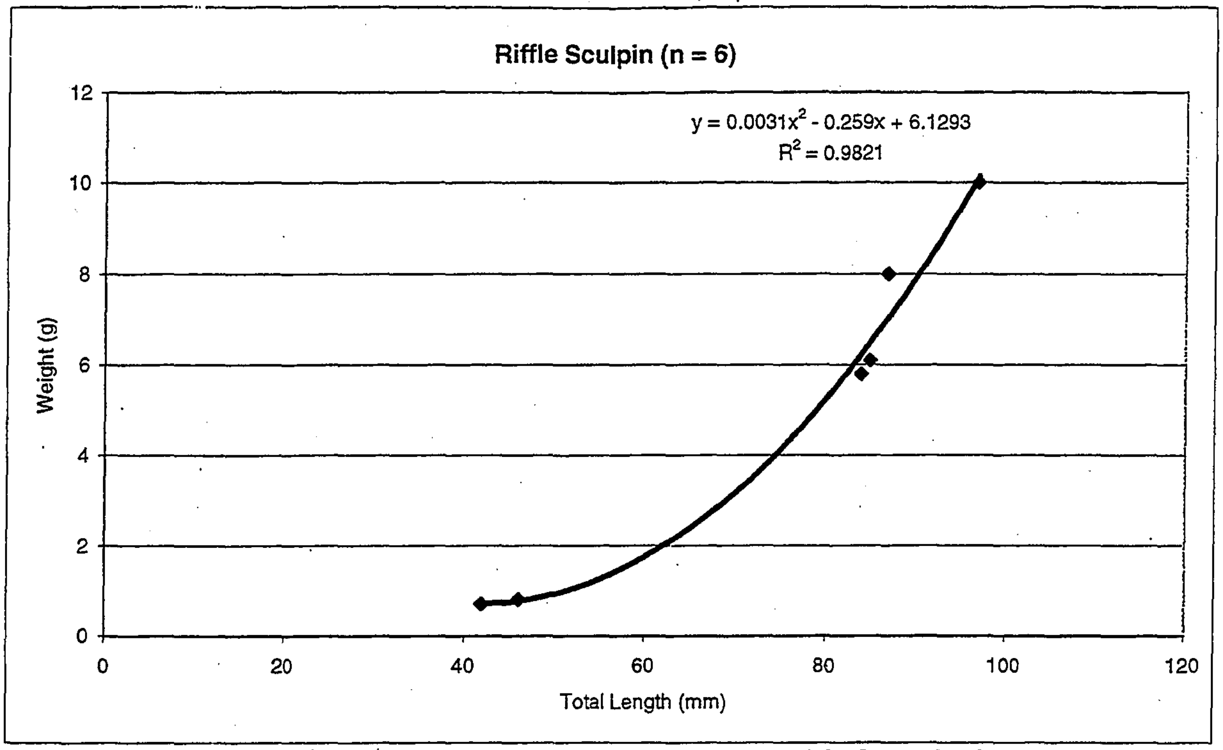


Figure 3.4-5: Total length-to-weight regression for riffle sculpin at 3 sites (Mill Creek Confluence, Bardee's Bar, Poe Powerhouse) on the North Fork Feather River.

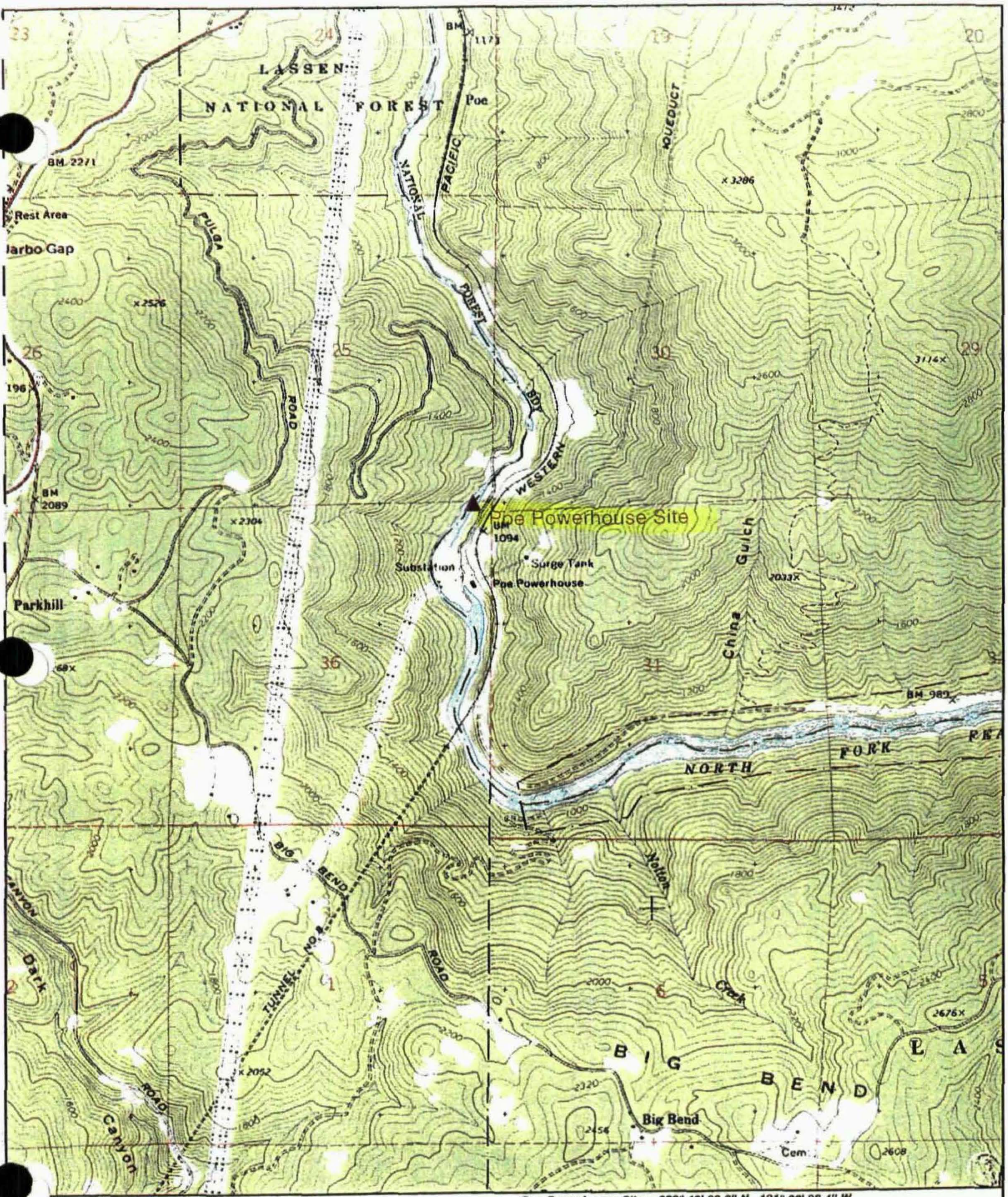
APPENDIX A

Site Maps

ault> - 2 Markers, Length = 2 miles, 2974 feet **Mill Creek Confluence Site - 039° 48' 15.1" N, 121°** **Bardee's Bar Site - 039° 46' 09.5" N, 121° 27' 23.9'**

Name: PULGA
Date: 10/19/100
Scale: 1 inch equals 2000 feet

Location: 039° 47' 05.1" N 121° 26' 55.7" W
Caption: Locations for Mill Creek Confluence site and Bardee's Bar Site



ault> - 1 Markers, Length = 0 feet

Poe Powerhouse Site - 039° 43' 36.2" N, 121° 28' 06.4" W

Name: BERRY CREEK
Date: 10/19/100
Scale: 1 inch equals 2000 feet

Location: 039° 43' 20.3" N 121° 28' 00.2" W
Caption: Location of Poe Powerhouse site.

APPENDIX B

Data Summary

Data Summary

All Sites Combined

	Sacramento Sucker	Smallmouth Bass	Hardhead	Sacramento Pikeminnow	Riffle Sculpin	Common Carp	Rainbow Trout	Totals
Total	118	83	86	16	6	3	1	313
Adults	87	17	5	1	4	3	1	118
Juveniles	31	66	81	15	2	0	0	195
Gill Nets	70	15	5	2	0	0	1	93
Electrofishing	48	68	81	14	6	3	0	220
Daylight Sampling	79	58	56	9	5	2	1	210
Twilight Sampling	39	25	30	7	1	1	0	103

Mill Creek Confluence

	Sacramento Sucker	Smallmouth Bass	Hardhead	Sacramento Pikeminnow	Riffle Sculpin	Common Carp	Rainbow Trout	Total
Total	76	5	43	11	2	0	0	137
Adults	48	3	3	1	0	0	0	55
Juveniles	28	2	40	10	2	0	0	82
Gill Nets	38	3	3	2	0	0	0	46
Electrofishing	38	2	40	9	2	0	0	91
Daylight Sampling	50	3	30	7	1	0	0	91
Twilight Sampling	26	2	13	4	1	0	0	46

Bardee's Bar

	Sacramento Sucker	Smallmouth Bass	Hardhead	Sacramento Pikeminnow	Riffle Sculpin	Common Carp	Rainbow Trout	Total
Total	25	13	35	3	1	1	1	79
Adults	22	9	1	0	1	1	1	35
Juveniles	3	4	34	3	0	0	0	44
Gill Nets	19	7	1	0	0	0	1	28
Electrofishing	6	6	34	3	1	1	0	51
Daylight Sampling	20	13	20	0	1	1	1	56
Twilight Sampling	5	0	15	3	0	0	0	23

Poe Powerhouse

	Sacramento Sucker	Smallmouth Bass	Hardhead	Sacramento Pikeminnow	Riffle Sculpin	Common Carp	Rainbow Trout	Total
Total	17	65	8	2	3	2	0	97
Adults	17	5	1	0	3	2	0	28
Juveniles	0	60	7	2	0	0	0	69
Gill Nets	13	5	1	0	0	0	0	19
Electrofishing	4	60	7	2	3	2	0	78
Daylight Sampling	9	42	6	2	3	1	0	63
Twilight Sampling	8	23	2	0	0	1	0	34

APPENDIX C

Data Printouts

North Fork of Feather River
Downstream of Mill Creek Confluence
Approx. Discharge: 120 cfs
Water Temp (F): 65
Date: 9/26/00

SKR	Sacramento sucker	RBT	Rainbow trout
SMB	Smallmouth bass	SCP	Riffle sculpin
HH	Hardhead	CP	Common Carp
PM	Sacramento pikeminnow		

Stream	Site	Segment	Segment Sample Effort (min)	Segment Sample Time (Day/Twil)	Net	Net Sample Time (Day/Twil)	Mesh Size (in)	Species	Total Length (mm)	Weight (g)	Mort.
NFFR	Mill Creek				1	Daylight	2	SKR	450	1045	
NFFR	Mill Creek				1	Daylight	2	SKR	460	1098	
NFFR	Mill Creek				1	Daylight	1.5	SKR	376	615	
NFFR	Mill Creek				1	Daylight	1.5	SKR	460	1010	
NFFR	Mill Creek				1	Daylight	1.5	SKR	369	633	
NFFR	Mill Creek	S1	50	Daylight				HH	45	0.6	Y
NFFR	Mill Creek	S1	50	Daylight				SKR	55	1.6	Y
NFFR	Mill Creek	S1	50	Daylight				HH	45	0.5	Y
NFFR	Mill Creek	S1	50	Daylight				HH	43	0.5	Y
NFFR	Mill Creek	S1	50	Daylight				HH	47	0.7	Y
NFFR	Mill Creek	S1	50	Daylight				SKR	73	3.7	Y
NFFR	Mill Creek	S1	50	Daylight				HH	41	0.5	Y
NFFR	Mill Creek	S1	50	Daylight				SCP	42	0.7	
NFFR	Mill Creek	S1	50	Daylight				HH	52	0.9	
NFFR	Mill Creek	S1	50	Daylight				SKR	64	3	
NFFR	Mill Creek	S1	50	Daylight				HH	98	6.3	
NFFR	Mill Creek	S1	50	Daylight				SKR	81	4.7	
NFFR	Mill Creek	S1	50	Daylight				SKR	77	4.3	
NFFR	Mill Creek	S1	50	Daylight				HH	45	0.6	
NFFR	Mill Creek	S1	50	Daylight				SKR	73	3.4	
NFFR	Mill Creek	S1	50	Daylight				SKR	57	-	
NFFR	Mill Creek				2	Daylight	2	SKR	455	1095	
NFFR	Mill Creek				2	Daylight	1.5	PM	465	669	
NFFR	Mill Creek	S2	49	Daylight				SKR	84	5.6	Y
NFFR	Mill Creek	S2	49	Daylight				SKR	90	7.8	Y
NFFR	Mill Creek	S2	49	Daylight				SKR	106	10.8	Y
NFFR	Mill Creek	S2	49	Daylight				HH	44	0.5	Y
NFFR	Mill Creek	S2	49	Daylight				HH	50	0.8	Y
NFFR	Mill Creek	S2	49	Daylight				HH	47	0.7	Y
NFFR	Mill Creek	S2	49	Daylight				HH	47	0.6	Y
NFFR	Mill Creek	S2	49	Daylight				HH	52	0.9	
NFFR	Mill Creek	S2	49	Daylight				HH	56	1.2	
NFFR	Mill Creek	S2	49	Daylight				HH	80	3.4	
NFFR	Mill Creek	S2	49	Daylight				PM	130	13.7	
NFFR	Mill Creek	S2	49	Daylight				HH	92	5.2	
NFFR	Mill Creek	S2	49	Daylight				HH	113	9	
NFFR	Mill Creek	S2	49	Daylight				HH	95	5.9	
NFFR	Mill Creek	S2	49	Daylight				HH	114	10.8	
NFFR	Mill Creek	S2	49	Daylight				HH	85	4.4	
NFFR	Mill Creek	S2	49	Daylight				PM	133	14.9	
NFFR	Mill Creek	S2	49	Daylight				PM	121	12.9	
NFFR	Mill Creek	S2	49	Daylight				HH	96	5.8	
NFFR	Mill Creek	S2	49	Daylight				SKR	94	7.5	
NFFR	Mill Creek	S2	49	Daylight				PM	114	11.1	
NFFR	Mill Creek	S2	49	Daylight				HH	82	3.6	
NFFR	Mill Creek	S2	49	Daylight				SKR	83	5.6	
NFFR	Mill Creek	S2	49	Daylight				SKR	93	7.3	
NFFR	Mill Creek	S2	49	Daylight				HH	38	0.3	
NFFR	Mill Creek	S2	49	Daylight				CRAYFISH	120	49	
NFFR	Mill Creek				1	Daylight	1.5	SKR	350	439	
NFFR	Mill Creek				2	Daylight	2	SKR	434	878	
NFFR	Mill Creek				3	Daylight	2	SKR	470	1160	
NFFR	Mill Creek				3	Daylight	2	SKR	433	872	
NFFR	Mill Creek				2	Daylight	2	SKR	515	1575	
NFFR	Mill Creek				3	Daylight	1	SKR	265	224	

Stream	Site	Segment	Segment Sample Effort (min)	Segment Sample Time (Day/Twil)	Net	Net Sample Time (Day/Twil)	Mesh Size (in)	Species	Total Length (mm)	Weight (g)	Mort.
NFFR	Mill Creek				3	Daylight	1	SKR	335	400	
NFFR	Mill Creek				3	Daylight	1.5	SKR	330	430	
NFFR	Mill Creek				3	Daylight	1.5	SKR	326	398	
NFFR	Mill Creek				3	Daylight	1.5	SKR	337	408	
NFFR	Mill Creek				3	Daylight	2	SKR	440	1109	
NFFR	Mill Creek				3	Daylight	2	SKR	422	990	
NFFR	Mill Creek				3	Daylight	2	SKR	478	1026	
NFFR	Mill Creek	S3	44	Daylight				SKR	468	1164	
NFFR	Mill Creek	S3	44	Daylight				SKR	400	672	
NFFR	Mill Creek	S3	44	Daylight				SKR	274	230	
NFFR	Mill Creek	S3	44	Daylight				SKR	120	18	
NFFR	Mill Creek	S3	44	Daylight				HH	78	3	
NFFR	Mill Creek	S3	44	Daylight				SKR	305	333	
NFFR	Mill Creek	S3	44	Daylight				SKR	257	203	
NFFR	Mill Creek	S3	44	Daylight				SKR	315	347	
NFFR	Mill Creek	S3	44	Daylight				SKR	277	229	
NFFR	Mill Creek	S3	44	Daylight				SMB	89	8	
NFFR	Mill Creek	S3	44	Daylight				SKR	130	22	
NFFR	Mill Creek	S3	44	Daylight				HH	52	0.8	
NFFR	Mill Creek	S3	44	Daylight				SKR	77	4.2	Y
NFFR	Mill Creek	S3	44	Daylight				PM	49	1	Y
NFFR	Mill Creek	S3	44	Daylight				SKR	96	0.6	
NFFR	Mill Creek	S3	44	Daylight				HH	52	0.9	Y
NFFR	Mill Creek	S3	44	Daylight				SKR	78	4.2	
NFFR	Mill Creek	S3	44	Daylight				SKR	75	4	
NFFR	Mill Creek	S3	44	Daylight				HH	51	0.9	
NFFR	Mill Creek	S3	44	Daylight				HH	45	0.6	Y
NFFR	Mill Creek	S3	44	Daylight				HH	52	0.9	Y
NFFR	Mill Creek	S3	44	Daylight				PM	44	0.5	
NFFR	Mill Creek				4	Daylight	1.5	SMB	282	326	
NFFR	Mill Creek				4	Daylight	2	SMB	290	370	
NFFR	Mill Creek				4	Daylight	1	SKR	285	252	
NFFR	Mill Creek				4	Daylight	1	SKR	323	360	
NFFR	Mill Creek				4	Daylight	1.5	SKR	378	523	
NFFR	Mill Creek				4	Daylight	1.5	SKR	348	439	
NFFR	Mill Creek				4	Daylight	2	SKR	386	631	
NFFR	Mill Creek				4	Daylight	2	HH	479	1030	
NFFR	Mill Creek	S1	25	Twilight				SKR	125	16.3	
NFFR	Mill Creek	S1	25	Twilight				HH	47	0.7	
NFFR	Mill Creek	S1	25	Twilight				HH	43	0.6	
NFFR	Mill Creek	S1	25	Twilight				HH	49	0.7	
NFFR	Mill Creek	S1	25	Twilight				SCP	46	0.8	
NFFR	Mill Creek	S2	25	Twilight				SKR	91	7.6	
NFFR	Mill Creek	S2	25	Twilight				SKR	89	7.7	
NFFR	Mill Creek	S2	25	Twilight				PM	132	14.2	
NFFR	Mill Creek	S2	25	Twilight				PM	131	16.4	
NFFR	Mill Creek	S2	25	Twilight				SMB	90	10.1	
NFFR	Mill Creek	S2	25	Twilight				HH	43	0.7	Y
NFFR	Mill Creek	S2	25	Twilight				HH	38	0.4	
NFFR	Mill Creek	S2	25	Twilight				SKR	67	3	
NFFR	Mill Creek	S2	25	Twilight				SKR	61	2.3	
NFFR	Mill Creek	S2	25	Twilight				SKR	84	6.2	
NFFR	Mill Creek	S3	30	Twilight				HH	54	0.9	Y
NFFR	Mill Creek	S3	30	Twilight				SKR	82	5.3	
NFFR	Mill Creek	S3	30	Twilight				HH	67	2.9	
NFFR	Mill Creek	S3	30	Twilight				HH	51	0.8	
NFFR	Mill Creek	S3	30	Twilight				PM	102	9.2	
NFFR	Mill Creek	S3	30	Twilight				SKR	260	175	Y
NFFR	Mill Creek	S3	30	Twilight				SKR	79	4.8	
NFFR	Mill Creek	S3	30	Twilight				HH	53	1.1	
NFFR	Mill Creek	S3	30	Twilight				HH	101	6.4	
NFFR	Mill Creek	S3	30	Twilight				SKR	167	42.4	
NFFR	Mill Creek	S3	30	Twilight				SKR	289	262	
NFFR	Mill Creek	S3	30	Twilight				SKR	252	166	
NFFR	Mill Creek	S3	30	Twilight				HH	96	5.2	

Stream	Site	Segment	Segment Sample Effort (min)	Segment Sample Time (Day/Twil)	Net	Net Sample Time (Day/Twil)	Mesh Size (in)	Species	Total Length (mm)	Weight (g)	Mort.
NFFR	Mill Creek				1	Twilight	1.5	SKR	386	662	
NFFR	Mill Creek				2	Twilight	1.5	HH	412	654	
NFFR	Mill Creek				3	Twilight	0.5	PM	135	17	
NFFR	Mill Creek				3	Twilight	1	HH	210	76	
NFFR	Mill Creek				3	Twilight	1.5	SKR	313	342	
NFFR	Mill Creek				3	Twilight	1.5	SKR	386	558	
NFFR	Mill Creek				3	Twilight	1.5	SKR	331	407	
NFFR	Mill Creek				3	Twilight	1.5	SKR	317	347	
NFFR	Mill Creek				4	Twilight	1.5	SKR	423	807	
NFFR	Mill Creek				4	Twilight	1.5	SKR	490	1340	
NFFR	Mill Creek				4	Twilight	1.5	SKR	394	669	
NFFR	Mill Creek				4	Twilight	1.5	SKR	380	602	
NFFR	Mill Creek				4	Twilight	1.5	SKR	374	594	
NFFR	Mill Creek				4	Twilight	1.5	SKR	412	726	
NFFR	Mill Creek				4	Twilight	1.5	SKR	410	642	
NFFR	Mill Creek				4	Twilight	1.5	SKR	280	274	
NFFR	Mill Creek				4	Twilight	1.5	SKR	381	580	
NFFR	Mill Creek				4	Twilight	1.5	SMB	299	380	

	Start	Stop	Start	Stop	Totals	Daylight/ Twilight
S1	10:40	11:00	11:10	11:40	50	D
S2	12:23	1:12			49	D
S3	3:09	3:40	3:50	4:03	44	D
S1	4:50	5:15			25	T
S2	5:15	5:40			25	T
S3	5:45		6:00	6:30	30	T

North Fork of Feather River
Bardee's Bar
Approx. Discharge: 120 cfs
Date: 9/27/00

SKR	Sacramento sucker	RBT	Rainbow trout
SMB	Smallmouth bass	SCP	Riffle sculpin
HH	Hardhead	CP	Common Carp
PM	Sacramento pikeminnow		

Stream	Site	Segment	Segment Sample Effort (min)	Segment Sample Time (Day/Twil)	Net	Net Sample Time (Day/Twil)	Mesh Size (in)	Species	Total Length (mm)	Weight (g)	Mort.
NFFR	Bardee's Bar	S4	35	Daylight				SKR	445	823	
NFFR	Bardee's Bar	S4	35	Daylight				SKR	421	809	
NFFR	Bardee's Bar	S4	35	Daylight				SMB	171	70.3	
NFFR	Bardee's Bar	S4	35	Daylight				SMB	89	8.4	
NFFR	Bardee's Bar	S4	35	Daylight				SMB	94	12	
NFFR	Bardee's Bar				4	Daylight	2	RBT	362	989	
NFFR	Bardee's Bar				4	Daylight	2	SMB	294	947	
NFFR	Bardee's Bar				4	Daylight	1.5	SKR	380	613	
NFFR	Bardee's Bar	S3	32	Daylight				HH	50	0.9	Y
NFFR	Bardee's Bar	S3	32	Daylight				HH	51	0.7	Y
NFFR	Bardee's Bar	S3	32	Daylight				HH	48	0.6	Y
NFFR	Bardee's Bar	S3	32	Daylight				SMB	216	160	
NFFR	Bardee's Bar	S3	32	Daylight				SCP	87	8	
NFFR	Bardee's Bar	S3	32	Daylight				SKR	61	2	
NFFR	Bardee's Bar	S3	32	Daylight				HH	43	1	
NFFR	Bardee's Bar	S3	32	Daylight				HH	49	1	
NFFR	Bardee's Bar				1	Daylight	2	SKR	425	866	
NFFR	Bardee's Bar				1	Daylight	2	SMB	324	514	
NFFR	Bardee's Bar	S2	28	Daylight				HH	43	1	Y
NFFR	Bardee's Bar	S2	28	Daylight				CP	550	2500	
NFFR	Bardee's Bar	S2	28	Daylight				HH	50	<1	
NFFR	Bardee's Bar	S2	28	Daylight				HH	36	<1	
NFFR	Bardee's Bar	S2	28	Daylight				HH	46	<1	
NFFR	Bardee's Bar	S2	28	Daylight				HH	45	<1	
NFFR	Bardee's Bar	S2	28	Daylight				SKR	72	4	
NFFR	Bardee's Bar	S2	28	Daylight				HH	48	0.7	
NFFR	Bardee's Bar	S2	28	Daylight				HH	52	0.8	
NFFR	Bardee's Bar	S2	28	Daylight				SMB	77	5.8	
NFFR	Bardee's Bar	S2	28	Daylight				HH	52	0.8	
NFFR	Bardee's Bar	S2	28	Daylight				HH	48	0.4	
NFFR	Bardee's Bar	S2	28	Daylight				HH	35	0.3	
NFFR	Bardee's Bar				3	Daylight	1.5	SKR	330	394	
NFFR	Bardee's Bar				3	Daylight	1.5	SMB	270	345	
NFFR	Bardee's Bar				5	Daylight	0.75	HH	232	119	
NFFR	Bardee's Bar				4	Daylight	1.5	SMB	292	450	
NFFR	Bardee's Bar				4	Daylight	1.5	SKR	398	674	
NFFR	Bardee's Bar				4	Daylight	1.5	SKR	372	559	
NFFR	Bardee's Bar	S1	32	Daylight				SMB	318	420	
NFFR	Bardee's Bar	S1	32	Daylight				HH	47	0.4	Y
NFFR	Bardee's Bar	S1	32	Daylight				HH	52	0.5	Y
NFFR	Bardee's Bar	S1	32	Daylight				HH	50	0.5	
NFFR	Bardee's Bar	S1	32	Daylight				HH	51	0.5	
NFFR	Bardee's Bar				1	Daylight	1	SKR	281	266	
NFFR	Bardee's Bar				1	Daylight	1.5	SMB	323	517	
NFFR	Bardee's Bar				1	Daylight	1.5	SMB	307	478	
NFFR	Bardee's Bar				1	Daylight	1.5	SKR	351	457	
NFFR	Bardee's Bar				1	Daylight	1.5	SKR	410	743	
NFFR	Bardee's Bar				1	Daylight	1.5	SKR	390	607	
NFFR	Bardee's Bar				1	Daylight	2	SKR	455	1133	
NFFR	Bardee's Bar				1	Daylight	1.5	SKR	353	516	
NFFR	Bardee's Bar				1	Daylight	1.5	SKR	396	741	
NFFR	Bardee's Bar				1	Daylight	1.5	SMB	321	525	
NFFR	Bardee's Bar				1	Daylight	1.5	SKR	377	698	
NFFR	Bardee's Bar				1	Daylight	1.5	SKR	381	628	
NFFR	Bardee's Bar				1	Daylight	1.5	SKR	367	512	
NFFR	Bardee's Bar				3	Daylight	1.5	SKR	315	360	
NFFR	Bardee's Bar	S4	17	Twilight				SKR	379	652	
NFFR	Bardee's Bar	S4	17	Twilight				HH	44	<1	Y
NFFR	Bardee's Bar	S4	17	Twilight				HH	46	<1	Y

Stream	Site	Segment	Segment Sample Effort (min)	Segment Sample Time (Day/Twil)	Net	Net Sample Time (Day/Twil)	Mesh Size (in)	Species	Total Length (mm)	Weight (g)	Mort.
NFFR	Bardee's Bar	S4	17	Twilight				HH	39	<1	
NFFR	Bardee's Bar	S4	17	Twilight				HH	49	<1	
NFFR	Bardee's Bar	S4	17	Twilight				HH	54	<1	
NFFR	Bardee's Bar	S4	17	Twilight				HH	58	<1	
NFFR	Bardee's Bar	S4	17	Twilight				HH	42	0.5	
NFFR	Bardee's Bar	S3	15	Twilight				PM	52	0.5	
NFFR	Bardee's Bar	S3	15	Twilight				PM	52	0.5	
NFFR	Bardee's Bar	S2	15	Twilight				HH	52	0.5	
NFFR	Bardee's Bar	S2	15	Twilight				HH	40	0.4	
NFFR	Bardee's Bar	S2	15	Twilight				HH	41	0.4	
NFFR	Bardee's Bar	S2	15	Twilight				SKR	72	3.7	
NFFR	Bardee's Bar	S1	18	Twilight				HH	37	0.4	Y
NFFR	Bardee's Bar	S1	18	Twilight				HH	38	0.5	Y
NFFR	Bardee's Bar	S1	18	Twilight				HH	41	0.5	Y
NFFR	Bardee's Bar	S1	18	Twilight				HH	46	0.8	
NFFR	Bardee's Bar	S1	18	Twilight				PM	41	0.4	Y
NFFR	Bardee's Bar	S1	18	Twilight				HH	39	0.4	
NFFR	Bardee's Bar				5	Twilight	1.5	SKR	405	742	
NFFR	Bardee's Bar				4	Twilight	1.5	SKR	339	420	
NFFR	Bardee's Bar				4	Twilight	1	SKR	291	244	

	Start	Stop		Totals	Daylight/ Twilight
S4	11:25	12:00		35	D
S3	12:28	1:00		32	D
S2	1:25	1:37	plus additional time	28	D
S1	3:18	3:50		32	D
S4	4:25	4:42		17	T
S3	4:50	5:05		15	T
S2	5:10	5:25		15	T
S1	5:32	5:50		18	T

North Fork of Feather River
Poe Powerhouse
Water Temp (F): 67
Date: 9/28/00

SKR	Sacramento sucker	RBT	Rainbow trout
SMB	Smallmouth bass	SCP	Riffle sculpin
HH	Hardhead	CP	Common Carp
PM	Sacramento pikeminnow		

Stream	Site	Segment	Segment Sample Effort (min)	Segment Sample Time (Day/Twil)	Net	Net Sample Time (Day/Twil)	Mesh Size (in)	Species	Total Length (mm)	Weight (g)	Mort.
NFFR	POE PH	S4	42	Daylight				SMB	151	38.5	
NFFR	POE PH	S4	42	Daylight				SMB	161	21.2	
NFFR	POE PH	S4	42	Daylight				SMB	91	12.8	
NFFR	POE PH	S4	42	Daylight				SMB	120	15.3	
NFFR	POE PH	S4	42	Daylight				SMB	79	7.2	
NFFR	POE PH	S4	42	Daylight				SMB	99	14.1	
NFFR	POE PH	S4	42	Daylight				SMB	69	3.1	
NFFR	POE PH	S4	42	Daylight				SMB	69	4.4	
NFFR	POE PH	S4	42	Daylight				SMB	71	4.8	
NFFR	POE PH	S4	42	Daylight				SMB	76	6.5	
NFFR	POE PH	S4	42	Daylight				SMB	60	2.9	
NFFR	POE PH	S4	42	Daylight				SMB	67	3.5	
NFFR	POE PH	S4	42	Daylight				SMB	90	8.8	Y
NFFR	POE PH	S4	42	Daylight				SCP	84	5.8	
NFFR	POE PH	S3	43	Daylight				SMB	74	4.7	
NFFR	POE PH	S3	43	Daylight				SMB	72	5.3	
NFFR	POE PH	S3	43	Daylight				SMB	66	4.3	
NFFR	POE PH	S3	43	Daylight				SMB	154	51.5	
NFFR	POE PH	S3	43	Daylight				SMB	170	67.6	
NFFR	POE PH	S3	43	Daylight				SMB	177	66.8	
NFFR	POE PH	S3	43	Daylight				SMB	165	57.8	
NFFR	POE PH	S3	43	Daylight				SMB	76	5.2	
NFFR	POE PH	S3	43	Daylight				SMB	92	10.4	
NFFR	POE PH	S3	43	Daylight				SMB	86	7.7	
NFFR	POE PH	S3	43	Daylight				SMB	90	11.1	
NFFR	POE PH	S3	43	Daylight				SMB	83	8.3	
NFFR	POE PH	S3	43	Daylight				SMB	72	4.4	
NFFR	POE PH	S3	43	Daylight				SMB	88	8.3	
NFFR	POE PH	S2	42	Daylight				SKR	428	817	
NFFR	POE PH	S2	42	Daylight				SMB	160	76	
NFFR	POE PH	S2	42	Daylight				PM	156	31.8	
NFFR	POE PH	S2	42	Daylight				SMB	83	7.2	
NFFR	POE PH	S2	42	Daylight				PM	110	10	
NFFR	POE PH	S2	42	Daylight				HH	115	10.5	
NFFR	POE PH	S2	42	Daylight				SMB	73	4.5	
NFFR	POE PH	S2	42	Daylight				HH	108	9.5	
NFFR	POE PH	S2	42	Daylight				SCP	85	6.1	
NFFR	POE PH	S2	42	Daylight				SKR	543	2500	
NFFR	POE PH				2	Daylight	1.5	SKR	384	592	
NFFR	POE PH				2	Daylight	2	SKR	427	841	
NFFR	POE PH				2	Daylight	1.5	SKR	392	729	
NFFR	POE PH				2	Daylight	2	SKR	409	824	
NFFR	POE PH				2	Daylight	1.5	SKR	376	616	
NFFR	POE PH				1	Daylight	1.5	SKR	392	817	Y
NFFR	POE PH	S2	42	Daylight				HH	110	10.5	
NFFR	POE PH	S2	42	Daylight				SMB	95	13.5	
NFFR	POE PH	S2	42	Daylight				HH	111	14.5	
NFFR	POE PH	S2	42	Daylight				HH	108	8	
NFFR	POE PH	S2	42	Daylight				HH	112	11	
NFFR	POE PH	S2	42	Daylight				SMB	68	4.5	
NFFR	POE PH	S1	42	Daylight				CP	605	3500	
NFFR	POE PH	S1	42	Daylight				SMB	147	39	
NFFR	POE PH	S1	42	Daylight				SMB	90	8	
NFFR	POE PH	S1	42	Daylight				SMB	75	5	
NFFR	POE PH	S1	42	Daylight				SMB	76	4	
NFFR	POE PH	S1	42	Daylight				SCP	97	10	
NFFR	POE PH	S1	42	Daylight				SKR	402	701	

Stream	Site	Segment	Segment Sample Effort (min)	Segment Sample Time (Day/Twil)	Net	Net Sample Time (Day/Twil)	Mesh Size (in)	Species	Total Length (mm)	Weight (g)	Mort.
NFFR	POE PH	S1	42	Daylight				SMB	83	7.5	
NFFR	POE PH	S1	42	Daylight				SMB	96	13.2	
NFFR	POE PH	S1	42	Daylight				SMB	102	15	
NFFR	POE PH	S1	42	Daylight				SMB	69	4.5	
NFFR	POE PH	S1	42	Daylight				SMB	61	3	
NFFR	POE PH	S1	42	Daylight				SMB	67	4	
NFFR	POE PH	S4	14	Twilight				SKR	402	669	
NFFR	POE PH	S4	14	Twilight				SMB	84	7.7	Y
NFFR	POE PH	S4	14	Twilight				SMB	76	6.5	
NFFR	POE PH	S4	14	Twilight				SMB	60	3.2	
NFFR	POE PH	S3	16	Twilight				CP	571	2600	
NFFR	POE PH	S3	16	Twilight				SMB	176	70	
NFFR	POE PH	S3	16	Twilight				SMB	166	53	
NFFR	POE PH	S3	16	Twilight				SMB	185	82	
NFFR	POE PH	S3	16	Twilight				SMB	87	8	Y
NFFR	POE PH	S3	16	Twilight				SMB	95	11	
NFFR	POE PH	S3	16	Twilight				SMB	142	35	
NFFR	POE PH	S3	16	Twilight				SMB	185	79	
NFFR	POE PH	S2	13	Twilight				SMB	89	8	
NFFR	POE PH	S2	13	Twilight				HH	148	23	
NFFR	POE PH	S2	13	Twilight				SMB	102	13	
NFFR	POE PH	S2	13	Twilight				SMB	81	7	
NFFR	POE PH	S2	13	Twilight				SMB	103	14	
NFFR	POE PH	S2	13	Twilight				SMB	77	5	
NFFR	POE PH	S2	13	Twilight				SMB	78	6	
NFFR	POE PH	S1	12	Twilight				SMB	127	28	
NFFR	POE PH	S1	12	Twilight				SMB	78	6	Y
NFFR	POE PH				5	Twilight	1.5	SMB	274	324	
NFFR	POE PH				5	Twilight	1	SMB	251	259	
NFFR	POE PH				5	Twilight	1	SMB	249	191	
NFFR	POE PH				4	Twilight	1.5	SMB	266	266	
NFFR	POE PH				4	Twilight	1.5	HH	534	1300	
NFFR	POE PH				3	Twilight	2	SKR	469	1050	
NFFR	POE PH				3	Twilight	2	SKR	372	661	
NFFR	POE PH				3	Twilight	1.5	SKR	352	536	Y
NFFR	POE PH				3	Twilight	1.5	SKR	336	385	
NFFR	POE PH				1	Twilight	2	SKR	493	1159	
NFFR	POE PH				2	Twilight	2	SKR	494	1166	
NFFR	POE PH				2	Twilight	1.5	SKR	331	391	
NFFR	POE PH				2	Twilight	1.5	SMB	276	296	

	Start	Stop	Start	Stop	Totals	Daylight/ Twilight
S4	11:26	12:08			42	D
S3	12:12	12:15	12:50	1:30	43	D
S2	2:21	3:03			42	D
S1	3:11	3:27	4:11	4:37	42	D
S4	4:44	4:58			14	T
S3	5:00	5:16			16	T
S2	5:20	5:26	5:56	6:03	13	T
S1	6:04	6:16			12	T

POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX E3-3

Feasibility of Using Hydroacoustics to Monitor Fish Entrainment at Poe Dam

Hydroacoustic Technology, Inc.

FEASIBILITY OF USING HYDROACOUSTICS TO MONITOR FISH ENTRAINMENT AT POE DAM

Prepared for

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December 7, 1999

1.0 INTRODUCTION

Pacific Gas & Electric Co. (PG&E) contracted Hydroacoustic Technology, Inc. (HTI) to assess the feasibility of using hydroacoustics to monitor fish entrainment at Poe Dam in November 1999. The objective of this study was to estimate the signal-to-noise ratio at Poe Dam, with the ultimate goal of implementing a long-term entrainment monitoring study.

Initial evaluations at the dam were conducted in November 1989 by Nealson and McFadden (1990). The hydroacoustic techniques available at that time did not measure fish direction of movement. As such, the monitoring transducer had to be deployed downstream in the intake at a point where fish entrainment was maximized. As a result, monitoring was conducted well downstream in the intake, in an area of turbulence and entrained air, resulting in a low signal-to-noise ratio.

With the subsequent availability of split-beam hydroacoustic techniques in the 1990's, direction of fish movement could be measured directly. These techniques allow direct determination of fish entrainment further upstream in the Poe Dam intake, with less flow, but also with less turbulence. The result would presumably be higher signal-to-noise ratios, permitting smaller fish to be monitored.

If the signal-to-noise ration was sufficient to permit monitoring of fish as small as 2 inches (50 mm) in length, the plan was to monitor fish entrainment periodically throughout the following 12 months.

2.0 SITE DESCRIPTION

Poe Dam is located in Northern California on the North Fork Feather River. The Poe Powerhouse Intake diverts water into a 19 ft diameter penstock with a base elevation of 1340 ft. The concrete intake is approximately 78 ft wide at the trashracks. The intake structure was divided into six individual intake bays immediately downstream of the trash racks.

The reservoir level during hydroacoustic sampling was approximately 1372 ft. Average water velocity in the penstock during data collection was approximately 8 fps at 2300 cfs. A significant amount of debris had accumulated on the trash racks prior to the tests.

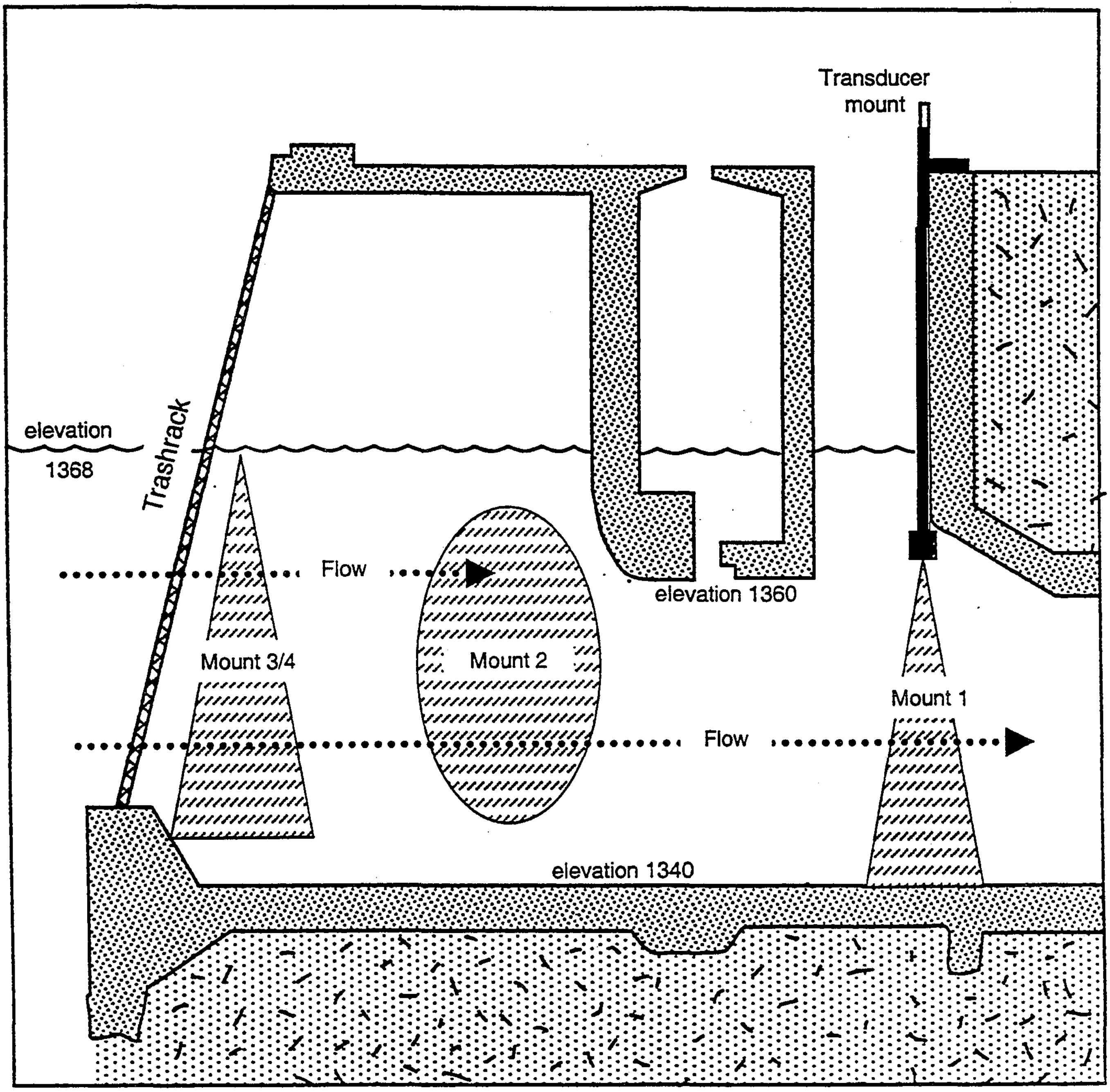

Figure 1. Cross-section of Poe Dam intake area (adapted from Nealson and Mcfadden (1990)).

3.0 METHODS

3.1 Introduction

Over the last 15 yr, the availability of scientific-quality hydroacoustic instruments has permitted efficient, unobtrusive monitoring of the abundance, distribution, and behavior of entrained fish at dams (Ransom and Raemhild 1985; Ransom and Steig 1994, 1995; and Steig and Hays 1987). General fisheries hydroacoustic methods are described by MacLennan and Simmonds (1992).

This evaluation was conducted November 2-3, 1999.

3.2 Hydroacoustic Equipment and Operation

The Poe Dam study was conducted using split-beam hydroacoustics and three-dimensional target tracking techniques. Split-beam techniques are described by Ehrenberg (1984, 1989) and Ehrenberg and Torkelson (1996). Split-beam phase and range measurements permit direct calculation of absolute velocity and three dimensional trajectory path through the beam for each detected fish.

The advantages of split-beam techniques over single-beam hydroacoustic techniques lay primarily in their ability to locate fish within the acoustic beam in three dimensions. This permits absolute tracking of fish movements through the beam, greatly enhancing monitoring of fish behavior. This also permits estimation of fish target strength (and thus fish length) with low variability, producing less variable estimates of fish target strength (Burwen et al. 1995, Traynor and Ehrenberg 1990). The split-beam system also has an inherently higher signal-to-noise ratio, which can permit monitoring of smaller fish at sites with higher levels of background interference.

A single *Model 241 Portable Split-Beam System* was used. The system was comprised of a 200 kHz *Model 241 Portable Split-Beam Echo Sounder* (SN 923436), a chart recorder, an oscilloscope, and two transducers. A 15° conical-beam transducer (SN 316616) and 6° x 10° elliptical-beam transducer (SN 827186) (nominal beam widths at the -3 dB points, with one-way propagation) were used.

The acoustic system was calibrated prior to deployment and data collection. The system operated at 0.2 msec pulse width, and 10 pings per sec. Both Chirp (FM Slide) and non-Chirp signals were tested.

3.3 Transducer Deployment

Transducer mount locations are shown in Figure 1. The 15° transducer was centered in the intake at two locations. Mount Location 1 monitored in the same position as was used in 1989, at the downstream end of the intake area. Here the transducer was mounted at a depth of approximately 3 ft, and aimed straight down (i.e., 0°).

Mount Location 2 (Figure 1) deployed the 6° x 10° transducer on the south wall of the intake, and aimed it horizontally toward the north wall. The transducer was mounted at a depth of 12 ft, and aimed 3° upstream. The wide axis of the elliptical beam (i.e., the 10° axis) was oriented vertically.

The 15° transducer was subsequently attached to the downstream side of the trashracks (Figure 1). Here the transducer was mounted at two different depths, near the surface (Mount Location), and 4 ft deep (Mount Location 4).

3.4 Data Analysis Methods

Split-beam data were processed automatically by the *Model 340 Digital Echo Processor*. The primary data record was the raw split-beam data files written to disk in real time. Chart recorder echograms and periodic DAT recordings were also collected. Data analysis was completed using specialized software developed by HTI.

The target strength (i.e., acoustic size) of each selected echo was estimated using the split-beam technique. The split-beam technique estimates target strength *in-situ*, using differences in phases between the received signals from the beam's four quadrants. This information is used to estimate angle off axis for each echo, calculate its on-axis amplitude, and convert this to target strength. A detailed description of the split-beam technique is presented by Ehrenberg (1984, 1989), and Ehrenberg and Torkelson (1996).

The objective of this study was to estimate the signal-to-noise ratio at the dam. To do this, background noise levels were measured at different transducer mount locations. These noise levels were then to be compared to the predicted target strength of the smallest fish size of interest, in order to ascertain if fish of the size of interest could be resolved during entrainment monitoring at the dam.

4.0 RESULTS AND DISCUSSION

4.1 1989 Results

During 1989 tests reported by Nealson and McFadden (1990), the monitoring transducer was placed downstream of the penstock opening, in order to maximize the chance that fish monitored were entrained. These tests indicated that the minimum fish detection length (Love 1977) over the full nominal beam width was approximately 23 inches (58 cm) in the upper 4-7 m of the water column. This was equivalent to a target strength of -31 dB. On axis, the minimum fish detection length was approximately 11 inches (28 cm), equivalent to a target strength of -37 dB.

4.2 1999 Results

For each of the four transducer mount locations, plots of background noise levels vs. range are presented in Figures 2-5.

For Mount Location 1 in the penstock (Figure 1), the same mount location evaluated in 1989, during 1999, at a range less than 8 m, the minimum fish target strength (dorsal) able to be monitored was -39 dB. This was equivalent to a fish length of approximately 18 cm (Love 1977). At a range over 8 m, the minimum fish target strength (dorsal) able to be monitored was -30 dB. This was equivalent to a fish length of approximately 60 cm. These results were similar to those observed in 1989 at this location.

For Mount Location 2 (Figure 1), sampling horizontally across the intake area downstream of the trash racks, maximum sample range was limited by a vortex halfway across the full width of the intake area. The minimum fish target strength (side aspect orientation) able to be monitored was -35 dB. This was equivalent to a fish length of approximately 25 cm.

At Mount Location 3 (Figure 1), on the downstream of the trash racks near the surface, the minimum fish target strength (dorsal) able to be monitored was -26 dB. This was equivalent to a fish length of approximately 100 cm. Large amounts of debris on the trashracks introduced entrained air immediately upstream of this area.

For Mount Location 4 at 4 ft deep, the minimum fish target strength (dorsal) able to be monitored was -34 dB. This was equivalent to a fish length of approximately 35 cm.

Significant noise was observed during all of the tests. This noise was caused primarily by entrained air from flow through the trashracks and from vortices within the intake area. The noise vanished when the turbine units were turned off.

None of the transducer mount locations tested experienced noise levels that would permit monitoring fish less than approximately 25-35 cm in length. This fish size was significantly larger than PG&E's desired minimum size of 2 inches (5 cm).

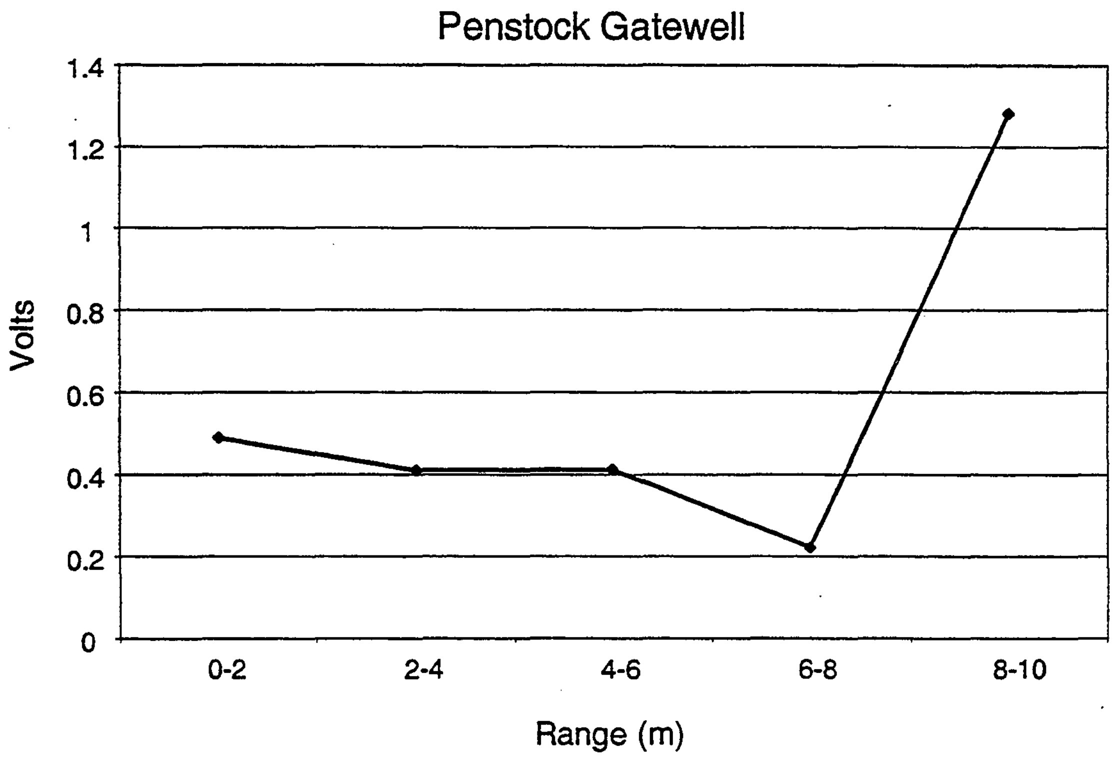

Figure 2. Background noise level with range for transducer Mount Location 1 in the intake area.

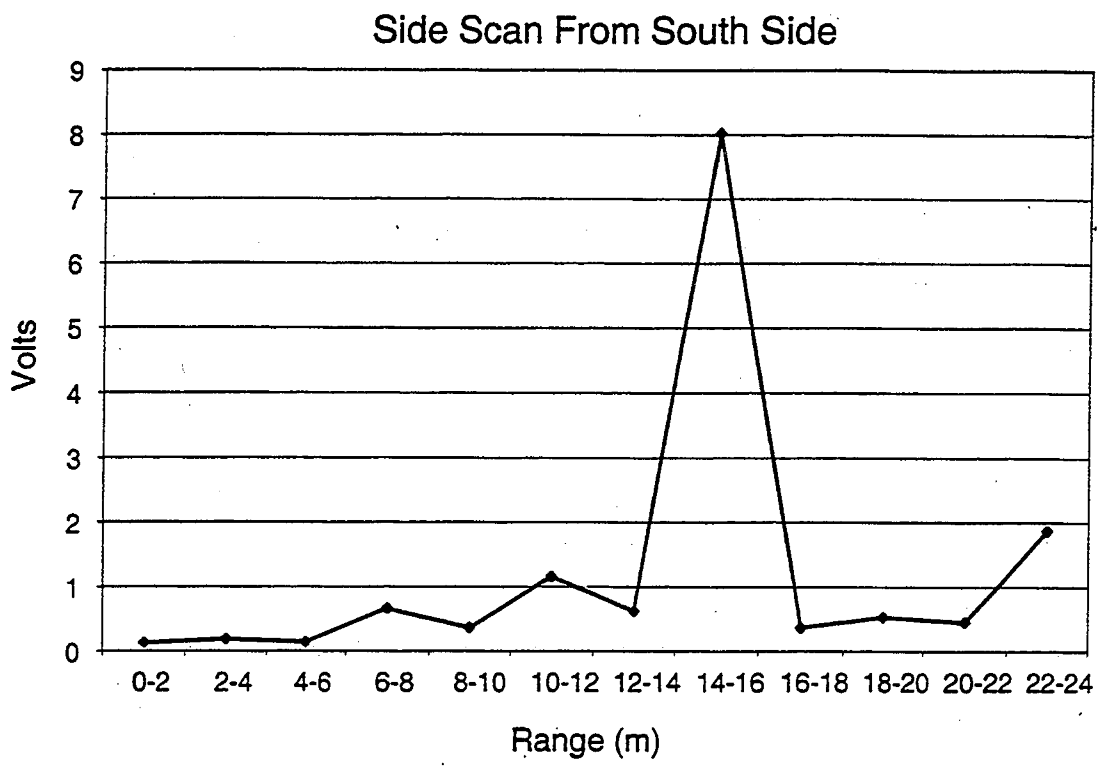

Figure 3. Background noise level with range for transducer Mount Location 2 aimed horizontally across the intake.

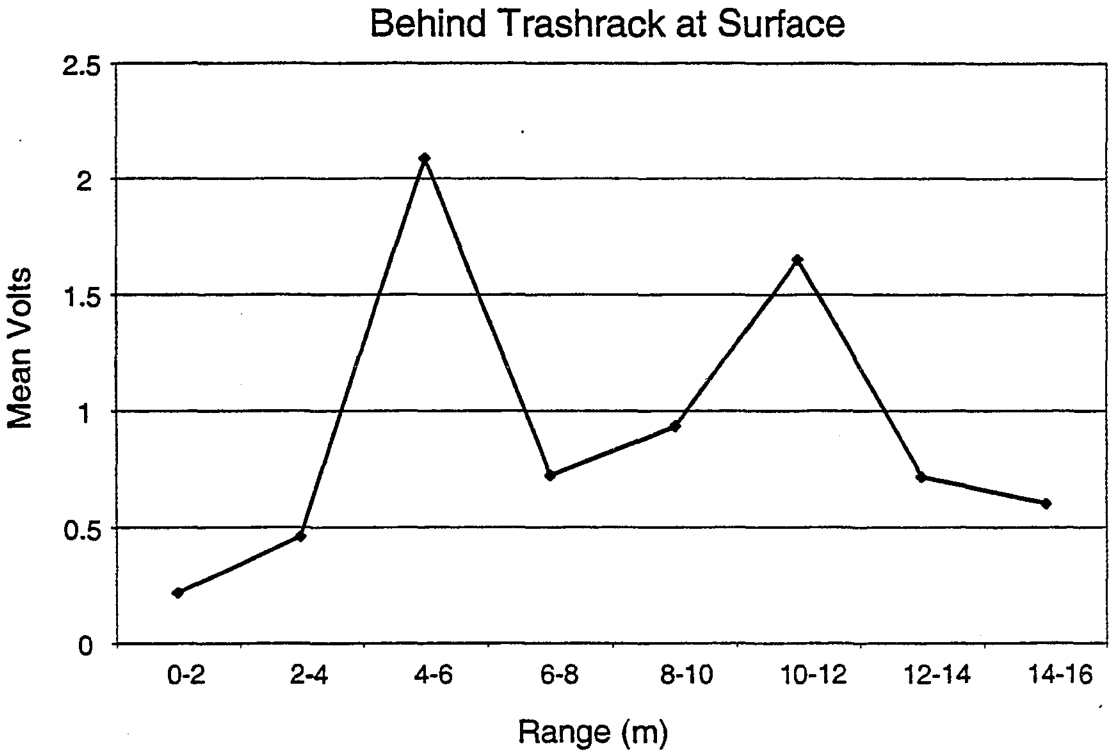

Figure 4. Background noise level with range for transducer Mount Location 3 near the surface.

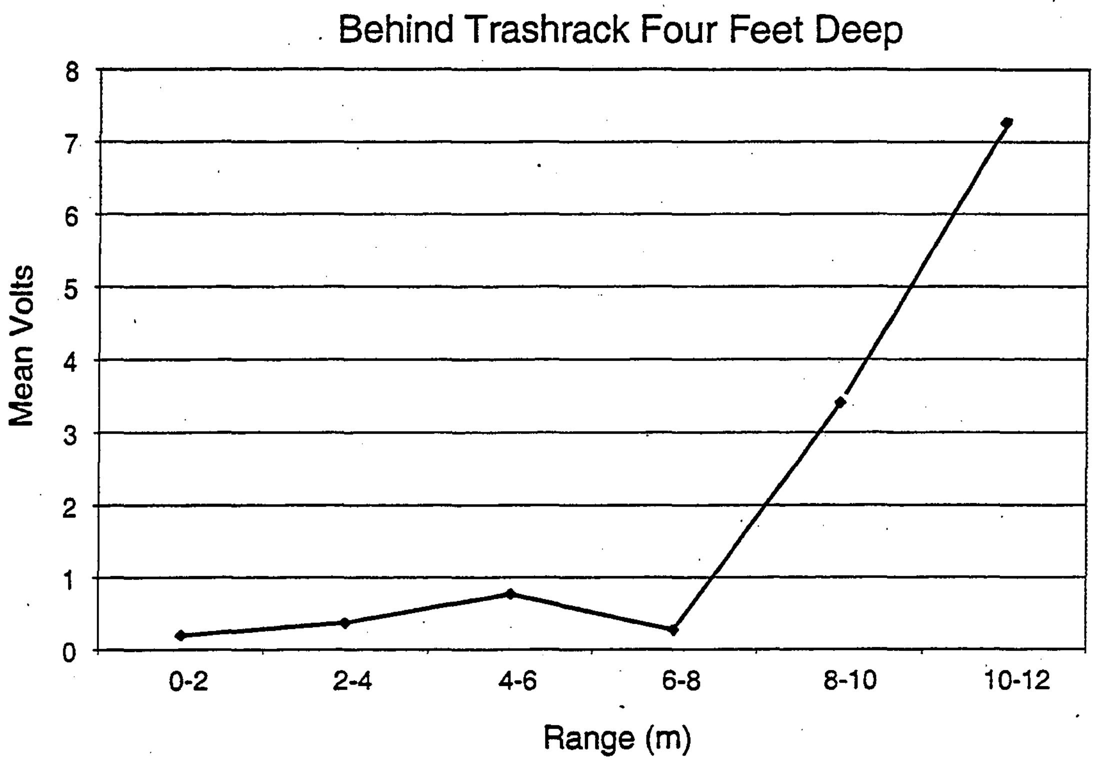

Figure 5. Background noise level with range for transducer Mount Location 4 at 4 ft deep.

5.0 CONCLUSIONS AND RECOMMENDATIONS

1) Signal-to-noise ratios were measured at four locations within the Poe Dam intake area.

2) None of the transducer mount locations tested experienced noise levels that would permit monitoring fish less than approximately 25-35 cm in length. This fish size was significantly larger than PG&E's desired minimum size of 2 inches (5 cm).

3) It may be possible to conduct monitoring by attaching multiple transducers on the trash racks, similar to Mount Location 3 (Figure 6). However, several transducers would be required in order to monitor a significant proportion of the frontal cross-sectional area of the intake. Six transducers would be required to cover all intake bays, and ideally should be mounted near the bottom and aimed upward. It is anticipated that debris removal from the trashracks (via periodic raking) would eliminate entrained air at Mount Location 3 and 4, allowing monitoring of fish of the minimum size of interest. However, this assumption should be verified before consideration of this type of deployment.

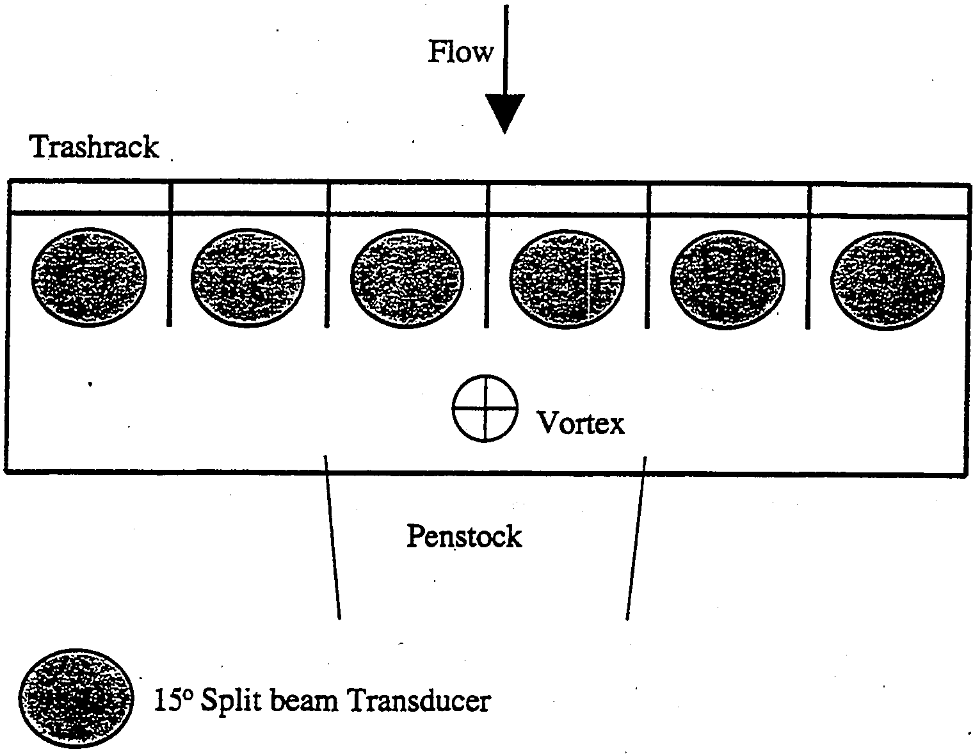

Figure 6. Plan view of Poe Dam intake area, showing potential location of trash rack-mounted transducers.

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POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX E3-4

An Assessment of the Benthic Macroinvertebrate Fauna of Six Reaches of the North Fork Feather River, Butte and Plumas Counties, California, 1999

An Assessment of the Benthic Macroinvertebrate Fauna of Six Reaches of the North Fork Feather River, Butte and Plumas Counties, California
October 1999

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INTRODUCTION

Streams below dams are subject to a number of effects not found in unregulated streams, including but not limited to alterations of natural temperature regimes, water chemistry and hydrology, which in turn affect the limnology and ecology of receiving waters. The literature on the subject is vast; good overviews are provided by Walberg et al. (1981) and Ward and Stanford (1979).

The purpose of the current investigation is to establish the baseline conditions of the benthic macroinvertebrate fauna in six sections of the North Fork Feather River (NFFR). The sections are either unregulated (East Branch), regulated with stable flow patterns (Belden), technically unregulated but with flow from both the unregulated East Branch and the regulated section containing the Belden reach (North Fork) or regulated but with highly varying flows (Rock Creek, Cresta, and Poe). The Belden, Rock Creek, Cresta, and Poe Federal Energy Regulatory Commission (FERC) operating licenses are currently in the renewal process. Some increase in the minimum flows in these reaches is anticipated, but the magnitude of those flows has not been determined.

It has been assumed that increasing the minimum flows will be beneficial to the aquatic biological community. A greater minimum flow may perhaps buffer the effects of sudden changes in flow, thus limiting the variability to which the benthic community is subjected. In areas where the stream has room to spread out, a greater minimum flow will also mean less stranding of invertebrates following extreme flows.

MATERIALS and METHODS

The stream sampling reaches chosen to represent the stream sections were selected with two attributes in mind: access and availability of riffle habitats. Access is limited on the NFFR and riffle habitats are rare. Most riffles are small, little more than gradient breaks, and do not meet the minimum size requirement normally used in stream habitat mapping, i.e., that the unit must be as long as the stream is wide at that location (McCain, et al., 1990). Riffles are used for benthic sampling primarily because they are easily sampled and have long been known to be the major source of production in streams (Hynes, 1970).

THE STREAM SAMPLING REACHES:

- The East Branch sampling reach is on the unregulated East Branch of the NFFR and is 0.5 mi in length, extending from a point approximately 0.4 mi downstream of the Halstead Flat bridge to about 0.1 mi upstream.
- The Belden sampling reach is on the North Fork of the NFFR, which is regulated by Butt Valley Reservoir and the Caribou Afterbay. It is 0.25 mi in length and begins 0.35 mi downstream of Mosquito Creek and ends 0.1 mi downstream of Mosquito Creek.
- The North Fork sampling reach is downstream of the confluence of the East Branch NFFR and the North Fork. This section is partially regulated in that it receives flow from the regulated North Fork and the unregulated East Branch. It is 0.5 mi in length, extending from approximately 0.3 mi upstream of Belden Town (via Howells Road) to about 0.8 mi upstream.
- The Rock Creek section is regulated by Rock Creek Reservoir and the sampling reach begins 0.3 mi downstream of Indian Jim School and ends 0.3 mi upstream near Granite Creek, a distance of 0.6 mi.

• The Cresta section is regulated by Cresta Reservoir, and the sampling reach is 0.4 mi in length and covers the area 0.5 mi to 0.1 mi downstream of Bear Ranch Creek.

• The Poe section is regulated by Poe Reservoir. The sampling reach begins 0.1 mi upstream of the Highway 70 bridge at Pulga and includes the first riffle upstream of Flea Valley Creek, a distance of 0.5 mi.

In every sampling reach California Department of Fish and Game (CDFG) Physical Habitat Quality and California Bioassesment Worksheet forms were filled out. All measurements were taken using standard equipment called for in CDFG's California Stream Bioassment Procedure (CSBP). Copies of these are included as an attachment.

Riffles were selected using the nonpoint source protocol of the CSBP. First, a reach was chosen based on safe access, and then three of the first five upstream riffles were chosen at random for sampling. Samples were collected from three one by two foot areas of stream bottom (when possible from the stream margins and in the thalweg) using a custom made Wildco stream bottom net with detachable bucket. The product of six square feet of bottom was combined as a single composite sample from each riffle, field elutriated to remove stones, sand and large pieces of detritus, placed in plastic jars, and preserved in a10% formalin solution stained with rose bengal dye. Lids with teflon closures were used to prevent leaking. Formalin was used instead of the recommended ethanol because it is vastly superior as a fixative and preservative. Rose bengal dye facilitates picking invertebrates from background detritus. Eighteen composite samples were taken in all, three from each stream reach.

In the laboratory, the formalin was poured off, the samples thoroughly rinsed, and spread out in water on a gridded tray 8" by 12" with 24 equal bottom divisions 2" square. Individual grids were chosen at random and the organisms picked from detritus under a dissecting microscope and transferred to 70% ethanol. At least 300 organisms were picked from each sample as the subsample to be identified. In every case the last grid chosen was picked and identified in its entirety. The CSBP requires a fixed count of 300 (+10%) organisms, but substantially more can apparently be used without altering the quality of information received (Sovell and Vondracek, 1999).

All organisms were identified to the species level using available keys whether they could be assigned specific epithets or not, using morphotypes. Each species was counted, and species lists and counts for each of the three samples from each reach are presented as appendices to this report. Each species was also assigned to a functional feeding group (Merritt and Cummins, 1996) and given a tolerance value provided by CDFG or by educated estimation. The unpicked and unidentified remainder of the samples was represerved in 70% ethanol. A reference collection of each species identified, the identified samples and the unidentified remainder will be curated indefinitely by Hydrozoology. For QA/QC purposes, all of the sample remainders were transferred to the CDFG Aquatic Bioassessment Laboratory at Rancho Cordova, CA, on January 24, 2000. The reference collection generated from this study will be made available to CDFG for QA/QC if so desired.

Data from the species lists were used to calculate the suite of metrics listed in the CSBP, except those (% scrapers, % predators) that show a variable response to stream impairment, and the tolerance/intolerance indices, which are simply another form of the more explanatory

METRIC	REACH/SAMPLE								
	East Branch			Belden			North Fork		
	1	2	3	1	2	3	1	2	3
Species Richness	31	28	35	49	45	48	37	54	32
(total)(mean)(Cv)	(46)(31.3)(9.2)			(74)(47.3)(3.6)			(68)(41.0)(13.2)		
EPT species	13	12	15	15	14	20	15	19	14
(total)(mean)(Cv)	(18)(13.3)(9.3)			(26)(16.3)(16.1)			(23)(16.0)(13.5)		
Ephemeroptera species	6	6	7	5	5	9	5	5	4
(total)(mean)(Cv)	(7)(6.3)(7.5)			(9)(6.3)(30.0)			(7)(4.7)(10.0)		
Plecoptera species	2	2	2	3	2	4	4	5	3
(total)(mean)(Cv)	(4)(2.0)(0.0)			(6)(3.0)(27.3)			(6)(4.0)(20.5)		
Trichoptera species	5	4	6	7	7	7	6	9	7
(total)(mean)(Cv)	(7)(5.0)(16.4)			(11)(7.0)(0.0)			(10)(7.3)(17.0)		

METRIC	REACH/SAMPLE								
	Rock Creek			Cresta			Poe		
	1	2	3	1	2	3	1	2	3
Species Richness	42	50	38	38	41	42	37	33	36
(total)(mean)(Cv)	(65)(43.3)(11.5)			(62)(40.3)(4.2)			(52)(35.3)(4.8)		
EPT species	12	20	14	13	13	14	17	15	16
(total)(mean)(Cv)	(21)(15.3)(22.2)			(20)(13.3)(3.5)			(21)(16.0)(5.1)		
Ephemeroptera species	4	8	5	4	5	6	5	5	5
(total)(mean)(Cv)	(8)(5.7)(29.8)			(7)(5.0)(16.4)			(6)(5.0)(0.0)		
Plecoptera species	2	3	1	1	1	1	3	4	4
(total)(mean)(Cv)	(4)(2.0)(41.0)			(3)(1.0)(0.0)			(5)(3.7)(12.7)		
Trichoptera species	6	9	8	8	7	7	9	6	7
(total)(mean)(Cv)	(9)(7.7)(16.1)			(10)(7.3)(6.4)			(10)(7.3)(17.0		

Table 1. Richness measures of NFFR benthic samples, October 1999.

percentages of intolerant and tolerant organisms. Tables 1-4 present richness, composition, tolerance and feeding group metrics. The coefficient of variation (Cv=s(100/sample mean)), a measure of the sample variability, has been included where appropriate (Table 1).

RESULTS and DISCUSSION

Species richness is probably the most valuable single metric that can be measured since it reflects variability in the habitat, since more species means more different places to live, and is thought to reflect favorably on stability in the benthic community (Patrick, 1970). In response to impairment of the stream reach this metric should decline. It can be seen (Table 1) that the East Branch reach has the lowest species richness (mean = 31.3 species), probably as a result of poor land use practices in the two major stream systems that make up its watershed, Spanish Creek and Indian Creek. The East Branch is generally shallow as a result of excess sediment and suffers from high summer temperatures.

The North Fork section of the NFFR, site of the Belden reach, is a regulated stream and no doubt suffers from some habitat degradation, but does not experience the drastic changes in flow that are typical of the Rock Creek, Cresta, and Poe sections of the NFFR. It has the appearance of a natural stream and operates at fixed summer and winter flows. As a result, the Belden reach had the highest species richness measured (mean = 47.3 species). The next section, fed by the North Fork and the East Branch, is the site of the North Fork reach, which also had a high species richness (mean = 41 species). Of the remaining sections, Rock Creek has the advantage of a wider channel than Cresta or Poe, so that the energy of high flows can be dissipated over a greater area. Also, substantial deposition of sediment is possible, resulting in not only more but more varied riffle habitat. The mean number of species in the Rock Creek reach was 43.3, in the Cresta reach 40.3, and in the Poe reach, 35.3.

EPT stands for Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). This metric is based on the assumption that these three orders of aquatic insects are more sensitive to impairment than any of the others. If this is true, then this metric and the number of species in the orders that make it up can also be expected to decline with a decline in the quality of the habitat. The difficulty here is that most of the species present in two of the orders (Ephemeroptera and Trichoptera) are relatively insensitive to impairment. At the order level only Plecoptera, as a general rule, are sensitive to even moderate impairment. We see as a result that in the best habitat available (represented by the Belden reach) there are not many more EPT species than in the other reaches, with the exception of the East Branch.

Table 2 lists the composition measures for each reach. The EPT indices (the percentage of EPT species in the samples) are high, but reflect an abundance of the Ephemeroptera and Trichoptera species discussed above, those that are relatively tolerant. This is borne out by inspection of the second line of the table, sensitive EPT species, or those known to be intolerant of impairment (tolerance values of 0, 1, 2 or 3 in the appendices). This group contains few species, and it is interesting to note that the highest percentage of sensitive species was found in samples from the East Branch, which although impaired is still a naturally flowing stream.

The final section of Table 2 is devoted to species diversity, a single unitless number representing both species richness (above) and evenness, a measure of how taxa are arrayed within a sample. A sample with species in equal numbers is considered more diverse than one in which most of the sample is given over to one or a few species (Magurran, 1988). CDFG suggests that the Shannon-Wiener diversity index (H') be calculated for benthic samples, but

METRIC	REACH/SAMPLE								
	East Branch			Belden			North Fork		
	1	2	3	1	2	3	1	2	3
EPT Index	0.75	0.80	0.80	0.64	0.56	0.65	0.68	0.43	0.85
(mean)		(0.78)			(0.62)			(0.64)	
Sensitive EPT Index	0.12	0.24	0.10	0.10	0.07	0.12	0.07	0.04	0.11
(mean)		(0.15)			(0.09)			(0.07)	
Brillouin Diversity Index, H	3.40	3.14	2.96	4.03	4.07	4.21	3.82	4.45	3.23
Shannon Diversity Index, H'	3.62	3.32	3.17	4.37	4.36	4.54	4.09	4.80	3.43
(mean H) / (mean H')		(3.17) / (3.37)			(4.10) / (4.42)			(3.83) / (4.11)	

METRIC	REACH/SAMPLE								
	Rock Creek			Cresta			Poe		
	1	2	3	1	2	3	1	2	3
EPT Index	0.66	0.64	0.78	0.47	0.46	0.54	0.83	0.80	0.68
(mean)		(0.69)			(0.49)			(0.78)	
Sensitive EPT Index	0.03	0.06	0.04	0.02	0.04	0.02	0.08	0.04	0.05
(mean)		(0.04)			(0.03)			(0.06)	
Brillouin Diversity Index, H	3.79	4.26	3.56	3.55	3.64	3.50	3.60	3.36	3.80
Shannon Diversity Index, H'	4.07	4.58	3.80	3.77	3.89	3.76	3.86	3.55	4.06
(mean H) / (mean H')		(3.87) / (4.15)			(3.56) / (3.81)			(3.59) / (3.82)	

Table 2. Composition measures of NFFR benthic samples, October 1999.

METRIC	REACH/SAMPLE								
	East Branch			Belden			North Fork		
	1	2	3	1	2	3	1	2	3
% Intolerant Species	0.12	0.24	0.12	0.10	0.07	0.12	0.06	0.09	0.12
(mean)		(0.16)			(0.10)			(0.09)	
% Tolerant Species	0.03	0.01	0.01	0.05	0.01	0.03	0.02	0.00	0.02
(mean)		(0.01)			(0.03)			(0.01)	
% Hydropsychidae	0.46	0.50	0.60	0.28	0.25	0.25	0.26	0.19	0.47
(mean)		(0.52)			(0.26)			(0.30)	
% Baetidae	0.15	0.05	0.08	0.23	0.21	0.22	0.23	0.15	0.22
(mean)		(0.09)			(0.22)			(0.20)	
% Dominant Taxon	0.26	0.29	0.30	0.25	0.20	0.18	0.17	0.13	0.34
(mean)		(0.28)			(0.21)			(0.21)	

METRIC	REACH/SAMPLE								
	Rock Creek			Cresta			Poe		
	1	2	3	1	2	3	1	2	3
% Intolerant Species	0.04	0.06	0.03	0.02	0.04	0.03	0.08	0.04	0.05
(mean)		(0.05)			(0.03)			(0.06)	
% Tolerant Species	0.03	0.06	0.03	0.05	0.04	0.06	0.02	0.02	0.05
(mean)		(0.04)			(0.05)			(0.03)	
% Hydropsychidae	0.28	0.19	0.29	0.09	0.08	0.04	0.51	0.54	0.35
(mean)		(0.26)			(0.07)			(0.47)	
% Baetidae	0.30	0.22	0.33	0.29	0.30	0.41	0.08	0.13	0.10
(mean)		(0.28)			(0.33)			(0.11)	
% Dominant Taxon	0.26	0.19	0.28	0.28	0.30	0.39	0.24	0.28	0.18
(mean)		(0.25)			(0.32)			(0.24)	

Table 3. Tolerance/Intolerance measures of NFFR benthic samples, October 1999.

this report uses the more appropriate Brillouin (1962) diversity index (H). The Shannon index makes the following assumptions: that individuals are chosen randomly (not true, since our sampling procedure is stratified), that individuals are chosen from an infinite population (untrue), and that all the species in the population are represented in the sample (never) (Pielou, 1966, 1975, Kaesler and Herricks 1978, Kaesler et al. 1978, Krueger et al. 1988, and Magurran 1988). The Brillouin index makes none of these assumptions and is instead a measure of the diversity of the sample itself. The Shannon-Wiener index is listed in the table for comparison's sake only. In addition to its other defects as an index, it can be seen that it invariably overstates the actual species diversity.

The highest species diversities are, predictably, from samples collected in the Belden Reach. Diversity indices from the North Fork Reach and the Rock Creek reach are similar to each other and relatively high, while those of the Cresta and Poe reaches are moderate. The relatively low species diversity of the East Branch is probably a function of lack of species richness. According to Magurran (1988) the Brillouin species diversity index is particularly sensitive to species richness.

Table 3 presents tolerance and intolerance measures, beginning with the percentages of intolerant species (tolerance values of 0, 1, or 2) and tolerant species (values of 8, 9, or 10). The East Branch has by far the highest percentage of intolerant species and the values generally decline as one goes downstream. The Cresta reach has the lowest percentage of intolerant organisms. Species tolerant of impairment are most common in the Cresta reach, but as there are few truly tolerant species on the lists, the values are generally low throughout the system.

The next two metrics deal with the insect families that were the most abundant members of the orders Trichoptera and Ephemeroptera previously discussed as being relatively insensitive to impairment (Table 1). The families Hydropsychidae (Trichoptera) and Baetidae (Ephemeroptera) combined made up 40% of the fauna in the reach where they were the least common (Cresta) and 61% where they were the most common (East Branch). Hydropsychidae made up over a quarter of the fauna everywhere except the Cresta reach. Baetidae made up at least 20% of the fauna everywhere except the East Branch reach. These families are expected to become more common with increased habitat degradation. They are the dominant taxa of the NFFR and one species from each of these families appears as the dominant taxon in the last part of Table 3. In most samples the dominant taxon was a member of the Hydropsychidae, but in the Rock Creek and Cresta reaches it was the mayfly *Baetis tricaudatus*, the most widespread mayfly in California.

Table 4 presents three metrics, the first two of which should increase as a result of impairment. Collector/gatherers are detritus feeders, and their percentages are highest in the Cresta and Rock Creek reaches, but moderately high in the Belden and North Fork reaches, and at substantial levels in the East Branch and Poe reaches. Filterers strain small particles from the water column and are extremely successful in the East Branch (mean = 54%) and Cresta (mean = 63%) reaches, and common in the remaining reaches.

The last part of Table 4 deals with shredders, animals that chew up vegetable matter and thereby introduce this primarily terrestrial form of energy into the stream ecosystem. The percentage of shredders is expected to decrease in the event of impairment. In the NFFR it is generally low throughout the system, but highest in the Cresta reach, an artifact of the abundance of the Chironomid genus *Cricotopus*, small fly (Diptera) larvae. Shredder abundance

METRIC	REACH/SAMPLE								
	East Branch			Belden			North Fork		
	1	2	3	1	2	3	1	2	3
% Collectors	0.34	0.20	0.22	0.42	0.39	0.39	0.35	0.55	0.30
(mean)		(0.25)			(0.40)			(0.39)	
% Filterers	0.48	0.51	0.62	0.32	0.33	0.31	0.40	0.21	0.51
(mean)		(0.54)			(0.32)			(0.37)	
% Shredders	0.05	0.04	0.01	0.05	0.07	0.09	0.10	0.07	0.01
(mean)		(0.03)			(0.07)			(0.06)	
METRIC	REACH/SAMPLE								
	Rock Creek			Cresta			Poe		
	1	2	3	1	2	3	1	2	3
% Collectors	0.48	0.53	0.45	0.44	0.55	.60	0.18	0.20	0.27
(mean)		(0.49)			(0.53)			(0.22)	
% Filterers	0.33	0.32	0.42	0.42	0.25	0.15	0.63	0.66	0.59
(mean)		(0.36)			(0.28)			(0.63)	
% Shredders	0.04	0.06	0.02	0.07	0.10	0.13	0.03	0.05	0.05
(mean)		(0.04)			(0.10)			(0.04)	

Table 4. Functional feeding group measures of NFFR benthic samples, October 1999.

is a seasonal phenomenon, and the percentage of shredders in the system prior to leaf fall is expected to be low. Following leaf fall, it is likely that the percentage of shredders will be highest in the only reach with substantial vegetation close to the stream (Belden).

In the 18 samples taken for this study, 124 species were collected. The vast majority of the organisms were found in a core group of about 30 species, which were collected in all or nearly all reaches. Ten species were represented by single individuals and a larger number by no more than two or three.

Secondary production in the NFFR is generally high (see the extrapolated totals at the end of each reach species list), ranging from 3465 organisms/M^2 in one sample from the Belden reach to 16872 organisms/M^2 in a sample from the Cresta reach.

The California Bioassessment Worksheets and Physical Habitat quality forms included with this report reflect stream reaches that are generally optimal or suboptimal in most respects except for marginal conditions conferred by a lack of riffles and poor conditions as a result of lack of riparian vegetation on the mainstem of the NFFR. The exception is the Belden reach, which has both abundant riffles and a vigorous riparian zone. Embeddedness is low to moderate throughout, but boulders, a poor substrate for macroinvertebrate production, are common in the gravel-starved reaches of Rock Creek, Cresta and Poe.

The various sections of the NFFR all suffer from anthropogenic disturbances of one type or another. The least affected is clearly the North Fork of the NFFR, here represented by the Belden sampling reach, which has a flow stability that allows it to retain a healthy riparian zone absent from most of the rest of the river. The most affected is probably the Cresta section, with the narrowest natural channel further constricted by Highway 70 and the railroad and sidecasting from their construction. Poor land use practices in the East Branch watershed, primarily overgrazing, keep it from having the unaffected condition in which it could serve as an experimental control for comparison with other parts of the NFFR.

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EAST BRANCH REACH

TAXON	TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
Phylum Platyhelminthes					
Family Planariidae /*Dugesia tigrina*	collector/gatherer	*4*	2		3
P. Nemertea					
F. Tetrastemmatidae /*Prostoma graecense*	predator	*4*	2	2	4
P. Annelida					
F. Naididae /*Nais communis/variabilis*	collector/gatherer	*5*	1	1	
/*N. pardalis*	collector/gatherer	*6*	3	1	
/*N. simplex*	collector/gatherer	*6*		2	1
F. Tubificidae /*Bothrioneurum vejdovskyanum*	collector/gatherer	*8*	3		
F. Lumbriculidae /unidentified species	collector/gatherer	*4*	2		
P. Arthropoda					
Class Insecta					
Order Ephemeroptera					
F. Baetidae /*Baetis insignificans*	collector/gatherer	*5*	16	3	2
/*B. tricaudatus*	collector/gatherer	*5*	32	13	22
F. Ephemerellidae /*Ephemerella inermis*	collector/gatherer	*0*	3	1	6
F. Heptageniidae/*Epeorus* sp. (subgenus *Iron*)	scraper	*0*	1	4	2
/*Rhithrogena* sp.	scraper	*0*	4	22	2
eptophlebiidae /*Paraleptophlebia* sp.	collector/gatherer	*4*			1
F. Tricorythidae/*Tricorythodes minutus*	collector/gatherer	*5*	2	2	1
O. Odonata					
F. Gomphidae /*Ophiogomphus occidentis*	predator	*1*	1		1
O. Plecoptera					
F. Chloroperlidae /*Sweltsa* sp.	predator	*1*			1
F. Perlidae /*Calineuria californica*	predator	*1*	1		
/*Hesperoperla pacifica*	predator	*2*		3	
F. Perlodidae /*Isoperla* sp.	predator	*2*	24	37	20
O. Trichoptera					
F. Hydropsychidae /*Ceratopsyche cockerelli*	collector/filterer	*4*			1
/*Cheumatopsyche campyla*	collector/filterer	*5*	63	95	92
/*Hydropsyche occidentalis*	collector/filterer	*4*	81	72	94
F. Hydroptilidae /*Hydroptila* sp. B	herbivore	*6*			2
F. Lepidostomatidae /*Lepidostoma* sp. B	shredder	*1*	3	11	3
F. Leptoceridae /*Ceraclea* sp.	collector/gatherer	*3*	1		
F. Philopotamidae /*Chimarra utahensis*	collector/filterer	*4*	3	1	1
O. Lepidoptera					
F. Pyralidae /*Petrophila* sp.	scraper	*5*	1	1	3
O. Coleoptera					
F. Elmidae /*Microcylloepus* sp.	collector/gatherer	*2*	2		
/*Optioservus quadrimaculatus*	scraper		4	7	5
/*Ordobrevia nubifera*	collector/gatherer	*4*			1
/*Zaitzevia parvula*	collector/gatherer	*4*	14	27	25
O. Diptera					
F. Ceratopogonidae /*Probezzia* sp.	predator	*6*			1
Chironomidae/*Rheotanytarsus* sp. A	collector/filterer	*6*			1
/*Rheotanytarsus* sp. B	collector/filterer	*6*			1

EAST BRANCH REACH

TAXON		TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
F. Chironomidae/*Cardiocladius* sp.		predator	*5*		5	
	/ *Cricotopus bicinctus*	shredder	*7*	10	1	
	/ *C. tremulus*	shredder	*7*	4		1
	/ *Eukiefferiella* sp. B	collector/gatherer	*8*	6	3	2
	/ *Lopescladius* sp.	collector/gatherer	*6*		1	
	/ *Orthocladius robacki*	collector/gatherer	*6*	2	1	2
	/ *Tvetenia* sp.	collector/gatherer	*5*		1	1
F. Simuliidae	/ *Simulium tuberosum*	collector/filterer	*6*	2		4
F. Tipulidae	/ *Antocha* sp.	collector/gatherer	*3*	13	9	1
F. Athericidae	/ *Atherix* sp.	predator	*2*			2
F. Empididae	/ *Hemerodromia* sp. A	predator	*6*			1
Cl. Arachnida						
O. Hydracarina						
F. Hygrobatidae/uid species		predator	*5*		1	
F. Sperchontidae	/ *Sperchon* sp. A	predator	*5*	4	4	1
			TOTAL SPECIES/SUBSAMPLE	31	28	35
			TOTAL SPECIES (REACH)		46	
			TOTAL NUMBER/SUBSAMPLE	310	331	311
			TOTAL NUMBER/SAMPLE (EXTRAPOLATED)	7440	7944	7464

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BELDEN REACH

TAXON		TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
Phylum Platyhelminthes						
Family Planariidae	/ *Dugesia tigrina*	collector/gatherer	*4*	1	1	
P. Nemertea						
F. Tetrastemmatidae	/ *Prostoma graecense*	predator	*4*	5	7	10
P. Nematoda						
F. Mermithidae	/unidentified species A	parasite	*5*	3	3	3
P. Annelida						
Class Oligochaeta						
F. Haplotaxidae	/ *Haplotaxis* cf. *gordoiodes*	collector/gatherer	6	2		
F. Naididae	/ *Nais bicuspidalis*	collector/gatherer	*6*			2
	/ *N. communis/variabilis*	collector/gatherer	*6*	1		
	/ *N. simplex*	collector/gatherer	*6*	3	4	10
F. Tubificidae	/ *Spirosperma ferox*	collector/gatherer	*8*	1		
F. Enchytraeidae	/uid species C	collector/gatherer	*4*		11	4
F. Lumbricidae	/uid species	collector/gatherer	*5*	6	12	10
F. Lumbriculidae	/ *Rhynchelmis rostrata*	collector/gatherer	*6*	1		1
	/uid species	collector/gatherer	*4*	10	1	
Cl. Polychaeta						
Sabellidae	/ *Manayunkia speciosa*	collector/filterer	*6*		22	3
. . Arthropoda						
Cl. Insecta						
O. Ephemeroptera						
F. Ameletidae	/ *Ameletus* sp.	scraper	*0*		1	1
F. Baetidae	/ *Baetis insignificans*	collector/gatherer	*5*	21	32	24
	/ *B. tricaudatus*	collector/gatherer	*5*	49	35	44
F. Ephemerellidae	/ *Ephemerella inermis*	collector/gatherer	*0*			2
F. Heptageniidae	/ *Epeorus* sp. (subgenus *Iron*)	scraper	*0*	6	7	8
	/ *Ironodes* sp.	scraper	*0*			1
	/ *Rhithrogena* sp.	scraper	*0*	5		6
F. Leptophlebiidae	/ *Paraleptophlebia* sp.	collector/gatherer	*4*			1
F. Tricorythidae	/ *Tricorythodes minutus*	collector/gatherer	*5*	3	4	3
O. Odonata						
F. Gomphidae	/ *Ophiogomphus occidentis*	predator	*1*	2	2	
O. Plecoptera						
F. Chloroperlidae	/ *Paraperla* sp.	predator	*1*			1
	/ *Sweltsa* sp.	predator	*1*	5		2
F. Perlidae	/ *Calineuria californica*	predator	*1*		1	
	/ *Hesperoperla pacifica*	predator	*2*	1		
F. Perlodidae	/ *Isoperla* sp.	predator	*2*	5		2
	/ *Skwala parallela*	predator	*2*		1	2
O. Megaloptera						
F. Corydalidae	/ *Orohermes crepusculus*	predator	*0*		1	
O. Trichoptera						
F. Brachycentridae	/ *Amiocentrus aspilus*	collector/gatherer	*1*		1	
	/ *Micrasema* sp.	shredder	*3*	5	5	10

BELDEN REACH

TAXON		TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
O. Trichoptera						
F. Glossosomatidae	/ *Anagapetus* sp.	scraper	0	1		
	/ *Glossosoma* sp.	scraper	0			3
F. Hydropsychidae	/ *Ceratopsyche cockerelli*	collector/filterer	4		1	
	/ *Cheumatopsyche campyla*	collector/filterer	5	9	16	22
	/ *Hydropsyche californica*	collector/filterer	4			1
	/ *Hydropsyche occidentalis*	collector/filterer	4	75	65	54
F. Hydroptilidae	/ *Hydroptila* sp. B	herbivore	6	4	4	5
F. Lepidostomatidae	/ *Lepidostoma* sp. B	shredder	1	6	8	9
F. Leptoceridae	/ *Ceraclea* sp.	collector/gatherer	3	1		
O. Lepidoptera						
F. Pyralidae	/ *Petrophila* sp.	scraper	5	4	7	1
O. Coleoptera						
F. Elmidae	/ *Heterlimnius* sp.	collector/gatherer	4	1	1	1
	/ *Optioservus quadrimaculatus*	scraper	4	2	2	2
	/ *Zaitzevia parvula*	collector/gatherer	4	4	1	1
O. Diptera						
F. Chironomidae	/ *Rheotanytarsus* sp. B	collector/filterer	6		1	
	/ *Sublettea* sp.	collector/gatherer	5		2	
	/ *Phaenopsectra* sp. C	collector/gatherer	7		1	
	/ *Cardiocladius* sp.	predator	5		2	1
	/ *Cricotopus bicinctus*	shredder	7	1	3	3
	/ *C. tremulus*	shredder	7	4	7	5
	/ *Eukiefferiella* sp. B	collector/gatherer	8	1	2	
	/ *Eukiefferiella* sp. E	collector/gatherer	8			1
	/ *Orthocladius obumbratus*	collector/gatherer	6	2	2	1
	/ *O. robacki*	collector/gatherer	6	5	5	3
	/ *Synorthocladius* sp.	collector/gatherer	2	1		
	/ uid Orthocladiinae pupa sp. C	nonfeeding	5	1		
	/ *Potthastia* sp.	collector/gatherer	6	7	2	3
F. Simuliidae	/ *Simulium tuberosum*	collector/filterer	6	1		
	/ *S. virgatum*	collector/filterer	6	1		
F. Tipulidae	/ *Antocha* sp.	collector/gatherer	3	6	10	8
F. Empididae	/ *Clinocera* sp.	predator	6	1		
	/ *Hemerodromia* sp. B	predator	6	1		
	/ *Wiedemannia* sp. B	predator	6	1		
Cl. Arachnida						
O. Hydracarina						
F. Hygrobatidae	/ *Hygrobates* sp.	predator	5	6	1	
F. Lebertiidae	/ *Lebertia* sp	predator	5	3	2	3
F. Sperchontidae	/ *Sperchon* sp. A	predator	5	7	20	14
F. Torrenticolidae	/ *Torrenticola* sp.	predator	5			1
P. Mollusca						
Cl. Gastropoda						
F. Planorbidae	/ *Neoplanorbis* sp.	scraper	6		1	3
	/ *Planorbella* sp.	scraper	6		1	
	/ *Vorticifex effusus*	scraper	6		4	2
Pleuroceridae	/ uid species	scraper	6			2

BELDEN REACH

TAXON	TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
Cl. Bivalvia					
F. Corbiculidae / *Corbicula fluminea*	filterer	*10*	4		5
F. Sphaeriidae / *Pisidium casertanum*	filterer	*8*	8		4
		TOTAL SPECIES/SUBSAMPLE	49	45	48
		TOTAL SPECIES (REACH)		74	
		TOTAL NUMBER/SUBSAMPLE	303	322	308
		TOTAL NUMBER/SAMPLE (EXTRAPOLATED)	3660	1932	3900

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NORTH FORK REACH

TAXON		TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
Phylum Platyhelminthes						
Family Planariidae	/ *Dugesia tigrina*	collector/gatherer	*4*	2	1	1
P. Nemertea						
F. Tetrastemmatidae	/ *Prostoma graecense*	predator	*4*	13	7	3
P. Nematoda						
F. Dorylaimidae	/ *Dorylaimus* sp.	predator	*5*	2		
F. Mermithidae	/unidentified species A	parasite	*5*		1	
P. Annelida						
F Haplotaxidae	/*Haplotaxis* cf. *gordioides*	collector/gatherer	6		6	
F. Naididae	/ *Nais bicuspidalis*	collector/gatherer	*6*		18	
	/ *N. communis/variabilis*	collector/gatherer	*6*	1	1	
	/ *N. simplex*	collector/gatherer	*6*	1	17	2
F. Lumbriculidae	/*Rhynchelmis rostrata*	collector/gatherer	6		1	
	/uid species	collector/gatherer	*4*		3	
P. Arthropoda						
Class Crustacea						
Order Ostracoda						
F. Cyprididae	/ *Isocypris* sp.	collector/gatherer	5	1		
Insecta						
‿. Ephemeroptera						
F. Baetidae	/ *Baetis insignificans*	collector/gatherer	*5*	17	20	20
	/ *B. tricaudatus*	collector/gatherer	*5*	53	28	53
	/ *Baetis* sp.	collector/gatherer	*5*	1		
F. Ephemerellidae	/ *Drunella spinifera*	predator	*0*	2		
F. Heptageniidae	/*Epeorus* sp. (subgenus *Iron*)	scraper	*0*	9	1	9
	/ *Rhithrogena* sp.	scraper	*0*		1	10
F. Tricorythidae	/*Tricorythodes minutus*	collector/gatherer	*5*		7	
O. Plecoptera						
F. Leuctridae	/uid species	shredder	*0*		1	
F. Chloroperlidae	/ *Sweltsa* sp.	predator	*1*		1	1
F. Perlidae	/ *Calineuria californica*	predator	*1*	1	1	
	/ *Hesperoperla pacifica*	predator	*2*	3		
F. Perlodidae	/ *Isoperla* sp.	predator	*2*	5	5	13
	/ *Skwala parallela*	predator	*2*	1	1	1
O. Trichoptera						
F. Brachycentridae	/ *Amiocentrus aspilus*	collector/gatherer	*1*		1	
F. Glossosomatidae	/ *Protoptila* sp.	scraper	*1*		1	1
F. Hydropsychidae	/ *Ceratopsyche cockerelli*	collector/filterer	*4*		1	3
	/ *Cheumatopsyche campyla*	collector/filterer	*5*	41	17	41
	/ *Hydropsyche occidentalis*	collector/filterer	*4*	41	41	110
F. Hydroptilidae	/ *Hydroptila* sp. B	herbivore	*6*	2	1	2
	/ *Leucotrichia pictipes*	scraper	*6*	1	1	
F. Leptoceridae	/ *Ceraclea* sp.	collector/gatherer	*3*		6	
O Trichoptera						
hilopotamidae	/ *Chimarra utahensis*	collector/filterer	*4*	32	1	11
F. Rhyacophilidae	/ *Rhyacophila coloradensis*	predator	*0*	1		1

NORTH FORK REACH

TAXON		TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
O. Lepidoptera						
F. Pyralidae	/ *Petrophila* sp.	scraper	*5*		1	
O. Coleoptera						
F. Elmidae	/ *Microcylloepus* sp.	collector/gatherer	*2*		1	1
	/ *Optioservus quadrimaculatus*	scraper	*5*	2	3	3
	/ *Ordobrevia nubifera*	collector/gatherer	*4*		1	
	/ *Zaitzevia parvula*	collector/gatherer	*4*	7	13	5
O. Diptera						
F. Chironomidae	/ *Trissopelopia* sp.	predator	*6*		9	1
	/ *Micropsectra* sp.	collector/gatherer	*7*		1	
	/ *Rheotanytarsus* sp. B	collector/filterer	*6*	2	1	
	/ *Microtendipes* sp. C	collector/gatherer	*6*		1	
	/ *Microtendipes* sp. (pupa)	nonfeeding	*6*		1	
	/ *Robackia demeijerei*	collector/gatherer	*6*	1	1	
	/ *Cardiocladius* sp.	predator	*5*	1		
	/ *Cricotopus bicinctus*	shredder	*7*	13	15	
	/ *C. tremulus*	shredder	*7*	14	6	6
	/ *C. trifascia*	shredder	*7*	3		
	/ *Eukiefferiella* sp. B	collector/gatherer	*8*	3		6
	/ *Eukiefferiella* sp. C (pupa)	nonfeeding	*8*	1		
	/ *Eukiefferiella* sp. (pupa)	nonfeeding	*8*	1		
	/ *Orthocladius obumbratus*	collector/gatherer	*6*	2	1	1
	/ *O. robacki*	collector/gatherer	*6*	1	7	1
	/ *Rheocricotopus* sp. (pupa)	nonfeeding	*6*		1	
	/ *Synorthocladius* sp.	collector/gatherer	*2*		10	
	/ *Thienemanniella* sp.	collector/gatherer	*6*		2	
	/ *Tvetenia* sp.	collector/gatherer	*5*			1
	/ *Potthastia* sp.	collector/gatherer	*6*	2	16	
F. Simuliidae	/ *Simulium tuberosum*	collector/filterer	*6*	7	5	2
F. Tipulidae	/ *Antocha* sp.	collector/gatherer	*3*	16	10	7
	/ *Hexatoma* sp. B	predator	*2*		3	
F. Athericidae	/ *Atherix* sp.	predator	*2*		1	1
F. Empididae	/ *Hemerodromia* sp. A	predator	*6*		3	4
	/ *Hemerodromia* sp. B	predator	*6*			1
Cl. Arachnida						
O. Hydracarina						
F. Hygrobatidae	/ *Hygrobates* sp.	predator	*5*		2	
F. Sperchontidae	/ *Sperchon* sp.A	predator	*5*	4	8	4
	/ *Sperchon* sp. B	predator	*5*	1		
			TOTAL SPECIES/SUBSAMPLE	39	54	32
			TOTAL SPECIES (REACH)		68	
			TOTAL NUMBER/SUBSAMPLE	311	314	326
			TOTAL NUMBER/SAMPLE (EXTRAPOLATED)	2488	2512	2608

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ROCK CREEK REACH

TAXON		TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
Phylum Platyhelminthes						
Family Planariidae	/ *Dugesia tigrina*	collector/gatherer	*4*	17	3	
P. Nemertea						
F. Tetrastemmatidae	/ *Prostoma graecense*	predator	*4*	7	3	
P. Nematoda						
F. Mermithidae	/unidentified species A	parasite	*5*			1
	/uid species B	parasite	*5*	1		
P. Annelida						
F. Haplotaxidae	/*Haplotaxis* cf. *gordioides*	collector/gatherer	6	2	7	1
F. Naididae	/ *Nais bicuspidalis*	collector/gatherer	*6*	1	7	7
	/ *N. simplex*	collector/gatherer	*6*	1	7	5
F. Tubificidae	/ *Spirosperma ferox*	collector/gatherer	*8*	3	3	
F. Enchytraeidae	/uid species C	collector/gatherer	*4*		1	
	/uid species E	collector/gatherer	*4*		1	
F. Lumbricidae	/uid species	collector/gatherer	*5*		4	
F. Lumbriculidae	/*Rhynchelmis rostrata*	collector/gatherer	*6*	2		
	/uid species	collector/gatherer	*4*	2	1	
P. Arthropoda						
ss Crustacea						
..der Amphipoda						
F. Crangonyctidae	/ *Synurella* sp.	collector/gatherer	*4*		1	
Cl. Insecta						
O. Ephemeroptera						
F. Baetidae	/ *Baetis insignificans*	collector/gatherer	*5*	11	9	16
	/ *B. tricaudatus*	collector/gatherer	*5*	83	61	94
	/ *Diphetor hageni*	collector/gatherer	*4*		1	
F. Ephemerellidae	/ *Ephemerella inermis*	collector/gatherer	*0*		3	
F. Heptageniidae	/*Epeorus* sp. (subgenus *Iron*	scraper	*0*	4	5	6
	/ *Rhithrogena* sp.	scraper	*0*		3	1
F. Leptophlebiidae	/ *Paraleptophlebia* sp.	collector/gatherer	*4*		1	
F. Tricorythidae	/*Tricorythodes minutus*	collector/gatherer	*5*	2	10	1
O. Plecoptera						
F. Chloroperlidae	/ *Sweltsa* sp	predator	*1*	1		
F. Perlodidae	/ *Isoperla* sp.	predator	*2*	5	5	6
	/ *Oroperla barbara*	predator	*2*		1	
	/ *Skwala parallela*	predator	*2*		2	
O. Trichoptera						
F. Hydropsychidae	/ *Ceratopsyche cockerelli*	collector/filterer	*4*		1	2
	/ *Cheumatopsyche campyla*	collector/filterer	*5*	22	28	25
	/ *Hydropsyche californica*	collector/filterer	*4*	13	6	10
	/ *Hydropsyche occidentalis*	collector/filterer	*4*	54	27	60
F. Hydroptilidae	/ *Hydroptila* sp. B	herbivore	*6*	2	2	5
	/ *Leucotrichia pictipes*	scraper	*6*	1	2	4
F Leptoceridae	/ *Ceraclea* sp.	collector/gatherer	*3*		4	
..hilopotamidae	/ *Chimarra utahensis*	collector/filterer	*4*	9	31	26
F. Polycentropodidae	/ *Polycentropus* sp.	predator	*6*		1	2

ROCK CREEK REACH

TAXON	TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
O. Lepidoptera					
F. Pyralidae / *Petrophila* sp.	scraper	*5*	1	1	1
O. Coleoptera					
F. Elmidae / *Microcylloepus* sp.	collector/gatherer	*2*	1		
/ *Zaitzevia parvula*	collector/gatherer	*4*	9	13	2
O. Diptera					
F. Chironomidae/*Trissopelopia* sp.	predator	*6*		1	1
/ *Paratanytarsus* sp.	collector/gatherer	*6*			1
/ *Rheotanytarsus* sp. B	collector/filterer	*6*		3	3
/ *Cardiocladius* sp.	predator	*5*	5	3	2
/ *Cricotopus bicinctus*	shredder	*7*	4	4	1
/ *C. tremulus*	shredder	*7*	8	13	5
/ *C. trifascia*	shredder	*7*	2	1	
/ *Eukiefferiella* sp. A	collector/gatherer	*8*		1	1
/ *Eukiefferiella* sp. B	collector/gatherer	*8*	3	14	4
/ *Eukiefferiella* sp. C	collector/gatherer	*8*	2		
/ *Eukiefferiella* sp. E	collector/gatherer	*8*			1
/ *Orthocladius obumbratus*	collector/gatherer	*6*		1	2
/ *O. robacki*	collector/gatherer	*6*		7	4
/ *Orthocladius* (sg. *Euorthocladius*)	collector/gatherer	*6*	4	4	
/ *Rheocricotopus* sp. (pupa)	nonfeeding	*6*	1		
/ *Tvetenia* sp.	collector/gatherer	*5*	2		
/ *Potthastia* sp	collector/gatherer	*6*	1	2	6
F. Simuliidae / *Simulium arcticum*	collector/filterer	*6*	13	4	9
/ *Simulium* sp.	collector/filterer	*6*	3		
F. Tipulidae / *Antocha* sp.	collector/gatherer	*3*	6	4	4
F. Athericidae / *Atherix* sp.	predator	*2*	1		1
F. Pelecorhynchidae / *Glutops* sp.	predator	*3*	1		
F. Empididae / *Hemerodromia* sp. A	predator	*6*	1		
/ *Hemerodromia* sp. B	predator	*6*			1
Cl. Arachnida					
O. Hydracarina					
F. Hygrobatidae / *Hygrobates* sp.	predator	*5*	1	3	6
F. Sperchontidae / *Sperchon* sp. A	predator	*5*	3		2
P. Mollusca					
Cl. Bivalvia					
F. Corbiculidae / *Corbicula fluminea*	filterer	*10*	2	1	
		TOTAL SPECIES/SUBSAMPLE	43	49	38
		TOTAL SPECIES (REACH)		65	
		TOTAL NUMBER/SUBSAMPLE	316	319	329
		TOTAL NUMBER/SAMPLE (EXTRAPOLATED)	7584	3828	3948

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CRESTA REACH

TAXON	TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
Phylum Platyhelminthes					
F. Planariidae / *Dugesia tigrina*	collector/gatherer	*4*		1	4
P. Nemertea					
F. Tetrastemmatidae / *Prostoma graecense*	predator	*4*	1	6	8
P. Nematoda					
F. Mermithidae /unidentified species A	parasite	*5*			2
P. Annelida					
F. Naididae / *Nais bicuspidalis*	collector/gatherer	*6*	7	48	8
/ *N. communis/variabilis*	collector/gatherer	*6*		1	2
/ *N. simplex*	collector/gatherer	*6*	3	1	
/ *Slavina appendiculata*	collector/gatherer	*6*		1	
F. Tubificidae / *Spirosperma ferox*	collector/gatherer	*8*			2
F. Lumbriculidae/*Eclipidrilus frigidus*	collector/gatherer	*4*	2	1	
/ *Rhynchelmis rostrata*	collector/gatherer	*6*	1		
/uid species	collector/gatherer	*4*			2
P. Arthropoda					
Class Insecta					
Order Ephemeroptera					
Baetidae / *Baetis insignificans*	collector/gatherer	*5*	3	2	7
/ *B. tricaudatus*	collector/gatherer	*5*	111	105	137
F. Ephemerellidae / *Ephemerella inermis*	collector/gatherer	*0*			1
F. Heptageniidae/*Epeorus* sp. (subgenus *Iron*)	scraper	*0*	6	11	7
/ *Rhithrogena* sp.	scraper	*0*	3		
F. Leptophlebiidae / *Paraleptophlebia* sp.	collector/gatherer	*4*		3	1
F. Tricorythidae/*Tricorythodes minutus*	collector/gatherer	*5*		1	1
O. Plecoptera					
F. Chloroperlidae / *Sweltsa* sp.	predator	*1*		1	
F. Perlidae / *Calineuria californica*	predator	*1*			1
F. Perlodidae / *Isoperla* sp.	predator	*2*	1		
O. Trichoptera					
F. Brachycentridae / *Micrasema* sp.	shredder	*3*	2		
F. Helicopsychidae / *Helicopsyche borealis*	scraper	*3*			1
F. Hydropsychidae / *Cheumatopsyche campyla*	collector/filterer	*5*	11	3	3
/ *Hydropsyche californica*	collector/filterer	*4*	7	3	
/ *Hydropsyche occidentalis*	collector/filterer	*4*	18	23	11
F. Hydroptilidae / *Hydroptila* sp. B	herbivore	*6*	4	3	3
/ *Leucotrichia pictipes*	scraper	*6*	2		3
F. Philopotamidae / *Chimarra utahensis*	collector/filterer	*4*	17	5	9
F. Polycentropodidae / *Polycentropus* sp.	predator	*6*	1	3	4
F. Rhyacophilidae / *Rhyacophila coloradensis*	predator	*0*		1	
O. Lepidoptera					
F. Pyralidae / *Petrophila* sp.	scraper	*5*	2	1	2
O. Coleoptera					
F Elmidae / *Optioservus quadrimaculatus*	scraper	*4*	1		
/ *Ordobrevia nubifera*	collector/gatherer	*4*	3		
/ *Zaitzevia parvula*	collector/gatherer	*4*	2	1	1

CRESTA REACH

TAXON		TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
O. Diptera						
F. Chironomidae	/*Trissopelopia* sp.	predator	6			1
	/*Micropsectra* sp.	collector/gatherer	7		1	
	/*Rheotanytarsus* sp. A	collector/filterer	6	1		1
	/*Rheotanytarsus* sp. B	collector/filterer	6	1	3	2
	/*Phaenopsectra* sp. A	collector/gatherer	7		1	
	/*Cardiocladius* sp.	predator	5	3		5
	/*Cricotopus bicinctus*	shredder	7	3	8	4
	/*C. tremulus*	shredder	7	14	21	34
	/*C. trifascia*	shredder	7	7	8	7
	/*Eukiefferiella* sp. A	collector/gatherer	8	1		
	/*Eukiefferiella* sp. B	collector/gatherer	8	19	13	19
	/*Orthocladius obumbratus*	collector/gatherer	6		4	
	/*O. robacki*	collector/gatherer	6	5	2	4
	/*Orthocladius* (sg. *Euorthocladius*)	collector/gatherer	6	2		7
	/*Synorthocladius* sp.	collector/gatherer	2			1
	/*Thienemanniella* sp.	collector/gatherer	6		3	1
	/*Tvetenia* sp.	collector/gatherer	5	1		
	/*Potthastia* sp.	collector/gatherer	6	3	3	5
F. Simuliidae	/*Simulium arcticum*	collector/filterer	6	73	28	20
	/*S. canadense* (pupa)	nonfeeding	6		2	
	/*S. tuberosum*	collector/filterer	6		16	3
	/*Simulium* sp.	collector/filterer	6	37	7	2
F. Tipulidae	/*Antocha* sp.	collector/gatherer	3	12	3	9
	/*Dicranota* sp.	predator	3		1	
F. Empididae	/*Hemerodromia* sp. A	predator	6		2	1
Cl. Arachnida						
O. Hydracarina						
F. Hygrobatidae	/*Hygrobates* sp.	predator	5	2	1	
F. Sperchontidae	/*Sperchon* sp. A	predator	5			1
			TOTAL SPECIES/SUBSAMPLE	38	41	42
			TOTAL SPECIES (REACH)		62	
			TOTAL NUMBER/SUBSAMPLE	392	352	347
			TOTAL NUMBER/SAMPLE (EXTRAPOLATED)	9408	8448	4164

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POE REACH

TAXON	TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
Phylum Platyhelminthes					
Family Planariidae / *Dugesia tigrina*	collector/gatherer	*4*			13
P. Nemertea					
F. Tetrastemmatidae / *Prostoma graecense*	predator	*4*	8	3	
P. Nematoda					
F. Mermithidae /unidentified species A	parasite	*5*	3	1	
P. Annelida					
F. Naididae / *Nais simplex*	collector/gatherer	*6*	5		
F. Lumbricidae /uid species	collector/gatherer	*5*	1		1
F. Lumbriculidae/ *Eclipidrilus frigidus*	collector/gatherer	*4*	1	5	1
/ *Rhynchelmis rostrata*	collector/gatherer	*6*	1		3
P. Arthropoda					
Class Insecta					
Order Ephemeroptera					
F. Baetidae / *Baetis insignificans*	collector/gatherer	*5*	4	4	4
/ *B. tricaudatus*	collector/gatherer	*5*	22	44	27
F. Heptageniidae/ *Epeorus* sp. (subgenus *Iron*)	scraper	*0*	8	8	5
/ *Rhithrogena* sp.	scraper	*0*	11	1	1
eptophlebiidae / *Paraleptophlebia* sp.	collector/gatherer	*4*			1
.. Tricorythidae/ *Tricorythodes minutus*	collector/gatherer	*5*	1	1	
O. Plecoptera					
F. Chloroperlidae / *Sweltsa* sp.	predator	*1*		1	1
F. Perlidae / *Calineuria californica*	predator	*1*		1	4
/ *Hesperoperla pacifica*	predator	*2*	1	1	1
F. Perlodidae / *Isoperla* sp.	predator	*2*	4	5	
/ *Skwala parallela*	predator	*2*	1		1
O. Trichoptera					
F. Brachycentridae / *Micrasema* sp.	shredder	*3*	1		
F. Hydropsychidae / *Ceratopsyche cockerelli*	collector/filterer	*4*	2		2
/ *Cheumatopsyche campyla*	collector/filterer	*5*	60	61	48
/ *Hydropsyche californica*	collector/filterer	*4*	21	34	28
/ *Hydropsyche occidentalis*	collector/filterer	*4*	74	103	25
F. Hydroptilidae / *Hydroptila* sp. B	herbivore	*6*	7	1	6
F. Leptoceridae / *Ceraclea* sp.	collector/gatherer	*3*	1	1	
F. Philopotamidae / *Chimarra utahensis*	collector/filterer	*4*	25	29	53
F. Rhyacophilidae / *Rhyacophila coloradensis*	predator	*0*			1
/ *R. malkini* (pupa)	nonfeeding	*0*	1		
O. Lepidoptera					
F. Pyralidae / *Petrophila* sp.	scraper	*5*		1	3
O. Coleoptera					
F. Elmidae / *Ordobrevia nubifera*	collector/gatherer	*4*	1		
/ *Zaitzevia parvula*	collector/gatherer	*4*	5	4	6
O. Diptera					
F Chironomidae/ *Trissopelopia* sp.	predator	*6*		1	
/ *Rheotanytarsus* sp. A	collector/filterer	*6*		1	
/ *Rheotanytarsus* sp. B	collector/filterer	*6*	1		

POE REACH

TAXON		TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
F. Chironomidae	/*Cardiocladius* sp.	predator	*5*	1	1	
	/*Cricotopus bicinctus*	shredder	*7*			1
	/*C. tremulus*	shredder	*7*	9	19	13
	/*Eukiefferiella* sp. A	collector/gatherer	*8*		1	
	/*Eukiefferiella* sp. B	collector/gatherer	*8*	3	4	12
	/*Eukiefferiella* sp. E	collector/gatherer	*8*	1		2
	/*Orthocladius obumbratus*	collector/gatherer	*6*			4
	/*O. robacki*	collector/gatherer	*6*	2	5	1
	/*Orthocladius* (sg. *Euorthocladius*)	collector/gatherer	*6*	1	4	5
	/*Synorthocladius* sp.	collector/gatherer	*2*			1
F. Simuliidae	/*Simulium arcticum*	collector/filterer	*6*	4	8	11
	/*S. tuberosum*	collector/filterer	*6*	3	6	11
	/*Simulium* sp.	collector/filterer	*6*	1		
F. Tipulidae	/*Antocha* sp.	collector/gatherer	*3*	8	3	2
F. Empididae	/*Hemerodromia* sp. A	predator	*6*			2
Cl. Arachnida						
O. Hydracarina						
F. Hygrobatidae	/*Hygrobates* sp.	predator	*5*			1
F. Sperchontidae	/*Sperchon* sp. A	predator	5	2	6	
P. Mollusca						
F. Corbiculidae	/*Corbicula fluminea*	filterer	*10*	1	2	1
			TOTAL SPECIES/SUBSAMPLE	38	33	36
			TOTAL SPECIES (REACH)		52	
			TOTAL NUMBER/SUBSAMPLE	306	370	302
			TOTAL NUMBER/SAMPLE (EXTRAPOLATED)	7344	4440	3624

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: FEATHER RIVER / EAST BRANCH NFFR   DATE/TIME: 102199 / 1030

COMPANY/AGENCY: HYDROZOOLOGY   SAMPLE ID NO.(S): EAST BRANCH 1,2,3

SITE DESCRIPTION: 0.4 MI BELOW HALSTEAD FLAT BRIDGE TO 0.1 MI ABOVE BRIDGE

CREW MEMBERS

WAYNE FIELDS
DOUG PARKINSON

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: 2760'
Ecoregion:
COMMENTS: riffles easily accessed

CHEMICAL CHARACTERISTICS

Water Temperature: 48°
Specific Conductance: 190.3 μS
pH: COULD NOT GET
Dissolved Oxygen: 98%

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.5 mi
Physical/habitat Quality Score: 135

Physical/Habitat Characteristics

	riffle 1	riffle 2	riffle 3
Riffle Length:	126'	31'	78'
Transect Location:	87'	22'	56'
Ave. Riffle Width:	60'	70'	20
Ave Riffle Depth:	10"	8"	8"
Riffle Velocity:	1.5 f/s	3.0 f/s	1.0 f/s
% Canopy Cover:	5%	Ø	Ø
Substrate Complexity:	16	11	14
Embeddedness:	30%	5%	20%
% Substrate:			
fines (<0.1")	1%	10%	1%
gravel (0.1-2")	5%	60%	9%
cobble (2-10")	90%	30%	90%
boulder (>10")	4%	Ø	Ø
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	MOD. TIGHT	LOOSE	MOD. LOOSE
% Gradient:	1.5%	3%	1.5%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: FEATHER RIVER / EAST BRANCH NFFR DATE/TIME: 10/2/99 / 1030
COMPANY/AGENCY: HYDROZOOLOGY SAMPLE ID NO.(S): EAST BRANCH 1, 2, 3
SITE DESCRIPTION: 0.4 Mi BELOW HALSTEAD FLAT BRIDGE TO 0.1 Mi ABOVE BRIDGE

(Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. *In streams where riffles* are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
8. Bank Stability *(score each bank)* Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank *failure absent or* minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of *erosion mostly healed* over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has *areas of erosion; high* erosion potential during floods.	Unstable; many eroded areas; "raw" areas *frequent along straight* sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 9 (LB)	Left Bank 10 (9)	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	(2) 1 0
SCORE 2 (RB)	Right Bank 10 9	8 7 6	5 4 3	(2) 1 0
10. Riparian Vegetative Zone Width *(score each* bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking *lots, roadbeds, clear-*cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted *zone only minimally.*	Width of riparian zone 6-12 meters; human activities have impacted *zone a great deal.*	Width of riparian zone <6 meters: little or no riparian vegetation due *to human activities.*
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	(2) 1 0
SCORE 2 (RB)	Right Bank 10 9	8 7 6	5 4 3	(2) 1 0

Total Score 135

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: FEATHER RIVER / NFFR
DATE/TIME: 102099 / 1440
COMPANY/AGENCY: HYDROZOOLOGY
SAMPLE ID NO.(S): BELDEN 1, 2, 3
SITE DESCRIPTION: BELDEN REACH ALONG CARIBOU RD. FROM 0.1 mile below MOSQUITO CREEK TO 0.35 mi below Mosquito Creek

CREW MEMBERS

WAYNE FIELDS
DOUG PARKINSON

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: 2640'
Ecoregion:
COMMENTS: MOST HABITAT UNITS ARE MIXED UNITS (PART POCKETWATER/ RUN; PART RIFFLE)

CHEMICAL CHARACTERISTICS

Water Temperature: 57°
Specific Conductance: 153.645
pH: COULD NOT GET
Dissolved Oxygen: 94%

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.25mi
Physical/habitat Quality Score: 130

Physical/Habitat Characteristics

	riffle 1	riffle 2	riffle 3
Riffle Length:	64'	66'	89'
Transect Location:	55'	56'	80'
Ave. Riffle Width:	50'	50'	50'
Ave Riffle Depth:	1.0	10"	6"
Riffle Velocity:	2.5 f/s	2.0 f/s	1.5 f/s
% Canopy Cover:	50%	30%	20%
Substrate Complexity:	19	15	15
Embeddedness:	20%	30%	30%
% Substrate:			
fines (<0.1")	5%	5%	5%
gravel (0.1-2")	20%	15%	40%
cobble (2-10")	50%	70%	50%
boulder (>10")	25%	10%	5%
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	MODERATELY LOOSE	MOD. LOOSE	MOD. LOOSE
% Gradient:	3%	2%	1.5%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: FEATHER RIVER /NFFR DATE/TIME: 102099 /1440
COMPANY/AGENCY: HYDROZOOLOGY SAMPLE ID NO.(S): BELDEN 1,2,3
SITE DESCRIPTION: BELDEN REACH ALONG CARIBOU RD FROM 0.1 mi below MOSQUITO Creek to 0.35 mi below MOSQUITO Creek

(Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody *macrophytes; vegetative* disruption through grazing or mowing minimal or not evident; almost all plants allowed *to grow naturally.*	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting *full plant growth* potential to any great extent; more than one-half of the potential plant stubble height *remaining.*	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less *than one-half of the* potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to *5 centimeters or less in* average stubble height.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0

Total Score 190

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: FEATHER RIVER / NFFR
DATE/TIME: 102099 / 1000
COMPANY/AGENCY: HYDROZOOLOGY
SAMPLE ID NO.(S): NORTH FORK 1, 2, 3
SITE DESCRIPTION: DOWNSTREAM OF 1ST LB TRIBUTARY 0.3 mi upstream of Belden Town A DISTANCE OF 0.5 mi UPSTREAM. / ACCESS FROM HOWELLS ROAD

CREW MEMBERS

WAYNE FIELDS
DOUG PARKINSON

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: 2240'
Ecoregion:
COMMENTS: MOST OF FIRST RIFFLE EXTREMELY DANGEROUS AT ANY FLOW — SPOT SAMPLING ONLY. ACCESS TO UPPER RIFFLE POTENTIALLY DANGEROUS AT HIGHER FLOWS, SAFER FROM HWY 70 SIDE

CHEMICAL CHARACTERISTICS

Water Temperature: 48°
Specific Conductance: 182.645
pH: COULD NOT GET
Dissolved Oxygen: 99%

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.5 mi
Physical/habitat Quality Score: 147

Physical/Habitat Characteristics

	riffle 1	riffle 2	riffle 3
Riffle Length:	155'	62'	23'
Transect Location:	(149')	55'	18'
Ave. Riffle Width:	40'	100	100'
Ave Riffle Depth:	1.5'	8"	4"
Riffle Velocity:	2.5 F/s	1.5 F/s	1 F/s
% Canopy Cover:	5%	Ø	Ø
Substrate Complexity:	17	15	13
Embeddedness:	10%	10%	20%
% Substrate:			
fines (<0.1")	Ø	Ø	Ø
gravel (0.1-2")	Ø	5%	10%
cobble (2-10")	10%	90%	80%
boulder (>10")	90%	5%	10%
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	MODERATELY LOOSE	LOOSE	MOD. LOOSE
% Gradient:	4.4%	1.5%	1.5%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: FEATHER RIVER / NFFR

DATE/TIME: 102099 / 1000

COMPANY/AGENCY: HYDROZOOLOGY

SAMPLE ID NO.(S): NORTH FORK 1, 2, 3

SITE DESCRIPTION: DOWNSTREAM OF 1ST LB TRIBUTARY 0.3 mi upstream of Belden Town A distance of 0.5 mi upstream / ACCESS FROM HOWELLS ROAD

(Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Condition Category: Suboptimal	Condition Category: Marginal	Condition Category: Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	(2) 1 0
SCORE 2 (RB)	Right Bank 10 9	8 7 6	5 4 3	(2) 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	(2) 1 0
SCORE 2 (RB)	Right Bank 10 9	8 7 6	5 4 3	(2) 1 0

Total Score 147

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: Feather River / NFFR
DATE/TIME: 101999 / 1430
COMPANY/AGENCY: HYDROZOOLOGY
SAMPLE ID NO.(S): Rock Creek 1,2.
SITE DESCRIPTION: 0.3 mi downstream of Indian Jim School to 0.3 mi upstrea.

CREW MEMBERS

Wayne Fields
Doug Parkinson

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: 2000'
Ecoregion:
COMMENTS: Lower 2 (of 5) riffles potentially hazardous at higher flows, also upper riffle

CHEMICAL CHARACTERISTICS

Water Temperature: 56°
Specific Conductance: 90.5μS
pH: Could not get
Dissolved Oxygen: 103%

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.6 m
Physical/habitat Quality Score: 163

Physical/Habitat Characteristics

Spot sampling 2

	riffle 1	riffle 2	riffle 3
Riffle Length:	47'	91'	25
Transect Location:	(34')	80'	18
Ave. Riffle Width:	30'	60'	115'
Ave Riffle Depth:	1.5'	9"	8"
Riffle Velocity:	2.0 f/s	1.0 f/s	2.0
% Canopy Cover:	Ø	Ø	Ø
Substrate Complexity:	19	15	15
Embeddedness:	15%	10%	Ø
% Substrate:			
fines (<0.1")	Ø%	Ø%	Ø
gravel (0.1-2")	1%	10%	1%
cobble (2-10")	19%	70%	29
boulder (>10")	80%	20%	70
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	moderately loose	mod. loose	loose
% Gradient:	1.5%	1.5%	

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: FEATHER RIVER / NFFR
DATE/TIME: 101999 / 1430
COMPANY/AGENCY: HYDROZOOLOGY
SAMPLE ID NO.(S): ROCK CREEK 1, 2, 3
SITE DESCRIPTION: 0.3 MI DOWNSTREAM OF INDIAN JIM SCHOOL TO 0.3 mi UPSTREAM

(Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are *continuous*, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 20	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 4 (LB)	Left Bank 10 9	8 7 6	5 (4) 3	2 1 0
SCORE 1 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 4 (LB)	Left Bank 10 9	8 7 6	5 (4) 3	2 1 0
SCORE 1 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 163

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: FEATHER RIVER / NFFR
DATE/TIME: 101999 / 0930
COMPANY/AGENCY: HYDROZOOLOGY
SAMPLE ID NO.(S): CRESTA 1, 2, 3
SITE DESCRIPTION: 0.1-0.5 MILES DOWNSTREAM OF BEAR RANCH CREEK

CREW MEMBERS

WAYNE FIELDS
DOUG PARKINSON

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: 1520'
Ecoregion:
COMMENTS: WILL BE DIFFICULT / DANGEROUS ACCESS AT HIGHER FLOWS

CHEMICAL CHARACTERISTICS

Water Temperature: 13.1°C
Specific Conductance: 107.5 S
pH: 8.0
Dissolved Oxygen: 99%

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.4mi
Physical/habitat Quality Score: 132

Physical/Habitat Characteristics

RIFFLE	#2 riffle 1	#4 riffle 2	riffle 3
Riffle Length:	60'	103'	66'
Transect Location:	43'	90'	62'
Ave. Riffle Width:	77'	60'	44'
Ave Riffle Depth:	6"	8"	8"
Riffle Velocity:	1.0 F/s	1.0 F/s	1.5 F/s
% Canopy Cover:	Ø	Ø	Ø
Substrate Complexity:	19	19	19
Embeddedness:	Ø%	Ø%	Ø%
% Substrate:			
fines (<0.1")	Ø	Ø	Ø
gravel (0.1-2")	10%	1%	1%
cobble (2-10")	40%	39%	19%
boulder (>10")	50%	60%	80%
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	LOOSE	MOD. LOOSE	MOD. LOOSE
% Gradient:	1.5%	1.5-2%	2.5%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: FEATHER RIVER / NFFR DATE/TIME: 101999 / 0930
COMPANY/AGENCY: HYDROZOOLOGY SAMPLE ID NO.(S): CRESTA 1, 2, 3
SITE DESCRIPTION: 0.1 – 0.5 MILES DOWNSTREAM OF BEAR RANCH CREEK

(Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 13	20 19 18 17 16	15 14 (13) 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 20	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Condition Category: Suboptimal	Condition Category: Marginal	Condition Category: Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 10	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 1 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 1 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 1 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 1 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score ________

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: FEATHER RIVER /NFFR DATE/TIME: 102599 / 1000
COMPANY/AGENCY: HYDROZOOLOGY SAMPLE ID NO.(S): POE 1, 2, 3
SITE DESCRIPTION: 0.1 Mile ABOVE HWY 70 BRIDGE AT PULGA TO FIRST RIFFLE UPSTREAM OF FLEA VALLEY CREEK

CREW MEMBERS

Wayne Fields
Doug Parkinson

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: 1480'
Ecoregion:
COMMENTS: LOWER RIFFLE SHORT W/ dangerous access FROM NORTH AT HIGHER FLOWS. ALL THE RIFFLES WILL REQUIRE CAUTION AT HIGHER FLOWS

CHEMICAL CHARACTERISTICS

Water Temperature: 54°
Specific Conductance: 98.9 μS
pH: COULD NOT GET
Dissolved Oxygen: 97%

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.5mi
Physical/habitat Quality Score: 142

Physical/Habitat Characteristics

	riffle 1	riffle 2	riffle 3
Riffle Length:	12'	69'	90'
Transect Location:	9'	65'	71'
Ave. Riffle Width:	30	45	100'
Ave Riffle Depth:	10"	1.0'	8"
Riffle Velocity:	2 F/s	1.5 F/s	2 F/s
% Canopy Cover:	Ø%	Ø%	5%
Substrate Complexity:	16	19	19
Embeddedness:	1-5%	1-5%	1-5%
% Substrate:			
fines (<0.1")	Ø	Ø	Ø
gravel (0.1-2")	10%	5%	5%
cobble (2-10")	60%	75%	75%
boulder (>10")	30%	20%	20%
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	19	19	19
% Gradient:	2.0%	2.0%	2.0%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: FEATHER RIVER / NFFR   DATE/TIME: 102599 / 1000
COMPANY/AGENCY: HYDROZOOLOGY   SAMPLE ID NO.(S): POE 1, 2, 3
SITE DESCRIPTION: 0.1 MILE ABOVE HWY 70 BRIDGE AT PULGA TO FIRST RIFFLE UPSTREAM OF FLEA VALLEY CREEK

(Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 2	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 (2) 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	(2) 1 0
SCORE 2 (RB)	Right Bank 10 9	8 7 6	5 4 3	(2) 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 1 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 (1) 0
SCORE 1 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 (1) 0

Total Score 142

POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX E3-5

The Benthic Macroinvertebrate Fauna of the Poe Reach of the North Fork Feather River, Butte and Plumas Counties, California, 2000

The Benthic Macroinvertebrate Fauna of the Poe Reach, North Fork Feather River, Butte County, California
September 2000

For: MHA Environmental Consulting, Inc.
520 South El Camino Real, Suite 800
San Mateo, CA 94402

By: Wayne C. Fields, Jr.
Hydrozoology
P.O.Box 682
Newcastle, CA 95658

INTRODUCTION

As part of the Federal Energy Regulatory Commission (FERC) relicensing procedure, it has been requested that the California Stream Bioassessment Protocol (CSBP) be used to determine the nature of the benthic macroinvertebrate fauna. This investigation of the fauna of the Poe Reach, North Fork feather River (NFFR) seeks to establish baseline data for an analysis of how changes in hydro operations of Poe Dam and Poe powerhouse may affect that fauna. Changes may be sought which provide higher minimum flows or more stable flows and thus ameliorate the effects of hydro operations on the stream ecosystem, resulting in a healthier and more diverse fauna. The quality of the fauna under the CSBP is based on a variety of measures (metrics) calculated from lists of species collected from riffles or riffle habitats within the reach.

MATERIALS AND METHODS

1. FIELD SAMPLING

The Poe Reach consists of that part of the NFFR between Poe dam and Poe Powerhouse, a distance of about eight miles. Flow in the reach is controlled by releases from Poe Dam. Sampling reaches within the Poe Reach were selected according to the CSBP nonpoint source protocol based on availability of riffles or riffle habitats and access, both of which are scarce in the NFFR. The sampling reaches chosen were (from downstream to upstream): the Poe Powerhouse Bridge reach, the Bardee's Bar reach, and the Pulga reach. Each reach consists of five contiguous riffles or riffle habitats. Sampling was conducted on a randomly chosen three of the five riffles or riffle habitats on September 25 and 27, 2000.

- The Poe Powerhouse reach extends from 0.1 to 0.6 miles upstream of the Poe Powerhouse bridge.
- the Bardee's Bar reach is approximately 0.5 miles in length and encompasses riffle habitats along the edge of the pronounced bend at Bardee's Bar.
- The Pulga reach extends from 0.1 miles upstream of Highway 70 to the top of the large riffle upstream of Flea Valley Creek, a distance of 0.5 miles. This site was sampled also in 1999 as part of the baseline study of the Rock Creek-Cresta FERC project. At that time it was referred to as the Poe section; comparisons are made here between the two years' sampling in this reach.

At each site a total of six square feet of stream bottom was sampled using a Wildco stream bottom sampling net with 0.5mm netting and a detachable bucket. Samples were collected from a variety of velocity/depth regimes within the site and combined to form a single sample. The sample was then field elutriated to remove sand, gravel and large detritus, placed in eight ounce plastic jars and preserved. Ten percent formalin dyed with rose bengal was used instead of the recommended ethanol because it is a superior fixative; rose bengal dye stains organisms so that they are made visible for picking. Lids with polyethylene closures were used to prevent jars from leaking. Three such samples were collected from each sampling reach, one from each riffle or riffle habitat. Nine samples were thus collected from the three sampling reaches to represent the benthic fauna of the Poe Reach. California Bioassessment Worksheets and Physical Habitat Quality forms were filled out for each sampling, describing them in physical terms. Copies of the forms are appended to this report, as well as copies of the forms filled out in 1999 for the Pulga reach.

2. LABORATORY PROCEDURES

In the laboratory the formalinn was poured off, and the sample rinsed and spread evenly in water on a gridded plexiglas tray 8" X 12" with 24 equal, numbered 2" square bottom divisions. Individual grids were chosen randomly and their contents picked under an illuminated 2 diopter magnifier and checked using a dissecting microscope. Invertebrates were transferred to 70% ethanol prior to identification. The CSBP requires that a subsample of at least 300 (+/-10%) organisms be picked for identification purposes. In every case the last grid chosen was picked in its entirety. The unpicked portion of the original sample (the remainder) was represerved in ethanol. A reference collection of each species has been established; the subsamples, reference collection and remainders will be curated indefinitely by Hydrozoology. For QA/QC purposes, a random 20% of the subsamples will be vouchered per directions of the California Department of Fish and Game's (CDFG) Aquatic Bioassessment Laboratory (ABAL) and transferred to them on a temporary basis for verification.

Organisms in the subsample were identified to the species level, using morphotypes, whether they could be completely named or not. This allows for accurate calculation of the metrics of species richness and species diversity, two important measures of ecological diversity. Each species in the subsample was counted; species lists for each subsample are presented as appendices to this report; the 1999 "Poe Reach" species lists are attached. The species lists are in spreadsheet form so that the data can be adjusted to the less accurate data analysis system used by the ABAL. The species lists also present the trophic category of each taxon (Merrit and Cummins 1996) and give a tolerance value for each taxon provided either by the ABAL or from experience.

Species list data were used to calculate a variety of the CSBP metrics. Tables 1-4 present the richness, EPT measures, tolerance and feeding group metrics of each subsample.

METRIC	REACH/SAMPLE								
	Poe Powerhouse			Bardee's Bar			Pulga		
	1	2	3	1	2	3	1	2	3
Species Richness	38	25	41	28	39	31	40	38	58
(total) (mean)	(51)	(35)		(50)	(33)		(69)	(45)	
Species Diversity	4.10	3.59	3.94	3.26	3.60	3.34	4.12	3.93	4.50
(mean)		(3.88)			(3.40)			(4.18)	

Table 1. Richness measures of Poe Reach benthic samples, September 2000

RESULTS AND DISCUSSION

1. RICHNESS MEASURES

Species richness is a way of describing the number of ecological niches present in the stream ecosystem - the more species there are, the more stable the benthic community is likely to be (Patrick 1970). If the stream environment improves, species richness should increase.

Species richness is especially high in the Pulga sampling reach; the uppermost riffle in the reach is particularly stable one of boulder and cobble with a wide variety of microhabitats. The riffles with the lowest species richness are in the two downstream reaches, and are composed of relatively small and unstable substrate items.

Table 1 gives Brillouin (1962) species diversity indices calculated for each sample in the reach. Species diversity is a metric which takes into account both how many species are present in a sample(species richness) and the degree to which those species are represented in the sample (evenness). For instance, a sample in which one species is thoroughly dominant is indicative of a habitat in which essentially only that species is successful. The greater the disparity between the dominant species and others, the lower the species diversity. This is best illustrated by the sample with the highest species diversity (Pulga #3, 4.50, Table 1) which has both the highest number of species (58, Table 1) and the lowest percent dominant taxon (11.8%, Table 3). Its opposite number is Bardee's Bar #1 (3.26), with the second fewest species (28, Table 1) and the next-to-highest percent dominant taxon (25.9%, Table 3). Generally speaking, diversities in the Poe Reach are high, reflecting a stable community at most sampling sites. Species diversity should increase if operations result in a more natural hydrograph.

METRIC	REACH/SAMPLE								
	Poe Powerhouse			Bardee's Bar			Pulga		
	1	2	3	1	2	3	1	2	3
EPT Species	20	13	19	16	18	15	17	17	22
(total) (mean)	(21)	(17)		(21)	(16)		(27)	(19)	
Ephemeroptera Species	7	6	7	6	6	5	5	6	7
(total) (mean)	(7)	(7)		(6)	(6)		(9)	(6)	
Plecoptera Species	3	2	2	5	4	3	2	4	5
(total) (mean)	(4)	(2)		(6)	(4)		(6)	(4)	
Trichoptera Species	10	5	10	5	8	7	10	7	10
(total) (mean)	(10)	(8)		(9)	(7)		(12)	(9)	
EPT Index	61.6	50.0	70.5	83.4	75.6	77.3	55.6	66.2	63.6
(mean)		(60.7)			(78.8)			(61.8)	
Sensitive EPT Index	2.0	1.4	2.5	3.9	2.7	4.8	2.2	7.2	4.6
(mean)		(2.0)			(3.8)			(4.6)	

Table 2. EPT measures of the Poe Reach benthic samples, September 2000

2. EPT MEASURES

EPT species are those in the insect orders Ephemeroptera, Plecoptera and Trichoptera, and are presumed to be more sensitive to disturbance than other groups of aquatic invertebrates. They constitute an important fraction of the fauna in the Poe Reach, where they make up approximately 40% of the species and 60-80% of the numbers collected (Table 2). Most of the EPT species are actually of middling sensitivity (see appendices); EPT species with tolerance values of 0,1 or 2 typically make up less than 5% of the fauna and are nearly all Plecoptera. Sensitive EPT species should be more successful if the stream environment improves.

3. TOLERANCE MEASURES

The percentage of intolerant species collected is given in Table 3. Note that it is essentially the same as the Sensitive EPT metric, being made up of (usually) the same species, mostly Plecoptera. There are few truly tolerant species (tolerance values of 8,9 or 10 - see appendices) present in the Poe Reach samples. They represent an even smaller portion of the fauna than the intolerant species (Table 3). Intolerant species should increase and tolerant species decrease with improvements in the habitat.

METRIC	REACH/SAMPLE								
	Poe Powerhouse			Bardee's Bar			Pulga		
	1	2	3	1	2	3	1	2	3
% Intolerant Species	2.4	1.4	2.5	3.9	2.7	4.8	1.9	7.2	4.6
(mean)		(2.1)		(3.8)				(4.6)	
% Tolerant Species	2.0	1.0	1.8	0.0	2.0	0.0	1.9	0.6	4.3
(mean)		(1.6)			(0.6)			(2.3)	
% Hydropsychidae	25.0	7.0	29.9	19.3	13.0	39.2	16.2	27.2	29.5
(mean)		(20.6)			(23.8)			(24.3)	
% Baetidae	20.2	23.1	24.5	29.8	38.8	17.8	17.2	11.8	10.2
(mean)		(22.6)			(28.8)			(13.1)	
% Dominant Species	13.4	18.2	17.4	25.9	28.1	17.5	14.1	16.6	11.8
(mean)		(16.3)			(23.8)			(14.2)	

Table 3. Tolerance/Intolerance measures of Poe reach benthic samples, September 2000

The relatively tolerant Baetidae (Ephemeroptera) and Hydropsychidae (Trichoptera) were usually the most abundant animals present in a sample (Table 3). In five of nine samples the dominant species was the mayfly *Baetis tricaudatus*, and in one sample the caddisfly *Hydropsyche occidentalis*. In all samples from the Pulga sampling reach the dominant species was the finger-net caddisfly *Chimarra utahensis*. Tolerant species within the Baetidae and Hydropsychidae should decline if the stream habitat is improved.

4. FUNCTIONAL FEEDING GROUP MEASURES

The percentage of animals which are either collector-gatherers or filterers should decline with improvements to a stream, and the shredder populations increase. Collector-gatherers and filterers combined made up over 80% of the fauna in Poe Reach samples, and shredders a vanishly small percentage. The shredder population is, unsurprisingly, low throughout the Poe Reach. These species depend on the input of coarse particulate organic matter (leaves, twigs, branches, etc.) from riparian areas. There is virtually no riparian zone in the Poe Reach, and upstream reservoirs trap nearly all organic matter entering the system.

METRIC	REACH/SAMPLE								
	Poe Powerhouse			Bardee's Bar			Pulga		
	1	2	3	1	2	3	1	2	3
% Collectors	39.0	49.6	38.8	35.2	50.5	28.1	36.5	31.4	33.1
(mean)		(42.4)			(37.9)			(33.7)	
% Filterers	36.6	40.9	35.2	52.1	35.8	61.2	43.4	50.8	46.9
(mean)		(37.6)			(49.7)			(47.0)	
% Shredders	2.0	0.0	0.0	0.0	0.3	0.6	2.5	1.5	1.3
(mean)		(0.6)			(0.3)			(1.8)	

Table 4. Functional Feeding Group measures of Poe Reach benthic samples, September 2000

PULGA SAMPLING REACH, 1999-2000

Samples collected in the Poe Powerhouse and Bardee's Bar sampling reaches constitute baseline sampling. Collections have now been made in the Pulga sampling reach in consecutive years, providing an observation of variation within the Poe Reach not due to any change in operation. For 1999 and 2000, Tables 5-8 compare Species Richness Measures, EPT Measures, Tolerance/Intolerance Measures and Functional Feeding Group Measures of samples collected at Pulga.

METRIC	YEAR/SAMPLE					
	1999			2000		
	1	2	3	1	2	3
Species Richness	38	33	36	40	38	58
(total) (mean)	(52)	(36)		(69)	(45)	
Species Diversity	3.60	3.36	3.80	4.12	3.93	4.50
(mean)		(3.59)			(4.18)	

Table 5. Richness measures of Pulga benthic samples, 1999-2000

Table 5 shows that total species richness increased by 32.6% between 1999 and 2000, while mean species richness increased by 28.6%. Mean species diversity increased by 16.4%.

METRIC	YEAR/SAMPLE					
	1999			2000		
	1	2	3	1	2	3
EPT species (total) (mean)	17 (21)	15 (16)	16	16 (27)	17 (18)	22
Ephemeroptera species (total) (mean)	5 (6)	5 (5)	5	5 (9)	6 (6)	7
Plecoptera Species (total) (mean)	3 (5)	4 (4)	4	2 (6)	4 (4)	5
Trichoptera Species (total) (mean)	9 (10)	6 (7)	7	10 (12)	7 (9)	10
EPT Index (mean)	79.1	79.7 (75.9)	68.9	55.6	66.2 (61.8)	63.6
Sensitive EPT Index (mean)	5.8	4.6 (5.1)	5.0	2.2	7.2 (4.6)	4.6

Table 6. EPT measures of Pulga benthic samples, 1999-2000

METRIC	YEAR/SAMPLE					
	1999			2000		
	1	2	3	1	2	3
% Intolerant Species (mean)	8.5	4.6 (6.0)	5.0	1.9	7.2 (4.6)	4.6
% Tolerant Species (mean)	1.6	1.9 (2.5)	5.0	1.9	0.6 (2.3)	4.3
% Hydropsychidae (mean)	51.3	53.5 (46.3)	34.1	16.2	27.2 (24.3)	29.5
% Baetidae (mean)	8.5	13.0 (10.6)	10.3	17.2	11.8 (13.1)	10.2
% Dominant Species (mean)	24.2	27.8 (23.2)	17.5	14.1	16.6 (14.2)	11.8

Table 7. Tolerance/Intolerance measures of Pulga benthic samples, 1999-2000

EPT species in all categories remained relatively constant (Table 6), but the EPT Index declined by 31.8% and the Sensitive EPT Index remained essentially unchanged.

Of the Tolerance/Intolerance measures (Table 7), most were relatively unchanged. Percent Hydropsychidae, however, declined by 47.5%, and percent dominant species by 38.7%.

METRIC	YEAR/SAMPLE					
	1999			2000		
	1	2	3	1	2	3
% Collectors	18.6	20.2	27.4	36.5	31.4	33.1
(mean)		(22.1)			(33.7)	
% Filterers	61.6	65.9	59.3	43.4	50.8	46.9
(mean)		(62.3)			(47.0)	
% Shredders	3.3	5.1	4.6	2.5	1.5	1.3
(mean)		(4.3)			(1.8)	

Table 8. Functional Feeding Group measures of Pulga benthic samples, 1999-2000

In Table 8, the percent collectors increased by 52.5% and the percent filterers declined by 24.6%. Percent shredders declined by 58.1%, but since a change of fewer than ten organisms is involved, it is insignificant.

The differences occurring between years in the Pulga sampling reach represent considerable variability for years in which no change in operations took place. It may thus be difficult to detect changes in metrics as a result of operational changes if they are masked by the kind of variability seen here, and if this is a widespread phenomenon in the NFFR.

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POE REACH

TAXON		TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
Phylum Platyhelminthes						
Family Planariidae	/ *Dugesia tigrina*	collector/gatherer	4			13
P. Nemertea						
F. Tetrastemmatidae	/ *Prostoma graecense*	predator	4	8	3	
P. Nematoda						
F. Mermithidae	/unidentified species A	parasite	5	3	1	
P. Annelida						
F. Naididae	/ *Nais simplex*	collector/gatherer	6	5		
F. Lumbricidae	/uid species	collector/gatherer	5	1		1
F. Lumbriculidae	/ *Eclipidrilus frigidus*	collector/gatherer	4	1	5	1
	/ *Rhynchelmis rostrata*	collector/gatherer	6	1		3
P. Arthropoda						
Class Insecta						
Order Ephemeroptera						
F. Baetidae	/ *Baetis insignificans*	collector/gatherer	5	4	4	4
	/ *B. tricaudatus*	collector/gatherer	5	22	44	27
F. Heptageniidae	/ *Epeorus* sp. (subgenus *Iron*)	scraper	0	8	8	5
	/ *Rhithrogena* sp.	scraper	0	11	1	1
ᵊptophlebiidae	/ *Paraleptophlebia* sp.	collector/gatherer	4			1
F. Tricorythidae	/ *Tricorythodes minutus*	collector/gatherer	5	1	1	
O. Plecoptera						
F. Chloroperlidae	/ *Sweltsa* sp.	predator	1		1	1
F. Perlidae	/ *Calineuria californica*	predator	1		1	4
	/ *Hesperoperla pacifica*	predator	2	1	1	1
F. Perlodidae	/ *Isoperla* sp.	predator	2	4	5	
	/ *Skwala parallela*	predator	2	1		1
O. Trichoptera						
F. Brachycentridae	/ *Micrasema* sp.	shredder	3	1		
F. Hydropsychidae	/ *Ceratopsyche cockerelli*	collector/filterer	4	2		2
	/ *Cheumatopsyche campyla*	collector/filterer	5	60	61	48
	/ *Hydropsyche californica*	collector/filterer	4	21	34	28
	/ *Hydropsyche occidentalis*	collector/filterer	4	74	103	25
F. Hydroptilidae	/ *Hydroptila* sp. B	herbivore	6	7	1	6
F. Leptoceridae	/ *Ceraclea* sp.	collector/gatherer	3	1	1	
F. Philopotamidae	/ *Chimarra utahensis*	collector/filterer	4	25	29	53
F. Rhyacophilidae	/ *Rhyacophila coloradensis*	predator	0			1
	/ *R. malkini* (pupa)	nonfeeding	0	1		
O. Lepidoptera						
F. Pyralidae	/ *Petrophila* sp.	scraper	5		1	3
O. Coleoptera						
F. Elmidae	/ *Ordobrevia nubifera*	collector/gatherer	4	1		
	/ *Zaitzevia parvula*	collector/gatherer	4	5	4	6
O. Diptera						
ᶠ ʰironomidae	/ *Trissopelopia* sp.	predator	6		1	
	/ *Rheotanytarsus* sp. A	collector/filterer	6		1	
	/ *Rheotanytarsus* sp. B	collector/filterer	6	1		

POE REACH

TAXON		TROPHIC CATEGORY	TOLERANCE VALUE	ORGANISMS/SAMPLE 1	2	3
F. Chironomidae	/*Cardiocladius* sp.	predator	*5*	1	1	
	/*Cricotopus bicinctus*	shredder	*7*			1
	/*C. tremulus*	shredder	*7*	9	19	13
	/*Eukiefferiella* sp. A	collector/gatherer	*8*		1	
	/*Eukiefferiella* sp. B	collector/gatherer	*8*	3	4	12
	/*Eukiefferiella* sp. E	collector/gatherer	*8*	1		2
	/*Orthocladius obumbratus*	collector/gatherer	*6*			4
	/*O. robacki*	collector/gatherer	*6*	2	5	1
	/*Orthocladius* (sg. *Euorthocladius*)	collector/gatherer	*6*	1	4	5
	/*Synorthocladius* sp.	collector/gatherer	*2*			1
F. Simuliidae	/*Simulium arcticum*	collector/filterer	*6*	4	8	11
	/*S. tuberosum*	collector/filterer	*6*	3	6	11
	/*Simulium* sp.	collector/filterer	*6*	1		
F. Tipulidae	/*Antocha* sp.	collector/gatherer	*3*	8	3	2
F. Empididae	/*Hemerodromia* sp. A	predator	*6*			2
Cl. Arachnida						
O. Hydracarina						
F. Hygrobatidae	/*Hygrobates* sp.	predator	*5*			1
F. Sperchontidae	/*Sperchon* sp. A	predator	*5*	2	6	
P. Mollusca						
F Corbiculidae	/*Corbicula fluminea*	filterer	*10*	1	2	1
			TOTAL SPECIES/SUBSAMPLE	38	33	36
			TOTAL SPECIES (REACH)		52	
			TOTAL NUMBER/SUBSAMPLE	306	370	302
			TOTAL NUMBER/SAMPLE (EXTRAPOLATED)	7344	4440	3624

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS		POE PROJECT		2000	
			POE PH REACH					
	TAXON	(NON-INSECTS)					NUMBER	
PHYLUM/CLASS/	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
ORDER				CATEGORY	VALUE			
Platyhelminthes	Planariidae	*Dugesia*	*tigrina*	C	4	22	52	6
Nemertea	Tetrastemmatidae	*Prostoma*	*graecense*	P	4	24	15	20
Annelida								
Tubificida	Naididae	*Nais*	*bicuspidalis*	C	4			4
		N.	*communis/variabilis*	C	5	2		2
	Lumbricidae	*unidentified*	*species*	C	5		10	1
Lumbriculida	Lumbriculidae	*Rhynchelmis*	*rostrata*	C	6	2	1	
Crustacea								
Arachnida	Hygrobatidae	*Hygrobates*	sp.	P	5	2		3
	Lebertiidae	*Lebertia*	sp.	P	5			1
	Torrenticolidae	*Torrenticola*	sp.	P	5	1		
Mollusca								
Gastropoda	Lymnaeidae	*Fossaria*	sp.	SC	5	5		1
	Physidae	*Physa*	*gyrina*	SC	8			1
Pelecypoda	Corbiculidae	*Corbicula*	*fluminea*	F	8	1	3	
	TAXON	(INSECTS)						
ORDER	FAMILY	GENUS	SPECIES					
Ephemeroptera	Baetidae	*Acentrella*	*insignificans*	C	6	8	4	9
		Baetis	*magnus*	C	4	12	19	11
		B.	*tricaudatus*	C	6	39	43	49
	Heptageniidae	*Epeorus (Iron)*	sp.	SC	4	2	1	5
		Rhithrogena	sp.	SC	4	2	4	1
	Isonychiidae	*Isonychia*	*velma*	F	3	3	16	3
	Tricorythidae	*Tricorythodes*	*minutus*	C	6	2		1

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS		POE PROJECT		2000	
			POE PH REACH					
PHYLUM/CLASS/ ORDER	FAMILY	GENUS	SPECIES	TROPHIC CATEGORY	TOLERANCE VALUE	SAMPLE 1	SAMPLE 2	SAMPLE 3
Plecoptera	Chloroperlidae	*Sweltsa*	sp.	P	1	1		
	Perlidae	*Calineuria*	*californica*	P	1			3
	Perlodidae	*Isoperla*	sp.	P	1	3	2	
		Skwala	*parallela*	P	1	1	1	1
Trichoptera	Hydropsychidae	*Ceratopsyche*	*cockerelli*	F	4	1		10
		Cheumatopsyche	*campyla*	F	5	14	3	5
		Hydropsyche	*californica*	F	6	26	7	25
		H.	*occidentalis*	F	6	32	10	44
	Hydroptilidae	*Hydroptila*	sp. A	H	6	4		1
		Hydroptila	sp. B	H	6	1		1
		Leucotrichia	*pictipes*	SC	6	1		1
	Philopotamidae	*Chimarra*	*utahensis*	F	4	24	32	24
	Polycentropodidae	*Polycentropus*	sp.	P	4	3		2
	Rhyacophilidae	*Rhyacophila*	*malkini (pupa)*	NF	1	1	1	2
Lepidoptera	Pyralidae	*Petrophila*	sp.	SC	5	8		3
Coleoptera	Psephenidae	*Eubrianax*	*edwardsii*	SC	4	6		
	Elmidae	*Optioservus*	*quadrimaculatus*	C	4	8	3	11
		Ordobrevia	*nubifera*	C	4		3	1
		Zaitzevia	*parvula*	C	5	1	7	2
Diptera	Blephariceridae	*Blepharicera*	sp.	SC	1			1
	Chironomidae							
	Chironominae							
	Tanytarsini	*Rheotanytarsus*	sp. A	F	6	6		5
		Rheotanytarsus	sp. B	F	6			1
	Orthocladinae	*Cardiocladius*	sp.	P	4		2	
		Cricotopus	*bicinctus*	C	8	5		4
		C.	*tremulus*	SH	6	2		2
		C.	*trifascia*	SH	6	4		

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS		POE PROJECT		2000	
			POE PH REACH					
PHYLUM/CLASS/	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
ORDER				CATEGORY	VALUE			
Diptera	Orthocladinae	*Eukiefferiella*	sp. B	C	4			1
	Diamesinae	*Potthastia*	sp.	C	4	8		6
	Simuliidae	*Simulium*	*piperi (pupa)*	NF	5		1	
	Simuliidae	*S.*	*tuberosum*	F	5		18	6
		S.	*virgatum*	F	5		28	
	Tipulidae	*Antocha*	sp.	C	5	5		1
				TOTAL	NUMBER	292	286	281
			C=collector/gatherer	TOTAL	SPECIES	38	25	41
			F=filterer	TOTAL	SPECIES			
			H=herbivore		(REACH)		51	
			NF=nonfeeding					
			P=predator					
			SC=scraper					
			SH=shredder					

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS		POE PROJECT		2000	
			PULGA REACH					
	TAXON	(NON-INSECTS)					NUMBER	
PHYLUM/CLASS/	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
ORDER				CATEGORY	VALUE			
Platyhelminthes	Planariidae	*Dugesia*	*tigrina*	C	4	2	25	12
Nemertea	Tetrastemmatidae	*Prostoma*	*graecense*	P	4	11	7	10
Nematoda	Mermithidae	unidentified	species	PA	5	2	1	
Annelida								
Tubificida	Naididae	*Nais*	*alpina*	C	5			3
		N.	*bicuspidalis*	C	4	13	18	4
		N.	*communis/variabilis*	C	5	14		
		N.	*simplex*	C	6			1
		N.	*sp.*	C	4	6	4	
		Slavina	*appendiculata*	C	6			1
	Tubificidae	*Branchiura*	*sowerbyi*	C	8			1
		Spirosperma	*ferox*	C	8			7
	Lumbricidae	uid	sp.	C	5			3
Lumbriculida	Lumbriculidae	*Eclipidrilus*	*frigidus*	C	4			2
		Rhynchelmis	*rostrata*	C	6	2	1	2
		uid	sp.	C	4			5
Crustacea								
Arachnida	Hygrobatidae	*Hygrobates*	sp.	P	5	1		3
Mollusca								
Pelecypoda	Corbiculidae	*Corbicula*	*fluminea*	F	8	1	1	1
	TAXON	(INSECTS)						
ORDER	FAMILY	GENUS	SPECIES					
Ephemeroptera	Baetidae	*Acentrella*	*insignificans*	C	6	13	5	11
		Baetis	*magnus*	C	4		2	6
		B.	*tricaudatus*	C	6	42	32	13

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS		POE PROJECT		2000	
			PULGA REACH					
PHYLUM/CLASS/ ORDER	FAMILY	GENUS	SPECIES	TROPHIC CATEGORY	TOLERANCE VALUE	SAMPLE 1	SAMPLE 2	SAMPLE 3
Ephemeroptera	Baetidae	*Camelobaetidius*	sp.	C	3			1
	Ephemerellidae	*Ephemerella*	*inermis*	C	3	1		2
	Heptageniidae	*Epeorus (Iron)*	sp.	SC	4		1	
		Rhithrogena	sp.	SC	4	1	2	
	Isonychiidae	*Isonychia*	*velma*	F	3	3	3	5
	Leptophlebiidae	*Paraleptophlebia*	sp. A	C	4			1
Plecoptera	Nemouridae	*Malenka*	sp.	C	1		1	
	Chloroperlidae	*Sweltsa*	sp.	P	1			1
	Perlidae	*Calineuria*	*californica*	P	1		1	1
		Hesperoperla	*pacifica*	P	2	1	2	1
	Perlodidae	*Isoperla*	sp.	P	1	3	16	3
		Skwala	*parallelá*	P	1			3
Trichoptera	Hydropsychidae	*Ceratopsyche*	*cockerelli*	F	4	2		4
		Cheumatopsyche	*campyla*	F	5	10	32	31
		Hydropsyche	*californica*	F	6	13	17	30
		H.	*occidentalis*	F	6	27	41	25
	Hydroptilidae	*Hydroptila*	sp. A	H	6	4	2	
		Leucotrichia	*pictipes*	SC	6	9	3	13
	Lepidostomatidae	*Lepidostoma*	sp. B	SH	1			1
	Philopotamidae	*Chimarra*	*utahensis*	F	4	45	55	36
	Polycentropodidae	*Polycentropus*	sp.	P	4			1
	Psychomyiidae	*Tinodes*	sp.	SC	4	1		1
	Rhyacophilidae	*Rhyacophila*	*coloradensis*	P	1	1		
		R.	*malkini (pupa)*	NF	1	2	4	4
Lepidoptera	Pyralidae	*Petrophila*	sp.	SC	5	3	1	10
Coleoptera	Elmidae	*Microcylloepus*	*similis*	C	4			1
		Optioservus	*quadrimaculatus*	C	4		1	3
		Ordobrevia	*nubifera*	C	4	1	2	

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS		POE PROJECT		2000	
			PULGA REACH					
PHYLUM/CLASS/	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
ORDER				CATEGORY	VALUE			
Coleoptera	Elmidae	*Zaitzevia*	*parvula*	C	5	1	5	4
Diptera	Chironomidae							
	Tanypodinae	*Pentaneura*	sp.	P	4			1
	Tanypodinae	*Thienemannimyia*	sp. (pupa)	NF	4			1
	Chironominae							
	Tanytarsini	*Rheotanytarsus*	sp. A	F	6		4	2
		Rheotanytarsus	sp. B	F	6	6	1	1
	Chironomini	*Microtendipes*	sp. C	C	6			1
	Orthocladinae	*Cardiocladius*	sp.	P	4	17	11	1
		Cricotopus	*bicinctus*	C	8	5	1	4
		C.	*tremulus*	SH	6	6	4	3
		C.	*trifascia*	SH	6	2	1	
		Eukiefferiella	sp. B	C	4	4		1
		Eukiefferiella	sp. C	C	4	4		1
		Orthocladius	*(Orthocladius) sp.*	C	4	1		1
		Orthocladius	sp. B (pupa)	NF	4			1
		Tvetenia	sp.	C	4			2
	Diamesinae	*Potthastia*	sp.	C	4	7	2	4
	Simuliidae	*Simulium*	*arcticum*	F	5			1
		S.	*tuberosum*	F	5	32	14	7
		S.	*virgatum*	F	5		3	
	Tipulidae	*Antocha*	sp.	C	5	1	5	4
		Dicranota	sp. A	P	3			2
				TOTAL	NUMBER	320	331	305
			PA=parasite	TOTAL	SPECIES	40	38	58
				TOTAL	SPECIES			
					(REACH)		69	

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS		POE PROJECT		2000	
			BARDEE'S BAR	REACH				
	TAXON	(NON-INSECTS)					NUMBER	
PHYLUM/CLASS/	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
ORDER				CATEGORY	VALUE			
Platyhelminthes	Planariidae	*Dugesia*	*tigrina*	C	4	7	10	13
Nemertea	Tetrastemmatidae	*Prostoma*	*graecense*	P	4	8	18	2
Annelida								
Tubificida	Naididae	*Nais*	*communis/variabilis*	C	5		4	
		Nais	*sp.*	C	4			1
	Tubificidae	*Spirosperma*	*ferox*	C	8		1	
	Lumbricidae	*unidentified*	*species*	C	5		1	
Lumbriculida	Lumbriculidae	*Rhynchelmis*	*rostrata*	C	6		4	5
Crustacea								
Arachnida	Torrenticolidae	*Torrenticola*	sp.	P	5		1	
Mollusca								
Pelecypoda	Corbiculidae	*Corbicula*	*fluminea*	F	8	1		
	TAXON	(INSECTS)						
ORDER	FAMILY	GENUS	SPECIES					
Ephemeroptera	Baetidae	*Acentrella*	*insignificans*	C	6	11	20	1
		Baetis	*magnus*	C	4	2	12	
		B.	*tricaudatus*	C	6	86	84	54
	Heptageniidae	*Epeorus (Iron)*	sp.	SC	4	3	6	2
		Rhithrogena	sp.	SC	4	17	2	3
	Isonychiidae	*Isonychia*	*velma*	F	3	3	5	3
Plecoptera	Nemouridae	*Zapada*	*cinctipes*	C	1	1		
	Chloroperlidae	*Sweltsa*	sp.	P	1	1		
	Perlidae	*Calineuria*	*californica*	P	1	2	1	
		Hesperoperla	*pacifica*	P	2	1	2	1
	Perlodidae	*Isoperla*	sp.	P	1	6	3	11

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS		POE PROJECT		2000	
			BARDEE'S BAR	REACH				
PHYLUM/CLASS/ ORDER	FAMILY	GENUS	SPECIES	TROPHIC CATEGORY	TOLERANCE VALUE	SAMPLE 1	SAMPLE 2	SAMPLE 3
Plecoptera	Perlodidae	*Skwala*	*parallela*	P	1		1	1
Trichoptera	Hydropsychidae	*Ceratopsyche*	*cockerelli*	F	4		2	3
		Cheumatopsyche	*campyla*	F	5	16	11	38
		Hydropsyche	*californica*	F	6	18	3	8
		H.	*occidentalis*	F	6	30	23	72
	Hydroptilidae	*Hydroptila*	sp. B	H	6		1	
		Leucotrichia	*pictipes*	SC	6		2	
	Philopotamidae	*Chimarra*	*utahensis*	F	4	78	47	39
	Polycentropodidae	*Polycentropus*	sp.	P	4			1
	Rhyacophilidae	*Rhyacophila*	*malkini (pupa)*	NF	1	2	1	2
Lepidoptera	Pyralidae	*Petrophila*	sp.	SC	5		1	1
Coleoptera	Elmidae	*Optioservus*	*quadrimaculatus*	C	4	3	3	1
		Ordobrevia	*nubifera*	C	4	3	2	3
		Zaitzevia	*parvula*	C	5	2	2	6
Diptera	Chironomidae							
	Chironominae							
	Tanytarsini	*Rheotanytarsus*	sp. A	F	6		2	
		Rheotanytarsus	sp. B	F	6	1	1	
	Orthocladinae	*Cardiocladius*	sp.	P	4	2	1	2
		Cricotopus	*bicinctus*	C	8		5	1
		C.	*tremulus*	SH	6		1	2
		Eukiefferiella	sp. A	C	4			1
		Eukiefferiella	sp. B	C	4	1		
		Eukiefferiella	sp. C	C	4		2	
		Tvetenia	sp.	C	4	1		
	Diamesinae	*Potthastia*	sp.	C	4		1	
	Simuliidae	*Simulium*	*arcticum*	F	5			3
		Simulium	*canadense*	F	5		1	

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS		POE PROJECT		2000	
			BARDEE'S BAR	REACH				
PHYLUM/CLASS/ ORDER	FAMILY	GENUS	SPECIES	TROPHIC CATEGORY	TOLERANCE VALUE	SAMPLE 1	SAMPLE 2	SAMPLE 3
Diptera	Simuliidae	*S.*	*tuberosum*	F	5	2	11	
		S.	*virgatum*	F	5	24	1	27
	Tipulidae	*Antocha*	sp.	C	5			1
	Tipulidae	*Dicranota*	sp. B	P	3			1
				TOTAL	NUMBER	332	299	309
				TOTAL	SPECIES	28	39	31
				TOTAL	SPECIES (REACH)		49	

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: FEATHER RIVER /NFFR
DATE/TIME: 102599 /1000
COMPANY/AGENCY: HYDROZOOLOGY
SAMPLE ID NO.(S): POE 1, 2, 3
SITE DESCRIPTION: 0.1 Mile ABOVE HWY 70 BRIDGE AT PULGA TO FIRST RIFFLE UPSTREAM OF FLEA VALLEY CREEK

CREW MEMBERS

Wayne Fields
Doug Parkinson

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: 1480'
Ecoregion:
COMMENTS: LOWER RIFFLE SHORT, W/ dangerous access FROM NORTH AT HIGHER FLOWS. ALL THE RIFFLES WILL REQUIRE CAUTION AT HIGHER FLOWS.

CHEMICAL CHARACTERISTICS

Water Temperature: 54°
Specific Conductance: 98.9 μS
pH: COULD NOT GET
Dissolved Oxygen: 97%

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length: ____
Transect 1: ____
Transect 2: ____
Transect 3: ____
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.5mi
Physical/habitat Quality Score: 142

Physical/Habitat Characteristics

	riffle 1	riffle 2	riffle 3
Riffle Length:	12'	69'	90'
Transect Location:	9'	65'	71'
Ave. Riffle Width:	30	45	100'
Ave Riffle Depth:	1.0"	1.0'	8"
Riffle Velocity:	2 F/s	1.5 F/s	2 F/s
% Canopy Cover:	Ø%	Ø%	5%
Substrate Complexity:	16	19	19
Embeddedness:	1-5%	1-5%	1-5%
% Substrate:			
fines (<0.1")	Ø	Ø	Ø
gravel (0.1-2")	10%	5%	5%
cobble (2-10")	60%	75%	75%
boulder (>10")	30%	20%	20%
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	19	19	19
% Gradient:	2.0%	2.0%	2.0%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: FEATHER RIVER / NFFR
DATE/TIME: 102599 / 1000
COMPANY/AGENCY: HYDROZOOLOGY
SAMPLE ID NO.(S): POE 1, 2, 3
SITE DESCRIPTION: 0.1 MILE ABOVE HWY 70 BRIDGE AT PULGA TO FIRST RIFFLE UPSTREAM OF FLEA VALLEY CREEK

(Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 2	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 (2) 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	(2) 1 0
SCORE 2 (RB)	Right Bank 10 9	8 7 6	5 4 3	(2) 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 1 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 (1) 0
SCORE 1 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 (1) 0

Total Score 142

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: NFFR
DATE/TIME: 092500 0910
COMPANY/AGENCY: PG&E / HYDROZOOLOGY
SAMPLE ID NO.(S): POE PH 1, 2, 3
SITE DESCRIPTION: BEGINNING 0.1 MILE ABOVE POE PH ROAD BRIDGE ABOUT 0.5 MILE UPSTREAM

CREW MEMBERS

W. FIELDS
D. PARKINSON

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: ≈ 900'
Ecoregion:

COMMENTS: ACCESS TRAIL TO SWIMMING HOLE 0.25 MILES UPSTREAM OF ~~POE~~ PH ROAD BR

CHEMICAL CHARACTERISTICS

Water Temperature: 15.5°C
Specific Conductance: 123 μs
pH: PROBE BROKEN
Dissolved Oxygen: 95%

Bioassessment Laboratory Information:

END A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.5 mi
Physical/habitat Quality Score: 143

Physical/Habitat Characteristics

	riffle 1 /run	riffle 2	riffle 3
Riffle Length:	92'	88'	170'
Transect Location:	68'/72'/88'	83'	130'
Ave. Riffle Width:	10'	40'	80'
Ave Riffle Depth:	0.8'	0.4'	0.8'
Riffle Velocity:	1.0 f/s	1.5 f/s	1.0 f/s
% Canopy Cover:	∅	∅	∅
Substrate Complexity:	15	5	11
Embeddedness:	10%	∅	10%
% Substrate:			
fines (<0.1")	∅	∅	∅
gravel (0.1-2")	5	80	10
cobble (2-10")	90	20	85
boulder (>10")	5	∅	5
bedrock (solid)	∅	∅	∅
Substrate Consolidation:	LOOSE	LOOSE	LOOSE
% Gradient:	1%	1.5%	1%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: NFFR
DATE/TIME: 092500/0910
COMPANY/AGENCY: PG&E, HYDROECOLOGY
SAMPLE ID NO.(S): POE PH 1, 2, 3
SITE DESCRIPTION: BEGINNING 0.1 MILE ABOVE POE PH ROAD BRIDGE ABOUT 0.5 Mile upstream

(Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 2 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 2 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 143

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: NFFR
DATE/TIME: 0925 1345
COMPANY/AGENCY: PG&E / HYDROZOOLOGY
SAMPLE ID NO.(S): BAR 1, 2, 3
SITE DESCRIPTION: HIGH GRADIENT RIFFLE AT BARDEE'S BAR DOWNSTREAM 0.5 MILE

CREW MEMBERS

W. FIELDS
D. PARKINSON

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: ≈ 1140'
Ecoregion:
COMMENTS: NO TRUE RIFFLES IN REACH - SMALL AREAS OF RIFFLE HABITAT

CHEMICAL CHARACTERISTICS

Water Temperature: 18°C
Specific Conductance: 120.43
pH: PROBE BROKEN
Dissolved Oxygen: "

Bioassessment Laboratory Information:

END A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.5 mi
Physical/habitat Quality Score: 134

Physical/Habitat Characteristics

	riffle 1	riffle 2	riffle 3
Riffle Length:	18'	12'	20'
Transect Location:	SPOT SAMPLING	"	"
Ave. Riffle Width:	6'	20'	80'
Ave Riffle Depth:	0.6'	0.8"	1.0'
Riffle Velocity:	1.0 f/s	1.0 f/s	2.5 f/s
% Canopy Cover:	Ø	Ø	Ø
Substrate Complexity:	17	17	15
Embeddedness:	Ø	10%	Ø
% Substrate:			
fines (<0.1")	Ø	Ø	Ø
gravel (0.1-2")	10%	20%	Ø
cobble (2-10")	80%	50%	10%
boulder (>10")	10%	30%	90%
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	LOOSE	LOOSE	TIGHT
% Gradient:	2%	1%	3%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: NFFR
DATE/TIME: 092500/1345
COMPANY/AGENCY: PG&E/HYDROECOLOGY
SAMPLE ID NO.(S): BAR 1,2,3
SITE DESCRIPTION: HIGH GRADIENT RIFFLE AT BARDEES BAR DOWNSTREAM 0.5 MI

(Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 1	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 (1) 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 1 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 (1) 0
SCORE 1 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 (1) 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 1 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 (1) 0
SCORE 1 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 (1) 0

Total Score 134

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: NFFR
DATE/TIME: 092709/0915 hrs
COMPANY/AGENCY: PG&E / HYDROZOOLOGY
SAMPLE ID NO.(S): ~~PGE~~ 1, 2, 3 PULGA
SITE DESCRIPTION: 0.1 MILE ABOVE HWY 70 BRIDGE TO BIG RIFFLE ABOVE PULGA 0.5 Miles

CREW MEMBERS

D. FIELDS
D. PARKINSON

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: ≈ 1480'
Ecoregion:
COMMENTS: RIFFLES GENERALLY SCARCE - SPOT SAMPLING IN RIFFLE HABITATS

CHEMICAL CHARACTERISTICS

Water Temperature: 16° C
Specific Conductance: 132 µs
pH: —
Dissolved Oxygen: —

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.5 mi
Physical/habitat Quality Score: 146

Physical/Habitat Characteristics

	riffle 1	riffle 2	riffle 3
Riffle Length:	20'	20'	931
Transect Location:	SPOTS	SPOTS	80'
Ave. Riffle Width:	55'	46'	100'
Ave Riffle Depth:	1.4'	0.8'	1.0'
Riffle Velocity:	2 f/s	1.5 f/s	2.5 f/s
% Canopy Cover:	Ø	Ø	Ø
Substrate Complexity:	19	15	19
Embeddedness:	Ø	10%	Ø
% Substrate:			
fines (<0.1")	Ø	Ø	Ø
gravel (0.1-2")	Ø	5%	Ø
cobble (2-10")	10%	75%	40%
boulder (>10")	90%	20%	60%
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	TIGHT	LOOSE	TIGHT
% Gradient:	2%	1.5%	2%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: NFFR
DATE/TIME: 09270 / 0915 HRS.
COMPANY/AGENCY: PG&E / HYDROZOOLOGY
SAMPLE ID NO.(S): ~~PGE~~ 1, 2, 3 PULGA
SITE DESCRIPTION: 0.1 Mile Above HWY 70 Bridge To Big Riffle Above Pulga (0.5 Miles)

(Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 2	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 2 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 2 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

38 42

Total Score 146

Poe Hydroelectric Project

Addendum to Macroinvertebrate Reports (Fields, 1999 and 2000)

Taxa Metrics Utilizing California Stream Bioassessment Procedure (CSBP) Categories

Poe Hydroelectric Project - Macroinvertebrate Sampling - Pulga Site (1999)

	Pulga 1	Pulga 2	Pulga 3	Mean	S.D.	CV
Taxanomic Richness	29	26	26	27.0	1.7	6.4
EPT Taxa	16	14	15	15.0	1.0	6.7
Ephemeroptera Taxa	5	5	5	5.0	0.0	0.0
Plecoptera Taxa	3	4	4	3.7	0.6	15.7
Trichoptera Taxa	8	5	6	6.3	1.5	24.1
EPT Index	79.1	79.7	68.9	75.9	6.1	8.0
Sensitive EPT Index	5.8	4.6	5	5.1	0.6	11.9
Diversity Index	3.45	2.89	3.3	3.2	0.3	9.0
% Intolerant Taxa	8.5	4.6	5	6.0	2.1	35.6
% Tolerant taxa	1.6	1.9	5	2.8	1.9	66.4
% Hydropsychidae Taxa	51.3	53.5	34.1	46.3	10.6	22.9
% Baetidae	8.5	13	10.3	10.6	2.3	21.4
% Dominant Taxon	31	37	17.5	28.5	10.0	35.0
% Collectors	18.6	20.2	27.4	22.1	4.7	21.2
% Filterers	61.6	65.9	59.3	62.3	3.4	5.4
% Shredders	3.3	5.1	4.6	4.3	0.9	21.4

Poe Hydroelectric Project - Macroinvertebrate Sampling - Pulga Site (2000)

	Pulga 1	Pulga 2	Pulga 3	Mean	S.D.	CV
Taxanomic Richness	30	30	40	33.3	5.8	17.3
EPT Taxa	15	15	20	16.7	2.9	17.3
Ephemeroptera Taxa	5	5	6	5.3	0.6	10.8
Plecoptera Taxa	2	4	5	3.7	1.5	41.7
Trichoptera Taxa	8	6	9	7.7	1.5	19.9
EPT Index	55.6	66.2	63.6	61.8	5.5	8.9
Sensitive EPT Index	2.2	7.2	4.6	4.7	2.5	53.6
Diversity Index	3.62	3.63	4.1	3.8	0.3	7.2
% Intolerant Taxa	1.9	7.2	4.6	4.6	2.7	58.0
% Tolerant taxa	1.9	0.6	4.3	2.3	1.9	82.8
% Hydropsychidae Taxa	16.2	27.2	29.5	24.3	7.1	29.3
% Baetidae	17.2	11.8	10.2	13.1	3.7	28.1
% Dominant Taxon	14.1	17.5	18	16.5	2.1	12.8
% Collectors	36.5	31.4	33.1	33.7	2.6	7.7
% Filterers	43.4	50.8	46.9	47.0	3.7	7.9
% Shredders	2.5	1.5	1.3	1.8	0.6	36.4

Poe Hydroelectric Project - Macroinvertebrate Sampling - Bardee's Bar (2000)

	Bardee's 1	Bardee's 2	Bardee's 3	Mean	S.D.	CV
Taxanomic Richness	23	31	26	26.7	4.0	15.2
EPT Taxa	14	16	14	14.7	1.2	7.9
Ephemeroptera Taxa	5	5	5	5.0	0.0	0.0
Plecoptera Taxa	5	4	3	4.0	1.0	25.0
Trichoptera Taxa	4	7	6	5.7	1.5	27.0
EPT Index	86.4	76.2	77.3	80.0	5.6	7.0
Sensitive EPT Index	3.9	2.7	4.8	3.8	1.1	27.7
Diversity Index	3.06	3.34	3.16	3.2	0.1	4.5
% Intolerant Taxa	3.9	2.7	4.8	3.8	1.1	27.7
% Tolerant taxa	0	2	0	0.7	1.2	173.2
% Hydropsychidae Taxa	19.3	13	39.2	23.8	13.7	57.4
% Baetidae	29.8	38.8	17.8	28.8	10.5	36.6
% Dominant Taxon	26.5	32.1	25.9	28.2	3.4	12.1
% Collectors	35.2	50.5	27.8	37.8	11.6	30.6
% Filterers	52.1	35.8	61.2	49.7	12.9	25.9
% Shredders	0	0.3	0.6	0.3	0.3	100.0

Poe Hydroelectric Project - Macroinvertebrate Sampling - Poe Powerhouse (2000)

	Poe PH 1	Poe PH 2	Poe PH 3	Mean	S.D.	CV
Taxanomic Richness	33	21	34	29.3	7.2	24.7
EPT Taxa	17	11	16	14.7	3.2	21.9
Ephemeroptera Taxa	6	5	6	5.7	0.6	10.2
Plecoptera Taxa	3	2	2	2.3	0.6	24.7
Trichoptera Taxa	8	4	8	6.7	2.3	34.6
EPT Index	61.6	50	70.5	60.7	10.3	16.9
Sensitive EPT Index	2	1.4	2.5	2.0	0.6	28.0
Diversity Index	3.74	3.19	3.54	3.5	0.3	8.0
% Intolerant Taxa	2.4	1.4	2.5	2.1	0.6	29.0
% Tolerant taxa	2	1	1.8	1.6	0.5	33.1
% Hydropsychidae Taxa	25	7	29.9	20.6	12.1	58.4
% Baetidae	20.2	23.1	24.5	22.6	2.2	9.7
% Dominant Taxon	19.9	21.7	24.6	22.1	2.4	10.7
% Collectors	39	55.9	36.6	43.8	10.5	24.0
% Filterers	36.6	40.9	35.2	37.6	3.0	7.9
% Shredders	2	0	0	0.7	1.2	173.2

POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX E3-6

The Benthic Macroinvertebrate Fauna of the Poe Reach of the North Fork Feather River, Butte and Plumas Counties, California, 2001

The Benthic Macroinvertebrate Fauna of the Poe Reach, North Fork Feather River, Butte County, California
October 2001

For: MHA Environmental Consulting, Inc.
4 West Fourth Avenue, Suite 303
San Ramon, CA 94402

By: Wayne C. Fields, Jr.
Hydrozoology
P.O. Box 682
Newcastle, CA 95658

INTRODUCTION

Part of the Federal Energy Regulatory Commission (FERC) relicensing procedure of the Poe Project on the North Fork of the Feather River (NFFR) seeks to alleviate the impact of power production on natural resources. Changes in the flow regime (i.e., higher minimum flows, stabilized flows) may result in improved and/or additional habitat. This report focuses on the quality of macroinvertebrate habitat by studying the organisms collected from that habitat. The California Stream Bioassessment Protocol (CSBP) was employed as the framework for establishing collection sites, sampling, conducting laboratory work, and providing selected metrics used to determine the nature of the fauna.

MATERIALS AND METHODS

1. SAMPLING

The Poe Reach of the NFFR is between Poe Dam, which controls releases, and Poe Powerhouse, about eight miles downstream. Within the reach, three macroinvertebrate sampling reaches have been established, each containing five riffles, patches of riffle habitat or combinations thereof. These reaches were selected based on the availability of riffles and of access, both of which are scarce on the NFFR. The sampling reaches are:

- The Poe Powerhouse reach, extending from 0.1 to 0.6 miles upstream of the Poe Powerhouse Bridge. All but one of the riffles is on the edges of other habitat types. This reach was sampled for the first time in 2000.

- The Bardee's Bar reach is about 0.5 miles long and consists of patches of riffle habitat along the edge of the large bend at Bardee's Bar. This reach was also sampled in 2000.

- The Pulga reach begins 0.1 miles above Highway 70 and ends at the top of the large riffle upstream of Flea Valley Creek, about 0.5 miles. It consists of both true riffles and patches of riffle habitat. This reach was sampled in 1999 and 2000.

Sampling was conducted on October 4 and 5, 2001. Three riffles were chosen randomly from the five available in the reach. At each sampling site a total of six square feet of stream bottom was sampled using a Wildco stream bottom sampling net with 0.5mm netting and a detachable bucket. Samples were collected from the available variety of velocity/depth regimes within the riffle and combined as a single sample. The sample was then field elutriated to remove sand, gravel and large detritus, placed in eight ounce plastic jars, and preserved. Ten percent formalin dyed with rose bengal was used for preservation/fixation, using an amount equal to the volume of the sample for a final solution of approximately five percent. Lids with polyethylene closures were used on the jars to prevent leakage. Three such combination samples were collected from each sampling reach, one from each riffle chosen. Nine samples were thus collected from the three sampling reaches to represent the benthic fauna of the Poe Reach. California Bioassessment Worksheets and Physical Habitat Quality forms were filled out for each sampling reach, describing them in physical terms. Copies of the Worksheets and forms are appended to this report.

2. LABORATORY PROCEDURES

In the laboratory the formalin was poured off, and the sample rinsed and spread evenly in water on a gridded 8" X 12" Plexiglas tray with 24 equal, numbered 2" square bottom divisions. Individual squares were chosen randomly and isolated from other squares using one of three Plexiglas dams designed for the purpose. The contents of each selected square were placed in a glass dish, and the macroinvertebrates picked out under a dissecting microscope, counted, and placed in 70% ethanol. This procedure was repeated until the requisite number of organisms (300 +/- 10%) for the subsample was reached. In every case the last grid chosen was picked in its entirety. The unpicked portion of the sample (the remainder) was then briefly searched for obvious species that had not been removed during subsampling, and the rest represerved in ethanol. A reference collection consisting of each species encountered thus far has been established; the subsamples and the reference collection will be curated indefinitely by Hydrozoology. For QA/QC purposes, a random 20% of the subsamples will be vouchered per directions of the California Department of Fish and Game's (CDFG) Aquatic Bioassessment Laboratory (ABAL) and transferred to them on a temporary basis for verification of identification. The remainders will be retained as insurance until QA/QC verifications are done.

Organisms in the subsample were identified to the species level, using morphotypes, whether they could be completely named or not. This allows for the accurate calculation of the metrics of species richness and species diversity, two important approximations of ecological diversity. Each species in the subsample was counted; species lists for each subsample are presented as appendices to this report. The species lists also provide the trophic category of each species (Merrit and Cummins 1996) and give a tolerance value for each species provided either by the ABAL or from experience.

Species list data were used to calculate a variety of the CSBP metrics. Tables 1-4 present the richness, EPT measures, tolerance and feeding group metrics for each subsample collected in 2001. Tables 5-8 compare these same metrics derived from samples collected between 1999, 2000, and 2001 to provide a glimpse of variation observed so far.

3. RESULTS AND DISCUSSION (2001)

RICHNESS MEASURES

Table 1 presents richness measures calculated from the samples collected. Species richness is the most direct way of looking at habitat quality, as it provides a representation of the variety of ecological niches available. The more species there are, the more stable the benthic community is likely to be (Patrick, 1970). If the stream environment improves, species richness should increase. The species diversity index (H) of Brillouin (1962) was also calculated for each sample in the reach. Species diversity is a metric which takes into account both how many species are present (richness) and the degree to which those species are represented in the sample (evenness). A sample with few species will exhibit low species diversity. A sample with a single superdominant species indicates a habitat which favors just one species. The greater the disparity between the dominant species and others, the lower the evenness and thus the species diversity. As with species richness, an increase in species diversity should accompany any improvement in stream habitat quality.

METRIC	REACH/SAMPLE								
	Poe Powerhouse			Bardee's Bar			Pulga		
Species Richness (total) (mean)	34 (42)	29 (28)	20	25 (38)	31 (27)	26	41 (54)	39 (38)	34
Species Diversity (mean)	3.34 (3.10)	3.23	2.73	3.17 (2.98)	3.03	2.74	4.00 (3.87)	3.81	3.81

Table 1. Richness measures of Poe Reach benthic samples, October 2001

Calculations of species richness and diversity from samples collected throughout the Feather River System between 1999 and 2001 provide a potential range of values by which the current samples can be judged. Samples have been collected on the Middle Fork and East Branch, from Upper Butt Valley and Yellow Creeks, from the Upper North Fork between Canyon Dam and the North Fork, and in the Rock Creek and Cresta Reaches. Mean species richness ranges from about 20 species to about 50 species. Mean species diversity values range from about 1.0 to almost 4.4. The following scheme is suggested as a way of categorizing species richness and diversity in the Feather River system:

Mean Species Richness	Mean Species diversity	Benthic Invertebrate Community Condition
<25	<1.25	extremely poor
25-30	1.25-2.5	poor
31-35	2.5-3.0	fair
36-40	3.0-3.5	moderate
41-45	3.5-4.0	good
46-50	4.0-4.25	very good
>50	>4.25	excellent

Using the above table, it can be seen that samples from the Poe Powerhouse and Bardee's Bar reaches are poor in terms of species richness and fair to moderate in terms of species diversity. The Pulga Reach is moderate in terms of species richness and good in terms of species diversity.

EPT MEASURES

EPT species are those representing the insect orders Ephemeroptera, Plecoptera, and Trichoptera, and are presumed to be more sensitive to environmental disturbance than other

METRIC	REACH/SAMPLE								
	Poe Powerhouse			Bardee's Bar			Pulga		
	1	2	3	1	2	3	1	2	3
EPT Species	8	8	7	11	12	13	12	12	11
(total) (mean)	(10) (8)			(16) (12)			(16) (12)		
Ephemeroptera Species	4	4	3	3	3	4	4	3	3
(total) (mean)	(5) (4)			(4) (3)			(4) (3)		
Plecoptera species	0	0	0	1	2	3	0	2	2
(total) (mean)	(0) (0)			(3) (2)			(2) (1)		
Trichoptera species	4	4	4	7	7	6	8	7	7
(total) (mean)	(5) (4)			(9) (7)			(10) (7)		
EPT Index	56.8	52.5	56.2	60.5	73.8	50.8	53.3	52.9	54.3
(mean)	(55.2)			(61.7)			(53.5)		
Sensitive EPT Index	1.1	0.3	1.8	1.5	1.7	1.5	0.7	1.3	3.0
(mean)	(1.1)			(1.6)			(1.7)		

Table 2. EPT measures of Poe Reach benthic samples, October 2001

types of aquatic invertebrates. Taken together, they form the majority of organisms found in the Poe Reach (EPT Index) and usually over one third of the species (EPT species). Most of the species collected are not particularly sensitive, having tolerance values above 3 (see attached species lists). It should be noted that the only truly sensitive group (Plecoptera species) is absent from four of the nine samples from the Poe Reach and at low levels in the other samples. Three species of Plecoptera and one of Ephemeroptera make up all the Sensitive EPT species. Their numbers should increase if habitat quality is enhanced.

TOLERANCE MEASURES

Three metrics have been calculated in this category: % Intolerant Organisms, % Tolerant Organisms, and % Dominant Species. Two metrics calculated in the past (% Hydropsychidae and % Baetidae)have been dropped from consideration. There are two good reasons for this: first, some of the species in both families are not tolerant, and second, the species considered to be tolerant actually have tolerance values no higher than 6. These species can be found at nearly every sampling site in the drainage, and are probably best considered (to borrow a term from microbiology) facultative in terms of response to impairment. There were few truly tolerant organisms collected (values of 8 or higher) in the Poe Reach (see species lists), even fewer organisms than are found in the so-called intolerant category. Intolerant species should increase their populations and tolerant species decline in number as stream habitat is improved. The dominant species in five of the samples was the mayfly *Baetis tricaudatus* (Ephemeroptera: Baetidae). This species was subdominant in three of the remaining samples. It is the most widespread and successful mayfly in California. Two of the samples were dominated by the blackfly larva *Simulium virgatum* (Diptera: Simuliidae), and the remaining two samples dominated by the caddisfly *Hydropsyche californica* (Trichoptera: Hydropsychidae). As discussed above, the high counts of the dominant species are an important element in the calculation of a low species diversity, since they reduce evenness. Note the degree to which the fauna is dominated by a single species in the Poe Powerhouse and Bardee's Bar reaches, and the reduced species richness and species diversity. In the Pulga reach, the % Dominant Species is about half as abundant as at the other two reaches.

METRIC	REACH/SAMPLE								
	Poe Powerhouse			Bardee's Bar			Pulga		
	1	2	3	1	2	3	1	2	3
% Intolerant Organisms	1.4	0.3	1.8	1.5	2.0	1.5	1.0	1.4	3.0
(mean)	(1.2)			(1.7)			(1.8)		
% Tolerant Organisms 1.1	3.2	0.3	1.2	0.3	1.2	1.8	0.7	0.6	
(mean)	(1.5)			(0.9)			(1.0)		
% Dominant Species	35.2	39.8	27.6	34.4	41.1	33.8	15.1	21.0	16.4
(mean)	(34.2)			(36.4)			(17.5)		

Table 3. Tolerance/Intolerance measures of Poe Reach benthic samples, October 2001.

FUNCTIONAL FEEDING GROUP MEASURES

Ideally, the percentage of shredders (animals that feed on coarse vegetable matter) should increase with improvements to a stream. This assumes an increase in the amount of riparian vegetation. Poe Reservoir removes most of the coarse vegetable detritus arriving from upstream. Much of the reach is made up of long pools which trap vegetable detritus. There is also little in the way of a riparian zone on the Poe Reach. It is therefore to be expected that the shredder component of the fauna is small. In contrast, the percentages of filterers and collector/gatherer s are expected to be high since most of the available detritus exists as fine particles, most of which is in suspension. Together, these groups make up over 80% of the fauna. As expected, the percentage of filterers is highest closest to Poe Reservoir (at Pulga) and lowest farther away (Poe Powerhouse), and the percentage of collector/gatherers increases as one goes downstream. The high percentages of filterers from sample #3 at Poe Powerhouse and sample #3 at Bardee's Bar are due to the random inclusion of large numbers of blackfly larvae, which are notoriously patchy in their distribution.

METRIC	REACH/SAMPLE								
	Poe Powerhouse			Bardee's Bar			Pulga		
	1	2	3	1	2	3	1	2	3
% Collectors	60.4	68.1	39.8	55.5	53.9	40.6	50.9	37.3	29.0
(mean)	(56.1)			(50.1)			(39.1)		
% Filterers	29.8	18.9	59.3	35.0	41.4	56.3	32.6	48.8	54.9
(mean)	(36.0)			(44.2)			(45.4)		
% Shredders	1.1	1.5	0	0.3	0.3	0	2.8	3.4	1.2
(mean)	(0.9)			(0.2)			(2.5)		

Table 4. Functional feeding group measures of Poe Reach benthic samples, October 2001.

4. RESULTS AND DISCUSSION (1999-2001)

RICHNESS MEASURES

REACH	YEAR/METRIC		
	1999	2000	2001
		MEAN SPECIES RICHNESS	
POE POWERHOUSE	----	35	28
BARDEE'S BAR	----	33	27
PULGA	36	45	38
		MEAN SPECIES DIVERSITY	
POE POWERHOUSE	----	3.88	3.10
BARDEE'S BAR	----	3.40	2.98
PULGA	3.59	4.18	3.87

Table 5. Richness measures of Poe Reach benthic samples, 1999-2001.

Although there are now only three years of record in one of the sampling reaches and two in the others, a pattern is beginning to emerge. Species richness ranges from poor to fair in the Poe Powerhouse and Bardee's Bar reaches. Species diversity ranges from fair to good in those reaches. In the Pulga reach, species richness fluctuates from moderate to very good, and species diversity from good to very good. The Pulga reach consistently exhibits better habitat quality than the other two reaches, based on the quality scheme suggested above.

REACH	YEAR/METRIC		
	1999	2000	2001
		MEAN EPT SPECIES	
POE POWERHOUSE	----	17	8
BARDEE'S BAR	----	16	12
PULGA	16	18	12
		MEAN EPHEMEROPTERA SPECIES	
POE POWERHOUSE	----	7	4
BARDEE'S BAR	----	6	3
PULGA	5	6	3
		MEAN PLECOPTERA SPECIES	
POE POWERHOUSE	----	2	0
BARDEE'S BAR	----	4	2
PULGA	4	4	1
		MEAN TRICHOPTERA SPECIES	
POE POWERHOUSE	----	8	4
BARDEE'S BAR	----	7	7
PULGA	7	9	7
		MEAN EPT INDEX	
POE POWERHOUSE	----	60.7	55.2
BARDEE'S BAR	----	78.8	61.7
PULGA	75.9	61.8	53.5
		MEAN SENSITIVE EPT INDEX	
POE POWERHOUSE	----	2.0	1.1
BARDEE'S BAR	----	3.8	1.6
PULGA	5.1	4.6	1.6

Table 6. EPT measures of Poe Reach benthic samples, 1999-2001

EPT MEASURES

A comparison of the means of EPT measures over the years of record at the three sampling reaches does not reveal any particular pattern in terms of abundances of mayflies, stoneflies or caddisflies. Numbers of species tend to vary in the same range throughout the Poe Reach between sampling reaches and between years, although there were generally fewer EPT species in 2001 than in previous years. The one exception is the mean Sensitive EPT Index, which shows a consistently higher percentage in the Pulga reach than in the others.

TOLERANCE MEASURES

REACH	YEAR/METRIC 1999	2000	2001
		MEAN % INTOLERANT ORGANISMS	
POE POWERHOUSE	----	2.1	1.2
BARDEE'S BAR	----	3.8	1.7
PULGA	6.0	4.6	1.8
		MEAN % TOLERANT ORGANISMS	
POE POWERHOUSE	----	1.6	1.5
BARDEE'S BAR	----	0.6	0.9
PULGA	2.5	2.3	1.0
		MEAN % DOMINANT SPECIES	
POE POWERHOUSE	----	16.3	34.2
BARDEE'S BAR	----	23.8	36.4
PULGA	23.2	14.2	17.5

Table 7. Tolerance/Intolerance measures of Poe Reach benthic samples, 1999-2001.

Both tolerant and intolerant species exist at low levels throughout the Poe Reach. In any given year, there have been a few more intolerant organisms in the Pulga reach than in the other reaches. At the same time, there have been as many or more tolerant organisms in the same reach. There is no way to assess habitat quality using these contradictory figures. As described above for the 2000 sampling year, however, the percentage made up of the dominant species is consistently lowest at Pulga, reflecting a more varied and higher quality habitat.

FUNCTIONAL FEEDING GROUP MEASURES

Essentially the same pattern that prevailed in the three sampling reaches during 2001 asserts itself for the other years of record: there are usually more filtering organisms in samples collected near Poe Dam and more collector/gatherers in samples from downstream. Also, the mean number of shredders is low throughout the Poe Reach, but highest at Pulga. This is probably due to two factors: the presence of a modest amount of riparian vegetation in the Pulga sampling reach that is for practical purposes absent elsewhere, and the slightly wider, more depositional nature of the stream channel upstream of Flea Valley Creek when compared to the rest of the Poe Reach.

REACH	YEAR/METRIC		
	1999	2000	2001
		MEAN % COLLECTORS	
POE POWERHOUSE	----	42.4	55.8
BARDEE'S BAR	----	37.9	45.3
PULGA	22.1	33.7	39.1
		MEAN % FILTERERS	
POE POWERHOUSE	----	37.6	36.2
BARDEE'S BAR	----	49.7	42.9
PULGA	62.3	47.0	45.2
		MEAN % SHREDDERS	
POE POWERHOUSE	----	0.6	0.9
BARDEE'S BAR	----	0.3	0.2
PULGA	4.3	1.8	2.5

Table 8. Functional Feeding Group measures of Poe Reach benthic samples, 1999-2001.

We are only beginning to appreciate the nature of year to year variation in the metrics used to describe the fauna of the Poe Reach. As minimum flows increase, it may or may not be possible to separate the effects of changes in operations from natural variability.

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PG&E	NORTH FORK	FEATHER RIVER	BENTHOS	POE	PROJECT	2001		
			POE POWERHOUSE	REACH				100401
	TAXON	(NON-INSECTS)						
PHYLUM/CLASS/	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
ORDER				CATEGORY	VALUE			
Platyhelminthes	Planariidae	*Dugesia*	*tigrina*	C	4	23	43	27
Nemertea	Tetrastemmatidae	*Prostoma*	*graecense*	P	4	7	19	1
Nematoda	Mermithidae	unidentified	species	PA	4	1		
Annelida								
Tubificida	Naididae	*Nais*	*communis/variabilis*	C	6	2		3
	Lumbricidae	*Eisenella*	*tetraedra*	C	5	2	4	3
	Ocnerodrilidae	*cf. Eukerria*	*saltensis*	C	5		2	
Lumbriculida	Lumbriculidae	*Rhynchelmis*	*rostrata*	C	6	1	1	
Arthropoda								
Arachnida	Hygrobatidae	*Hygrobates*	sp.	P	5	4	3	
	Lebertiidae	*Lebertia*	sp.	P	5		1	
	Sperchontidae	*Sperchon*	sp. A	P	5	1	1	
Mollusca								
Gastropoda	Physidae	*Physa*	*gyrina*	SC	8	1	2	
	Lymnaeidae	*Fossaria*	sp.	SC	5	8	9	
Bivalvia	Corbiculidae	*Corbicula*	*fluminea*	F	8	2	9	1
	TAXON	(INSECTS)						
ORDER	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
				CATEGORY	VALUE			
Ephemeroptera	Baetidae	*Acentrella*	*turbida*	C	6	1	9	1
		Baetis	*magnus*	C	4		1	
		B.	*tricaudatus*	C	6	98	135	90
	Isonychiidae	*Isonychia*	*velma*	F	3	3	1	6
	Tricorythidae	*Tricorythodes*	*minutus*	C	6	1		
Trichoptera	Hydropsychidae	*Cheumatopsyche*	*campyla*	F	5	3	2	6
		Hydropsyche	*californica*	F	6	41	15	27
		H.	*occidentalis*	F	6	6		2
	Hydroptilidae	*Hydroptila*	sp. A	H	6		4	

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS	POE	PROJECT	2001		
			POE POWERHOUSE	REACH				100401
	TAXON	(INSECTS)						
ORDER	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
				CATEGORY	VALUE			
Trichoptera	Philopotamidae	*Chimarra*	*utahensis*	F	4	5	11	53
Coleoptera	Psephenidae	*Eubrianax*	*edwardsii*	SC	4	1		
	Elmidae	*Optioservus*	*quadrimaculatus*	C	4	1	14	3
		Zaitzevia	*parvula*	C	6	3	4	1
	Ptilodactylidae	*Stenocolus*	*scutellaris*	SH	2	1		
Diptera	Chironomidae							
	Diamesinae	*Potthastia*	sp.	C	4	7	1	
	Orthocladiinae	*Cardiocladius*	sp.	P	4			2
		Cricotopus	*flavocinctus*	C	6	17	6	3
		C.	*tremulus*	SH	6		1	
		C.	*trifascia*	SH	6	2	4	
		Cricotopus	sp. A	C	4	9	8	
		Eukiefferiella	sp. E	C	4	1		
		Nostococladius	sp.	M	4	1		
		Thienemanniella	sp	C	5	1		
		Tvetenia	sp.	C	4	1	3	
	Chironominae	*Rheotanytarsus*	sp. A	F	6	8		
	Simuliidae	*Simulium*	*aureum*	F	5			1
		S.	*piperi*	F	5	10	16	6
		S.	*tuberosum*	F	5			2
		S.	*virgatum*	F	(5)?	5	10	91
			C=collector/gatherer	TOTAL	NUMBER	278	339	329
			F=filterer	TOTAL	SPECIES	34	29	20
			M=miner	TOTAL	SPECIES	(REACH)	42	
			P=predator	TOTAL	"TAXA"	26	23	15
	"TAXA"		PA=parasite	TOTAL	"TAXA"	(REACH)	29	
H=3.03	3.03	2.54	SC=scraper		H	3.34	3.23	2.73
H'=3.23	3.19	2.65	SH=shredder		H'	3.59	3.42	2.86

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS	POE	PROJECT	2001		
			BARDEE'S BAR	REACH				100401
	TAXON	(NON-INSECTS)						
PHYLUM/CLASS/	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
ORDER				CATEGORY	VALUE			
Platyhelminthes	Planariidae	*Dugesia*	*tigrina*	C	4	48	14	24
Nemertea	Tetrastemmatidae	*Prostoma*	*graecense*	P	4	20	5	1
Nematoda	Mermithidae	unidentified	species	PA	4		3	
Annelida								
Tubificida	Lumbricidae	*Eisenella*	*tetraedra*	C	5	5	2	3
Lumbriculida	Lumbriculidae	*Rhynchelmis*	*rostrata*	C	6	2	3	1
Arthropoda								
Decapoda	Astacidae	*Pacifastacus*	*leniusculus*	C	6		1	
Arachnida	Sperchontidae	*Sperchon*	sp. A	P	5		1	
Mollusca								
Bivalvia	Corbiculidae	*Corbicula*	*fluminea*	F	8	4	1	4
	TAXON	(INSECTS)						
ORDER	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
				CATEGORY	VALUE			
Ephemeroptera	Baetidae	*Acentrella*	*turbida*	C	6	4	16	4
		Baetis	*tricaudatus*	C	6	116	141	95
	Heptageniidae	*Rhithrogena*	*morrisoni*	SC	4			1
	Isonychiidae	*Isonychia*	*velma*	F	3	3	3	1
Plecoptera	Perlidae	*Calineuria*	*californica*	P	1		1	1
		Hesperoperla	*pacifica*	P	2			1
	Perlodidae	*Isoperla*	sp.	P	1	1	1	1
Trichoptera	Hydropsychidae	*Cheumatopsyche*	*campyla*	F	5	8	16	7
		Ceratopsyche	*cockerelli*	F	4		1	
		Hydropsyche	*californica*	F	6	24	23	29
		H.	*occidentalis*	F	6	16	26	11
	Hydroptilidae	*Hydroptila*	sp. A	H	6	3		
		Leucotrichia	*pictipes*	SC	6	1	3	

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS	POE	PROJECT	2001		
			BARDEE'S BAR	REACH				100401
	TAXON	(INSECTS)						
ORDER	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
				CATEGORY	VALUE			
Trichoptera	Hydroptilidae	*Ochrotrichia*	sp.	C	4			1
	Philopotamidae	*Chimarra*	*utahensis*	F	4	27	20	12
	Rhyacophilidae	*Rhyacophila*	*malkini (pupa)*	NF	1	1	1	1
Coleoptera	Elmidae	*Optioservus*	*quadrimaculatus*	C	4	3	1	
		Ordobrevia	*nubifera*	C	4	3	1	
		Zaitzevia	*parvula*	C	6	3	2	1
	Ptilodactylidae	*Stenocolus*	*scutellaris*	SH	2		1	
Diptera	Chironomidae							
	Diamesinae	*Potthastia*	sp.	C	4		1	
	Orthocladiinae	*Cardiocladius*	sp.	P	4	5	1	2
		Cricotopus	*flavocinctus*	C	6		1	
		C.	*tremulus*	SH	6	1		
		Cricotopus	sp. A (pupa)	NF	4			2
		Eukiefferiella	sp. B	C	4	2		1
	Chironominae							
	Tanytarsini	*Rheotanytarsus*	sp. A	F	6		3	3
	Simuliidae	*Simulium*	*piperi*	F	5	7	4	6
		S.	*virgatum*	F	(6) 7	29	45	110
	Tipulidae	*Antocha*	sp.	C	5	1	3	2
			C=collector/gatherer	TOTAL	NUMBER	337	345 ~~343~~	325
			F=filterer	TOTAL	SPECIES	25	31	26
			NF=nonfeeding	TOTAL	SPECIES	(REACH)	38	/28
			P=predator	TOTAL	"TAXA"	21	(27)	22
			PA=parasite	TOTAL	"TAXA"	(REACH)	(31)	32
	"TAXA"		SC=scraper		H	3.17	3.03	2.74
H=2.97	2.82	2.53	SH=shredder		H'	3.34	3.21	2.9
H'=3.12	2.99	2.67						

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS	POE	PROJECT	2001		
			PULGA	REACH				100501
	TAXON	(NON-INSECTS)						
PHYLUM/CLASS/	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
ORDER				CATEGORY	VALUE			
Platyhelminthes	Planariidae	*Dugesia*	*tigrina*	C	4		21	20
		Phagocata	sp.	C	4	1	1	
Nemertea	Tetrastemmatidae	*Prostoma*	*graecense*	P	4	4	14	20
Annelida								
Tubificida	Naididae	*Nais*	*bicuspidalis*	C	4	32	6	5
		N.	*communis/variabilis*	C	6	4	1	
		N.	*pardalis*	C	5	12	13	
		N.	*simplex*	C	6	2		
	Tubificidae	*Spirosperma*	*nikolskyi*	C	6		2	3
		unidentified	species B	C	5			1
	Lumbricidae	*Eisenella*	*tetraedra*	C	5	1	1	3
Lumbriculida	Lumbriculidae	*Eclipidrilus*	*frigidus*	C	4	1	1	1
		Rhynchelmis	*rostrata*	C	6	2	3	2
		unidentified	species	C	4		2	
Arthropoda								
Arachnida	Hygrobatidae	*Hygrobates*	sp.	P	5	2	2	6
	Lebertiidae	*Lebertia*	sp.	P	5	1		
	Sperchontidae	*Sperchon*	sp. A	P	5	3		
Mollusca								
Gastropoda	Lymnaeidae	*Fossaria*	sp.	SC	5		1	
Bivalvia	Corbiculidae	*Corbicula*	*fluminea*	F	8	5	2	2
	TAXON	(INSECTS)						
ORDER	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
				CATEGORY	VALUE			
Ephemeroptera	Baetidae	*Acentrella*	*turbida*	C	6	5	3	6
		Baetis	*tricaudatus*	C	6	43	43	33
	Isonychiidae	*Isonychia*	*velma*	F	3	1	1	4

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS	POE	PROJECT	2001		
			PULGA	REACH				100501
	TAXON	(INSECTS)						
ORDER	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
				CATEGORY	VALUE			
Ephemeroptera	Tricorythidae	*Tricorythodes*	*minutus*	C	6	1		
Odonata	Coenagrionidae	*Argia*	*emma*	P	7	4	3	2
Plecoptera	Perlidae	*Hesperoperla*	*pacifica*	P	2		1	1
	Perlodidae	*Isoperla*	sp.	P	1		1	4
Trichoptera	Hydropsychidae	*Cheumatopsyche*	*campyla*	F	5	28	19	21
		Ceratopsyche	*cockerelli*	F	4	1		
		Hydropsyche	*californica*	F	6	32	62	55
		H.	*occidentalis*	F	6	23	6	24
	Hydroptilidae	*Hydroptila*	sp. A	H	6		1	
		Hydroptila	sp. B	H	6	7		1
		Leucotrichia	*pictipes*	SC	6	4	2	4
	Philopotamidae	*Chimarra*	*utahensis*	F	4	2	13	26
	Psychomyiidae	*Psychomyia*	sp.	C	2	1		
	Rhyacophilidae	*Rhyacophila*	*malkini (pupa)*	NF	1		1	1
Coleoptera	Elmidae	*Optioservus*	*quadrimaculatus*	C	4		2	2
		Zaitzevia	*parvula*	C	6	2	2	14
	Ptilodactylidae	*Stenocolus*	*scutellaris*	SH	2	1		
Diptera	Chironomidae							
	Diamesinae	*Potthastia*	sp.	C	4	6	3	1
	Orthocladiinae	*Cardiocladius*	sp.	P	4	13	5	10
		Cricotopus	*flavocinctus*	C	6	6		
		C.	*tremulus*	SH	6	5	6	3
		C.	*trifascia*	SH	6	2	4	1
		Cricotopus	sp. A	C	4	17	2	5
		Eukiefferiella	sp. A	C	4	1		
		Eukiefferiella	sp. B	C	4		2	1
		Eukiefferiella	sp. E	C	4	1	1	
		Orthocladius	*obumbratus*	C	4	2		

PG&E	NORTH FORK	FEATHER RIVER	BENTHOS	POE	PROJECT	2001		
			PULGA	REACH				100501
	TAXON	(INSECTS)						
ORDER	FAMILY	GENUS	SPECIES	TROPHIC	TOLERANCE	SAMPLE 1	SAMPLE 2	SAMPLE 3
				CATEGORY	VALUE			
Diptera	Chironomidae							
	Orthocladiinae	*Tvetenia*	sp.	C	4	1		
	Chironominae							
	Tanytarsini	*Rheotanytarsus*	sp. A	F	6	1		
	Simuliidae	*Simulium*	*piperi*	F	5		10	1
		S.	*virgatum*	F	5 7		31	51
	Tipulidae	*Antocha*	sp.	C	5	4	1	
	Empididae	*Hemerodromia*	sp. A	P	6	1		1
			C=collector/gatherer	TOTAL	NUMBER	285	295	335
			F=filterer	TOTAL	SPECIES	41	39	34
			H=herbivore	TOTAL	SPECIES	(REACH)	54	
			NF=nonfeeding	TOTAL	"TAXA"	28 27	27	26
			P=predator	TOTAL	"TAXA"	(REACH)	35 34	
	"TAXA"		PA=parasite		H	4	3.81	3.81
H=3.22	3.39	3.49	SC=scraper		H'	4.31	4.09	4.04
H'=3.42	3.59	3.68	SH=shredder					

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: NFFR
DATE/TIME: 100501/0930
COMPANY/AGENCY: PG&E
SAMPLE ID NO.(S): PULGA 1, 2, 3
SITE DESCRIPTION: From 0.2 mi above HWY 70 Bridge to 0.7 mile above bridge at Pulga

CREW MEMBERS

W. Fields
D. Parkinson

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: 1430
Ecoregion:
COMMENTS:

CHEMICAL CHARACTERISTICS

Water Temperature: 63°F 17°C
Specific Conductance: 121 uS
pH: —
Dissolved Oxygen: 8 mg/L

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 6.5 mi
Physical/habitat Quality Score: 141

Physical/Habitat Characteristics

	(1) riffle 1	(4) riffle 2	(5) riffle 3
Riffle Length:	56'	791	34'
Transect Location:	SPOTS	71'	65'
Ave. Riffle Width:	60'	80'	130'
Ave Riffle Depth:	1'2"	1'2"	12"
Riffle Velocity:	2.5 f/s	2.5 f/s	2.5 f/s
% Canopy Cover:	Ø	Ø	5%
Substrate Complexity:	LOW	MOD.	MOD.
Embeddedness:	5%	5%	5%
% Substrate:			
fines (<0.1")	Ø	Ø	Ø
gravel (0.1-2")	Ø	Ø	Ø
cobble (2-10")	20	30	10
boulder (>10")	80	70	90
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	TIGHT	TIGHT	TIGHT
% Gradient:	1.5%	2.0%	2.5%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: NFFR
DATE/TIME: 100501/0930
COMPANY/AGENCY: PG&E
SAMPLE ID NO.(S): PULGA 1, 2, 3
SITE DESCRIPTION: From 0.2 mi above HWY. 70 Bridge, To 0.7 mi above Bridge

(Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat: lack of habitat is obvious; substrate unstable or lacking.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

90

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 (6)	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	(2) 1 0
SCORE 3 (RB)	Right Bank 10 9	8 7 6	5 4 (3)	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	(2) 1 0
SCORE 3 (RB)	Right Bank 10 9	8 7 6	5 4 (3)	2 1 0

90
Total Score 51
141

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: NFFR
DATE/TIME: 100401/1315
COMPANY/AGENCY: PG&E
SAMPLE ID NO.(S): BARDEES BAR 1, 2, 3
SITE DESCRIPTION: .25 mile below to .25 mile above abandoned bridge

CREW MEMBERS

W. Field
D. Parkinson

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: 1140'
Ecoregion:
COMMENTS: with flow at ~120 cfs, almost impossible to cross.

CHEMICAL CHARACTERISTICS

Water Temperature: 64°F 18°C
Specific Conductance: 125 μS
pH:
Dissolved Oxygen: 11 mg/l

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.5 mi
Physical/habitat Quality Score: 132

Physical/Habitat Characteristics

	riffle 1 (1)	riffle 2 (2)	riffle 3 (3)
Riffle Length:	16'	20'	24'
Transect Location:	SPOTS	SPOTS	SPOTS
Ave. Riffle Width:	3'	4'	7'
Ave Riffle Depth:	8"	10"	6"
Riffle Velocity:	1 ft/s	2 ft/s	2 ft/s
% Canopy Cover:	Ø	Ø	Ø
Substrate Complexity:	MOD	LOW	MOD
Embeddedness:	10%	5%	5%
% Substrate:			
fines (<0.1")	Ø	Ø	Ø
gravel (0.1-2")	10	30	10
cobble (2-10")	70	60	60
boulder (>10")	20	10	30
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	LOW	LOW	LOW
% Gradient:	1.5%	1.5%	2%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: NFFR
DATE/TIME: [illegible]/1315
COMPANY/AGENCY: PG&E
SAMPLE ID NO.(S): BARDEES BAR 1, 2, 3
SITE DESCRIPTION: .25 Mile Below to .25 Mile above abandoned bridge

(Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 18	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 12	20 19 18 17 16	15 14 13 (12) 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

84

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 1	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 1 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 3 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 1 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 2 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

84
Total Score 48
132

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: NFFR
DATE/TIME: 1004 03/0915
COMPANY/AGENCY: PG&E
SAMPLE ID NO.(S): POEPH 1, 2, 3
SITE DESCRIPTION: 0.3 mi above Poe PH Bridge to 0.8 Mile above Bridge

CREW MEMBERS

W. Fields
D. Parkinson

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: 960'
Ecoregion:
COMMENTS: Flow about 120 cfs, has been up to 200 cfs recently.

CHEMICAL CHARACTERISTICS

Water Temperature: 60°F 15.5°C
Specific Conductance: 125 µS
pH:
Dissolved Oxygen: 10 mg/L

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.5 mi.
Physical/habitat Quality Score: 139

Physical/Habitat Characteristics

	(2) riffle 1	(3) riffle 2	(4) riffle 3
Riffle Length:	80	52'	44'
Transect Location:	SPOTS	SPOTS	38'
Ave. Riffle Width:	12'	8'	40'
Ave Riffle Depth:	8"	10"	8"
Riffle Velocity:	1 ft/s	2 ft/s	Variable 0.5-3.5 ft/s
% Canopy Cover:	Ø	Ø	Ø
Substrate Complexity:	Low	Low	Low
Embeddedness:	10%	10%	10%
% Substrate:			
fines (<0.1")	Ø	Ø	Ø
gravel (0.1-2")	10	40	20
cobble (2-10")	80	60	80
boulder (>10")	10	Ø	Ø
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	Low	Low	Low
% Gradient:	1%	1.5%	2%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: NFFR
DATE/TIME: 1004/0915
COMPANY/AGENCY: PG&E
SAMPLE ID NO.(S): POEPH, 1, 2, 3
SITE DESCRIPTION: 0.3 mi above Poe PH Bridge to 0.8 mile above Bridge

(Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 10	20 19 18 17 16	15 14 13 12 11	(10) 9 8 7 6	5 4 3 2 1 0

80

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 2	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 5 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 5 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 5 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 80
59
139

POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX E3-7

An Assessment of the Macroinvertebrate Fauna In Reaches of the North Fork Feather River, Affected by the Poe Hydroelectric Project, (2002 Annual Benthic Sampling)

November 2003

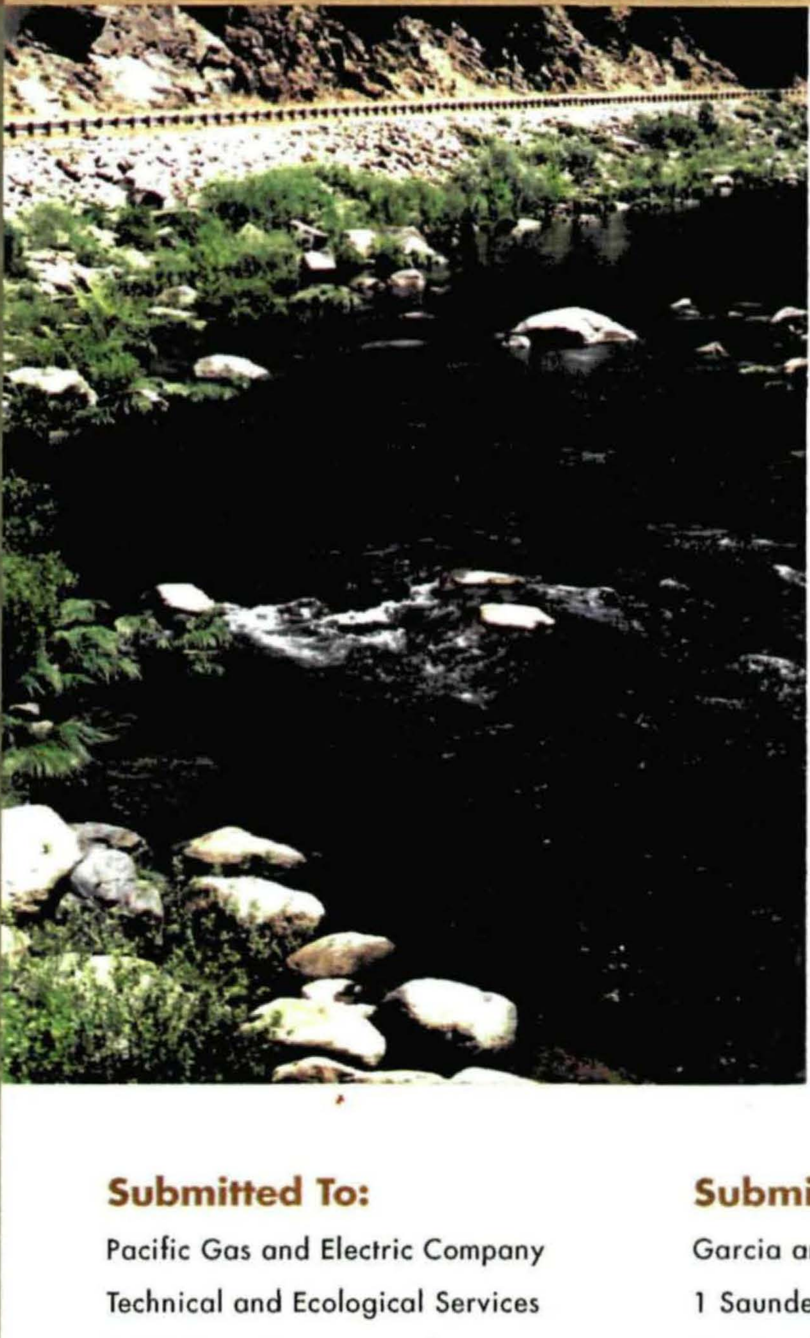
FINAL REPORT

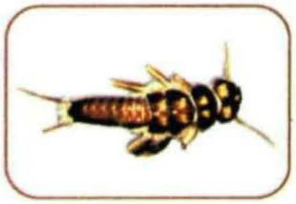
An Assessment of the Macroinvertebrate Fauna in Reaches of the North Fork Feather River Affected by the Poe Hydroelectric Project

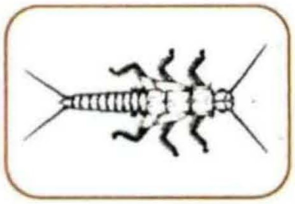
(FERC No. 2107)

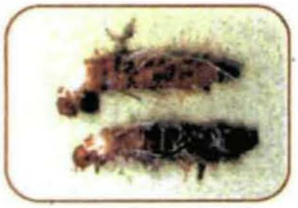
2002 Annual Benthic Sampling

GARCIA and ASSOCIATES
NATURAL & CULTURAL RESOURCE CONSULTANTS









Submitted To:

Pacific Gas and Electric Company
Technical and Ecological Services
3400 Crow Canyon Road
San Ramon, CA 94583

Submitted By:

Garcia and Associates (GANDA)
1 Saunders Avenue
San Anselmo, CA 94960

November 2003

GANDA

FINAL REPORT

An Assessment of the Macroinvertebrate Fauna in Reaches of the North Fork Feather River Affected by the Poe Hydroelectric Project (FERC No. 2107)

2002 Annual Benthic Sampling

Prepared for:

PACIFIC GAS AND ELECTRIC COMPANY
TECHNICAL AND ECOLOGICAL SERVICES
3400 CROW CANYON ROAD
SAN RAMON, CALIFORNIA 94583

Prepared by:

GARCIA AND ASSOCIATES
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November 2003

JOB 332/54

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APPENDICES

1.0 Introduction

As part of ongoing relicensing efforts for Pacific Gas and Electric Company's (PG&E) Poe Hydroelectric Project facilities (FERC No. 2107), annual benthic macroinvertebrate sampling has been conducted since 1999 in sections of the North Fork Feather River (NFFR, Butte County, CA) regulated by Poe Reservoir. During the fourth year of annual sampling in 2002, benthic samples were collected at three sites along the Poe Reach following a modified version of the California Stream Bioassessment Procedure (CSBP). Characterizations of the quality of benthic communities as indicators of overall water and habitat quality in reaches affected by hydroelectric operations are part of larger stream ecology investigations required for FERC relicensing. Results from the fourth year of benthic macroinvertebrate sampling conducted in September and October 2002 are reported herein, including comparisons with previous study years as well as with other NFFR reaches.

2.0 Methods

2.1 Site Selection

Sites for 2002 benthic sampling in the Poe Reach corresponded with those chosen in previous years (1999-2001). Sites were chosen based on the availability of riffles and adequate access (both of which are uncommon on the North Fork Feather River). The three sites are as follows (see **Figure 1**):

- ***Poe Powerhouse*** – from 0.1 to 0.6 mile upstream of the Powerhouse Bridge
- ***Bardee's Bar*** – approximately 0.5 mile of riffle edgewater along the large bend below Old Bardee's Bar Bridge
- ***Pulga*** – from 0.1 miles upstream of Pulga Bridge to just upstream of the Flea Valley Creek confluence (approximately 0.5 mile)

2.2 Benthic Macroinvertebrate Sampling

Benthic macroinvertebrate sampling occurred between September 23 and 25, 2002. Per the CSBP protocols, five riffle areas were identified at each site, of which three were selected at random for sampling. Three composite samples were collected within each riffle area using a Wildco 11-by-20 inch stream bottom sampler with a 0.5 mm mesh and detachable bucket. Each composite sample was collected over six square feet of substrate including the widest variety of depths, velocities, and substrate sizes possible. Samples were elutriated and cleaned in the field, placed in jars, labeled, and preserved in 10 percent formalin (with rose bengal dye). Three replicate samples were collected at each site (i.e., three riffles per site) for a total of nine samples in the Poe Reach.

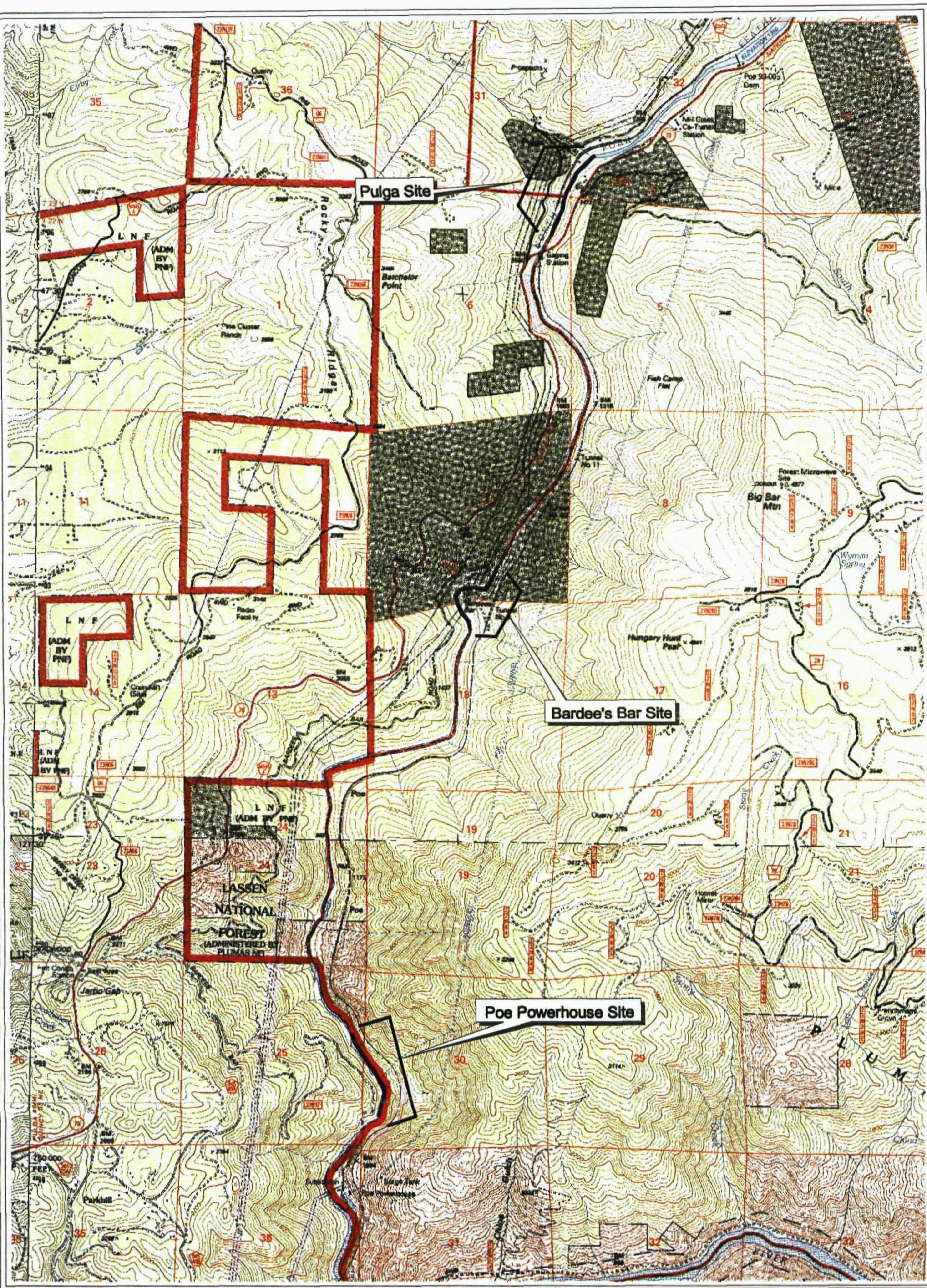


Figure 1.
Project Area
Poe Reach Macroinvertebrates
Butte and Plumas counties, California
November 2003

0.5 0 0.5 1 1.5 Miles

Basemap: USGS 7.5' Quadrangles
Berry Creek, Cherokee,
Paradise East, Pulga

N

Project Location

GANDA

2.3 Physical Habitat/Water Quality Sampling

Physical habitat and water quality at each site were described using the CSBP California Bioassessment Worksheet. Physical/chemical parameters included riffle length, width, depth, velocity, canopy cover, substrate complexity, embeddedness, substrate composition, substrate consolidation, gradient, water temperature, and dissolved oxygen.

Physical habitat for each sampling reach also was assessed using the CSBP Physical Habitat Quality Form. Habitat parameters included epifaunal substrate/available cover, embeddedness, velocity/depth regimes present, sediment deposition, channel flow status, channel alteration, bank stability, vegetative protection, and riparian vegetative zone width. Copies of the CSBP field worksheets and data forms are provided in **Appendix A**.

2.4 Data Analysis

All samples were processed and identified by Wayne Fields, Principal of Hydrozoology. Standard CSBP laboratory methods for subsampling were used (e.g., grid trays). However, all organisms were identified to the species level (beyond the CDFG Standard Effort). Morphotype designations were used when exact species epithets could not be determined so that true species richness and diversity could be calculated. A reference collection consisting of each species encountered thus far on the Feather River has been established and will be curated indefinitely by Hydrozoology.

A 20 percent QA/QC check was completed by CDFG's Aquatic Bioassessment Laboratory.

Taxonomic data were entered into a MS Access database and summary metrics for each replicate sample were calculated. These metrics included standard CSBP metrics (richness, composition, tolerance/intolerance, and functional feeding group measures), plus several others as defined in **Table 1**. Tolerance values and functional feeding group classifications for benthic macroinvertebrates were assigned using current CDFG designations.

Species diversity was calculated using the Shannon Index (the CSBP standard) as well as the Brillouin Index (Brillouin 1962). The Brillouin Index has been used to calculate diversity for this project since 1999.

All metrics were calculated for each of the three replicate samples collected at each site as well as averaged to obtain a mean metric value for each site. Statistical tests (ANOVA, MANOVA, etc.) were performed using the Minitab software package.

Table 1. Biological metrics used to describe macroinvertebrate samples collected from the Feather River following the California Stream Bioassessment Procedure (CSBP).

Biological Metrics	*Description of Metrics*	*Response to Impairment*
Richness Measures		
Species Richness	Total number of species	Decrease
EPT Species	Number of species in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)	Decrease
Ephemeroptera Species	Number of mayfly species	Decrease
Plecoptera Species	Number of stonefly species	Decrease
Trichoptera Species	Number of caddisfly species	Decrease
Diptera Species	Number of species in the order Diptera (true flies)	Variable
Chironomid Species	Number of species in the dipteran family Chironomidae	Increase
Shannon Diversity	General measure of sample diversity that incorporates richness and evenness (ln-based)	Decrease
Shannon Evenness*	Measure of how evenly species abundances are distributed	Decrease
Brillouin Diversity*	General measure of sample diversity that incorporates richness and evenness ($\log_2$-based)	Decrease
Est. Total # Indiv.*	Estimated total number of individuals collected per sample	Variable
Composition Measures		
EPT Index	Percent composition of EPT species	Decrease
Sensitive EPT Index	Percent composition of EPT species with tolerance values 0-3	Decrease
% Baetidae	Percent of organisms in the mayfly family Baetidae	Increase
% Hydropsychidae	Percent of organisms in the caddisfly family Hydropsychidae	Increase
% Dominant taxon	Percent of sample comprised of the most common taxon	Increase
% Sub-dominant taxon	Percent of sample comprised of the second most common taxon	Increase
Tolerance / Intolerance Measures		
% Tolerant Organisms	Percent of organisms that are highly tolerant of impairment as indicated by tolerance values of 8, 9, or 10	Increase
% Intolerant Organisms	Percent of organisms that are highly intolerant of impairment as indicated by tolerance values of 0, 1, or 2	Decrease
Weighted tolerance value	Value between 0 and 10, weighted by abundances of individuals designated as tolerant (higher values) or intolerant (lower values) of impairment/pollution	Increase
Functional Feeding Groups		
% Filterers	Percent of macrobenthos that filters fine particulate matter	Increase
% Scrapers	Percent of macrobenthos that grazes upon periphyton	Variable
% Collectors	Percent of macrobenthos that collects or gathers fine particulate matter	Increase
% Shredders	Percent of macrobenthos that shreds coarse particulate matter	Decrease
% Predators	Percent of macrobenthos that feeds on other organisms	Variable

*Additional metrics calculated but not included in the CSBP.

3.0 RESULTS

3.1 Benthic Macroinvertebrate Summary

Over 37,000_benthic macroinvertebrates were collected from the three sample sites in 2002. Of these, 2,810 individuals were identified representing 42 families and 19 taxonomic orders. Common taxa included the ubiquitous mayfly *Baetis tricaudatus*, blackfly larvae (*Prosimulium* sp.), net-spinning caddisfly larvae (*Hydropsyche californica, Chimarra utahensis, Cheumatopsyche campyla,* and *Hydropsyche occidentalis*), and the flatworm *Dugesia tigrina*. A complete taxa list for all nine replicate samples is presented in **Appendix B**.

The results of the 20 percent QA/QC check completed by CDFG's Aquatic Bioassessment Laboratory were consistent with Hydrozoology's taxonomy (**Appendix C**).

The average number of species for all samples was 37, including an average of 13 EPT* species. Shannon Diversity averaged 2.57 and Brillouin Diversity averaged 3.46. The EPT index averaged 63 percent (2% of which were sensitive EPT) and the dominant taxon comprised 30 percent of the average sample. Tolerant and intolerant organisms comprised six and three percent of the average sample, respectively. The mean weighted tolerance value was 4.9 (indicating moderate water quality). On average, filterers were the dominant functional feeding group (51%), followed by collectors (30%), predators (13%), scrapers (4%), and shredders (1%).

A summary of biological metrics for each site in 2002 is presented in **Table 2**. The dominant and subdominant species for each replicate sample is listed in **Appendix D**. A summary of biological metrics for each site based on the CDFG standard level of taxonomic effort (i.e., lesser effort than reported on here) is included in **Appendix E** for additional reference.

3.2 Physical Habitat/Water Quality Summary

Substrate was predominantly cobble and boulder at each site. Substrate complexity and consolidation were variable (low-medium and loose-tight, respectively) but were generally moderate. Average substrate composition was 44 percent cobble, 29 percent boulder, 22 percent gravel, 3 percent fines, and zero percent bedrock. Stream gradient averaged 1.4 percent (range 0.5% - 3.0%). Average riffle width was 6.2 m (range 1.8 m - 24.4 m). Depth averaged 0.25 m (range 0.15 m - 0.36 m) and velocity averaged 0.44 m/s (range 0.30 m/s - > 1.0 m/s). The mean Physical Habitat Score was 147 out of a possible 200, and ranged from 132 to 156. Recorded stream temperatures ranged from 16.5 to 19.5 °C. Dissolved oxygen ranged from 8.0 to 9.0 mg/L.

A summary of physical habitat and water quality parameters is presented in **Table 3**. Summary data are based on the mean values for the three replicates collected at each site.

* EPT species includes those species in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies).

Table 2. Summary of Biological Metrics from Annual CSBP Sampling: Poe Reach 2002

	Poe PH 1	Poe PH 2	Poe PH 3	Bardee's Bar 1	Bardee's Bar 2	Bardee's Bar 3	Pulga 1	Pulga 2	Pulga 3	**Poe PH**	**Bardee's Bar**	**Pulga**	**AVERAGE**
Richness Measures													
Taxa Richness	45	42	33	34	33	34	40	34	35	**40**	**34**	**36**	**37**
EPT Taxa	17	14	12	16	11	14	14	11	12	**14**	**14**	**12**	**13**
Ephemeroptera Taxa	7	5	5	5	4	5	3	3	4	**6**	**5**	**3**	**5**
Plecoptera Taxa	2	1	1	1	2	1	1	2	2	**1**	**1**	**2**	**1**
Trichoptera Taxa	8	8	6	10	5	8	10	6	6	**7**	**8**	**7**	**7**
Diptera Taxa	9	14	11	10	11	9	12	15	11	**11**	**10**	**13**	**11**
Chironomid Taxa	5	9	5	5	7	4	7	10	6	**6**	**5**	**8**	**6**
Shannon Diversity	2.70	2.78	2.60	2.48	2.41	2.32	2.74	2.65	2.45	**2.70**	**2.40**	**2.61**	**2.57**
Brillouin Diversity	3.61	3.73	3.53	3.37	3.25	3.14	3.69	3.56	3.30	**3.62**	**3.25**	**3.52**	**3.46**
Shannon Evenness	0.71	0.74	0.74	0.70	0.69	0.66	0.74	0.75	0.69	**0.73**	**0.68**	**0.73**	**0.71**
Est. Total # Indiv.	3780	3780	7704	2696	7296	2696	2432	3264	3672	**5088**	**4229**	**3123**	**4147**
Composition Measures													
EPT Index (%)	69.2	63.1	45.2	81.3	74.3	71.5	41.1	43.8	74.2	**59.1**	**75.7**	**53.0**	**62.6**
Sensitive EPT Index (%)	2.9	2.5	2.2	2.1	2.3	1.8	2.6	1.8	2.6	**2.5**	**2.1**	**2.4**	**2.3**
% Baetidae	35.9	27.7	20.9	31.8	34.2	40.7	9.2	12.9	10.8	**28.2**	**35.5**	**11.0**	**24.9**
% Hydropsychidae	19.4	21.7	7.5	37.4	27.6	22.3	12.5	23.2	55.2	**16.2**	**29.1**	**30.3**	**25.2**
% Dominant taxon	34.0	26.8	20.2	27.6	32.6	38.9	25.3	28.3	33.0	**27.0**	**33.0**	**28.9**	**29.6**
% Sub-dominant taxon	13.0	14.3	19.6	19.9	16.1	13.9	14.8	12.5	18.6	**15.7**	**16.6**	**15.3**	**15.9**
% Insects	85.4	90.1	89.4	90.2	86.5	87.8	56.6	95.6	90.5	**88.3**	**88.2**	**80.9**	**85.8**
Tolerance / Intolerance Measures													
% Tolerant Organisms	8.3	7.0	6.5	3.6	3.0	2.7	13.5	4.4	2.0	**7.3**	**3.1**	**6.6**	**5.7**
% Intolerant Organisms	4.1	3.2	3.1	3.0	2.6	2.1	2.6	2.6	2.6	**3.5**	**2.6**	**2.6**	**2.9**
Weighted Tolerance value	5.2	5.1	4.8	4.9	4.9	5.0	4.9	4.5	4.6	**5.0**	**4.9**	**4.7**	**4.9**
Functional Feeding Groups													
% Filterers	37.5	50.0	62.3	49.3	45.7	40.9	36.5	67.6	65.0	**49.9**	**45.3**	**56.4**	**50.5**
% Scrapers	6.7	4.1	6.9	2.7	2.0	1.2	3.3	4.4	5.6	**5.9**	**1.9**	**4.4**	**4.1**
% Collectors	43.8	33.4	22.4	37.1	39.8	43.6	17.4	18.8	16.3	**33.2**	**40.2**	**17.5**	**30.3**
% Shredders	0.6	0.6	0.3	0.3	0.3	1.5	0.0	0.0	1.0	**0.5**	**0.7**	**0.3**	**0.5**
% Predators	9.2	8.6	7.5	8.9	10.9	12.2	40.1	7.4	11.8	**8.4**	**10.6**	**19.7**	**12.9**

Table 3. Summary of CSBP California Bioassessment Worksheet Physical Habitat / Water Quality Measures: Poe Reach 2002

	POE PH	BARDEE'S BAR	PULGA	AVG
PHYSICAL HABITAT				
elevation (m)	293	347	451	-
riffle length (m)	10.1	7.5	12.2	9.9
width (m)	7.7	2.6	8.4	6.2
depth (m)	0.26	0.25	0.24	0.25
velocity (m/s)	0.66	0.20	0.46	0.44
%canopy	0.0	0.0	1.7	0.6
substrate complexity	medium	medium	low	low-medium
embeddedness (%)	6.7	5.0	10.0	7.2
substrate consolidation	loose	loose	loose	loose
fines (%)	3.3	3.3	3.3	3.3
gravel (%)	23.3	8.3	33.3	21.6
cobble (%)	48.3	45.0	40.0	44.4
boulder (%)	25.0	43.3	20.0	29.4
bedrock (%)	0.0	0.0	0.0	0.0
percent gradient	1.7	1.8	0.8	1.4
physical hab qual score	154	132	156	147.3
WATER QUALITY				
date	9/25/02	9/25/02	9/23/02	-
time	915	1200	1445	-
water temp (C)	16.5	16.5	19.5	17.5
DO (mg/l)	8.0	8.0	9.0	8.3

4.0 Discussion

The use of rapid bioassessment to evaluate macroinvertebrate communities can provide a snapshot of biological, physical, and chemical conditions in a stream reach. However, it is important to understand the spatial and temporal limitations of the methods and, ultimately, the conclusions drawn from their results. This is especially true for the Feather River system where sampleable riffle habitat is rare overall and the riffle areas (or patches thereof) that are sampled may be highly variable in terms of habitat quality or substrate composition. Samples from these reaches may encompass numerous uncontrolled sources of variation including those attributable to influences of hydroelectric operations.

4.1 Rating Benthic Community Condition

Species richness and diversity are considered the most important measures of ecological diversity because they describe the number of ecological niches available at a particular site as well as how they are occupied (i.e., the distribution of species abundances or evenness). Based on samples collected from various reaches of the Feather River between 1999 and 2001 (over 170 samples), Fields (2001) suggests a scheme for classifying benthic invertebrate community conditions in the Feather River system based on species richness and Brillouin diversity:

Table 4. Suggested Benthic Invertebrate Community Conditions Classification Scheme for the Feather River (after Fields 2001)

Mean Species Richness	Mean Brillouin Diversity	Benthic Community Condition
< 25	< 1.25	extremely poor
25 - 30	1.25 - 2.50	poor
31 - 35	2.51 - 3.00	fair
36 - 40	3.01 - 3.50	moderate
41 - 45	3.51 - 4.00	good
46 - 50	4.01 - 4.25	very good
> 50	> 4.25	excellent

This scheme provides a range of values by which current samples can be judged. Thus, mean richness (37) and diversity (3.46) for 2002 Poe samples rate "moderate" overall.

4.2 Longitudinal Trends Within Regulated Reaches

Studies of regulated reaches of the NFFR upstream of the Poe Reach (GANDA 2003, Fields 2001) as well as other hydroelectric projects in California (see GANDA 2002) have demonstrated that spatial variability tends to follow a distinct longitudinal pattern along regulated reaches from dam to reservoir. Specifically, there is an overall increase in the robustness of the benthic macroinvertebrate community as the heterogeneity of the stream environment increases with distance downstream of a dam. Increases in heterogeneity are attributed to inputs from tributaries and groundwater along these reaches that provide cool water, sediment, and allochthonous material.

Such increases in the Poe Reach were apparent in 2002, as richness and diversity generally improved from "fair" to "moderate," and from "moderate" to "good," respectively (sensu Fields 2001). However, these trends were somewhat obscured by anomalies at the Bardee's Bar site in the middle of the reach. As expected, species richness and diversity averaged highest at the Poe Powerhouse site at the bottom of the Poe Reach (see **Figures 2 and 3**). The Bardee's Bar site followed this trend only for Taxa Richness, EPT Taxa, and the estimated number of individuals. The Bardee's Bar site is comprised of patchy edgewater areas along the right bank of the large, un-sampleable main channel. Richness and diversity have been consistently lowest at this site in previous sampling years (2000-2001) as well. It is therefore not surprising that benthic communities sampled at this site in 2002 were characterized by both lower richness measures and higher variability as compared to other sites in the Poe Reach. It is likely that this variability has masked other expected trends in richness, composition, tolerance/intolerance, and functional feeding group measures within the Poe Reach for 2002 as well as for prior years.

One expected trend that was apparent within the Poe Reach was a steady increase in the mean estimated density of macroinvertebrates per sample (**Figure 4**). Similar downstream increases in macroinvertebrate density have been documented in other regulated systems (see GANDA 2002).

Upstream to downstream differences within the Poe Reach were examined using analyses of variance for species richness, Brillouin diversity, and estimated density of replicate samples from the Pulga and Poe Powerhouse sites. Although differences between sites were greatest for Brillouin diversity, species richness, and estimated density means, respectively, differences were not significant in either univariate (ANOVA, $p < 0.05$) or multivariate tests (MANOVA, $p < 0.05$) using these response variables (see **Appendix F**).

Coefficients of Variation (CVs) for within-site and among-site comparisons are presented in **Appendix G.**

4.3 Longitudinal Trends Among Regulated Reaches

While longitudinal trends have been documented *within* various reaches of the NFFR, trends are also evident *among* consecutive regulated reaches. The NFFR flows through the Rock Creek-Cresta Hydroelectric Project (FERC No. 1962) immediately upstream of the Poe Hydroelectric Project. Bioassessment data collected from the Rock Creek and Cresta reaches during 2002 (see GANDA 2003) reveal similar increases in benthic community robustness downstream. It is interesting to note that consistent increases are evident among these three consecutive reaches (i.e., Rock Creek, Cresta, and Poe). Mean species richness, for example, increased consistently from Rock Creek to Cresta to Poe, along with EPT richness (**Figure 5**). Likewise, mean diversity in each reach increased successively (**Figure 6**). The mean percent dominant taxon also improved (i.e., decreased) downstream among these three reaches in 2002 (**Figure 7**), as did the overall mean Weighted Tolerance Value (**Figure 8**). The mean number of intolerant organisms

Figure 2. Richness Trends in the Poe Reach: 2002

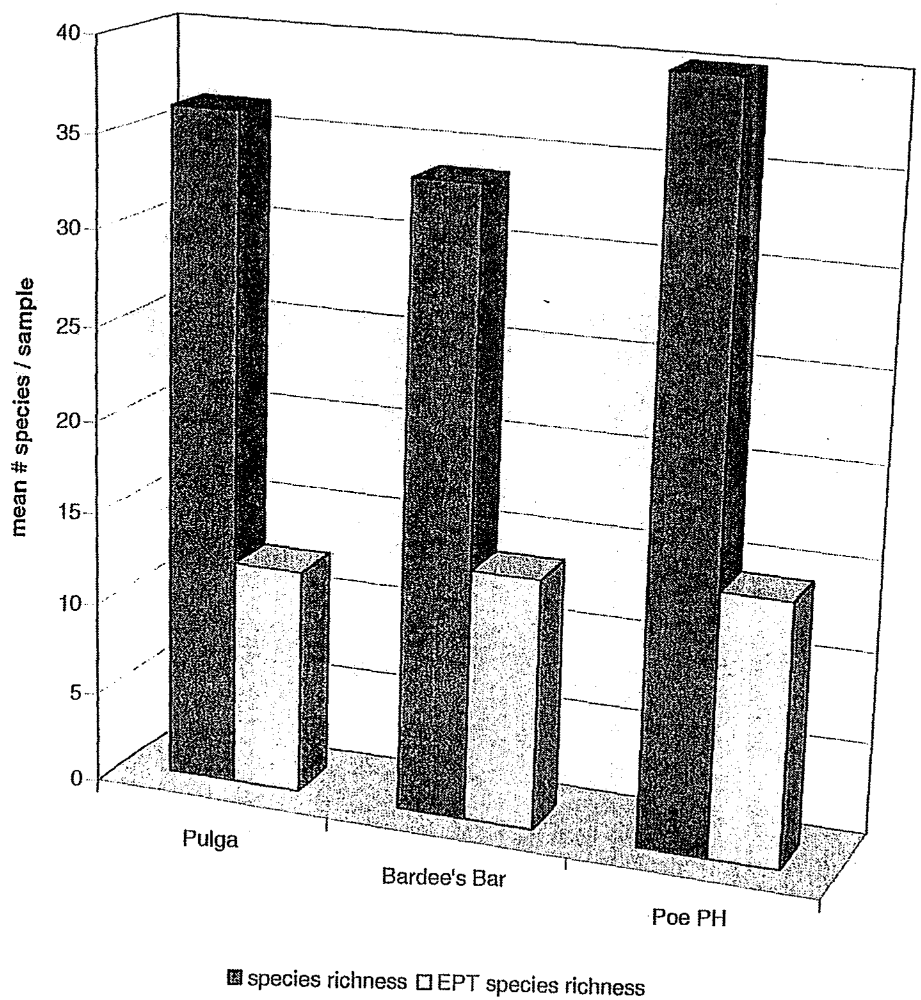


Figure 3. Diversity Trends in the Poe Reach: 2002

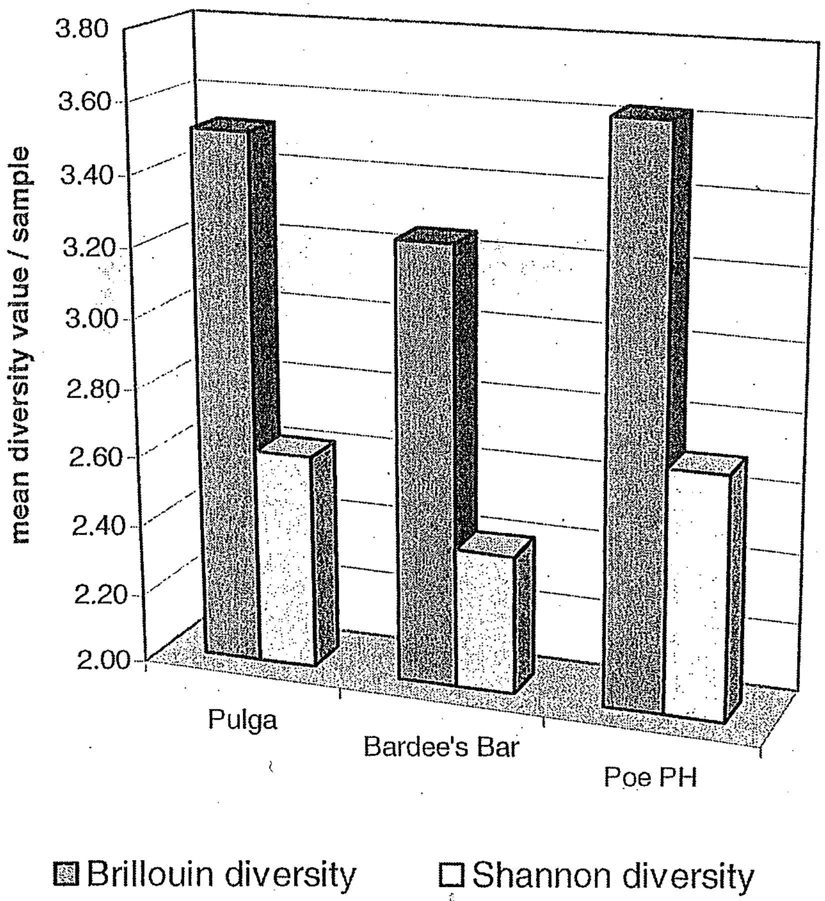


Figure 4. Density Trends in the Poe Reach: 2002

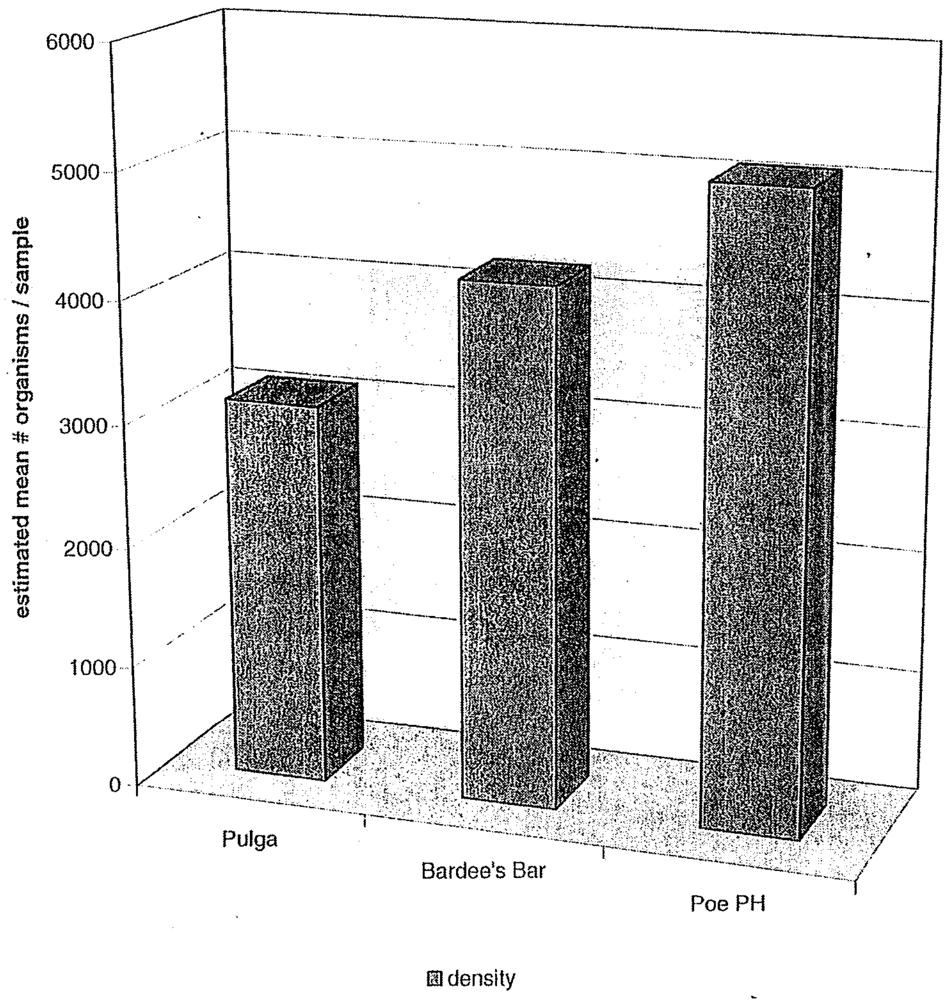


Figure 5. Increasing Species Richness in Downstream Reaches of the North Fork Feather River: 2002

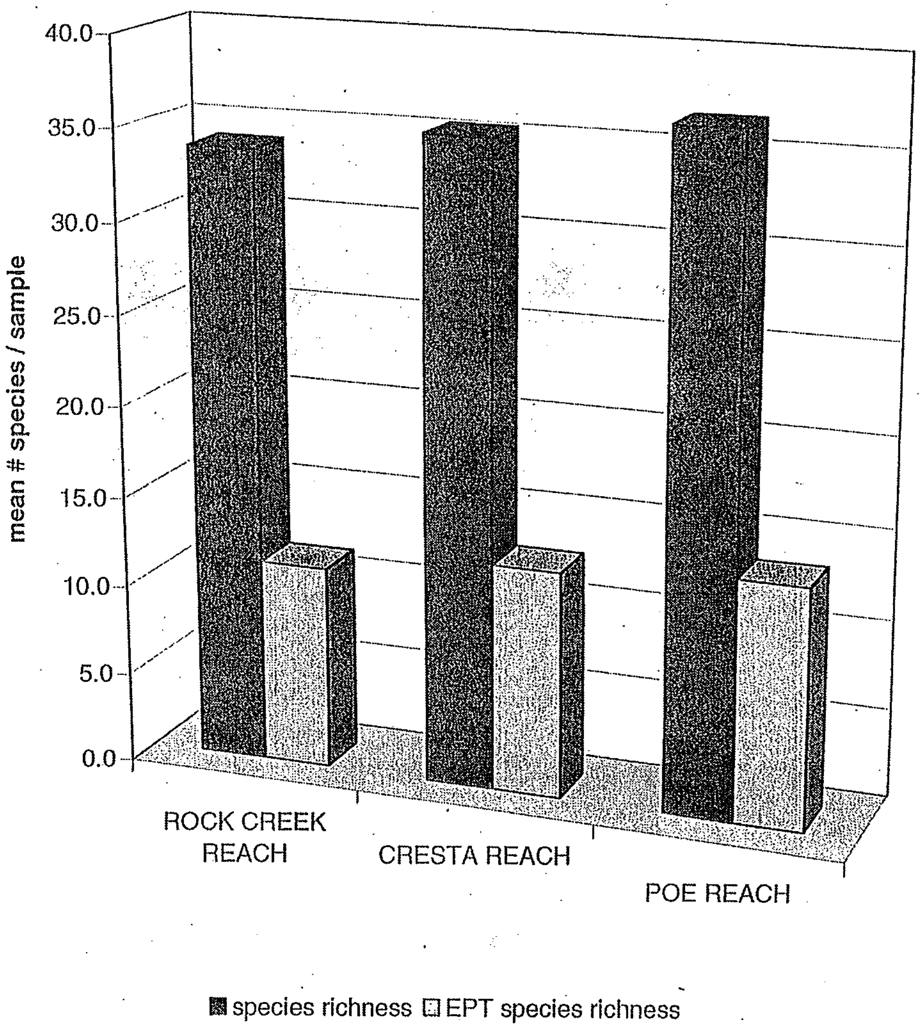


Figure 6. Increasing Diversity in Downstream Reaches of the North Fork Feather River: 2002

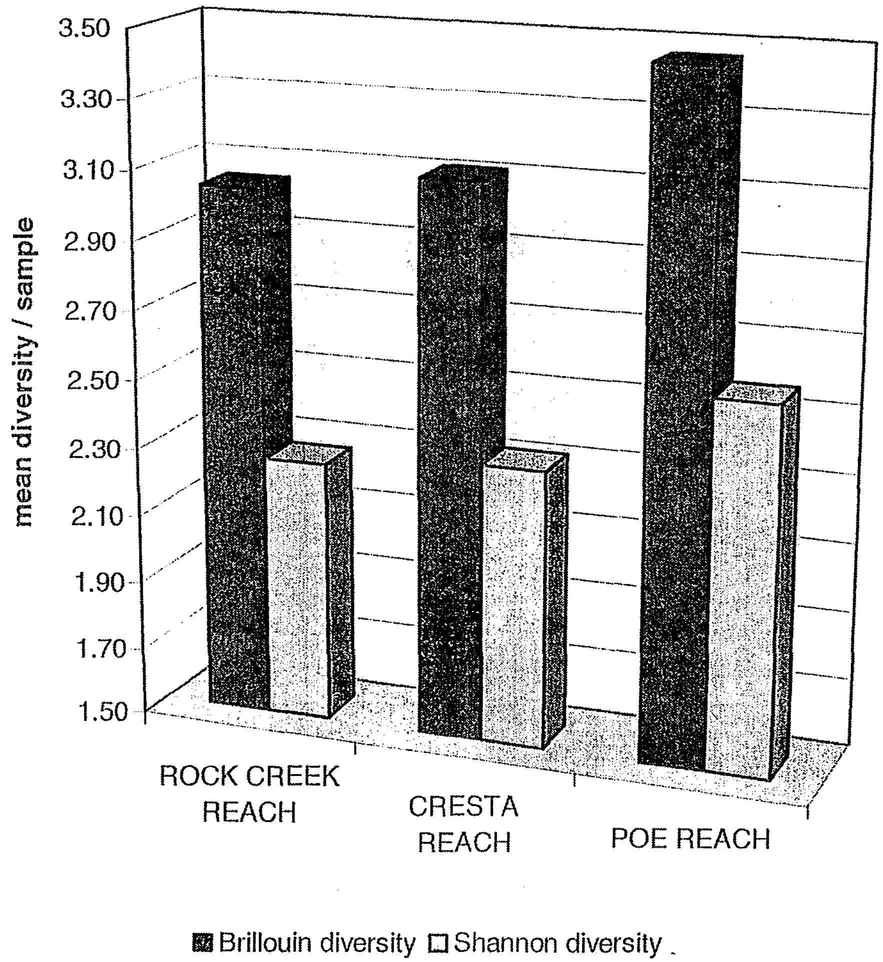


Figure 7. Decreasing Dominance in Downstream Reaches of the North Fork Feather River: 2002

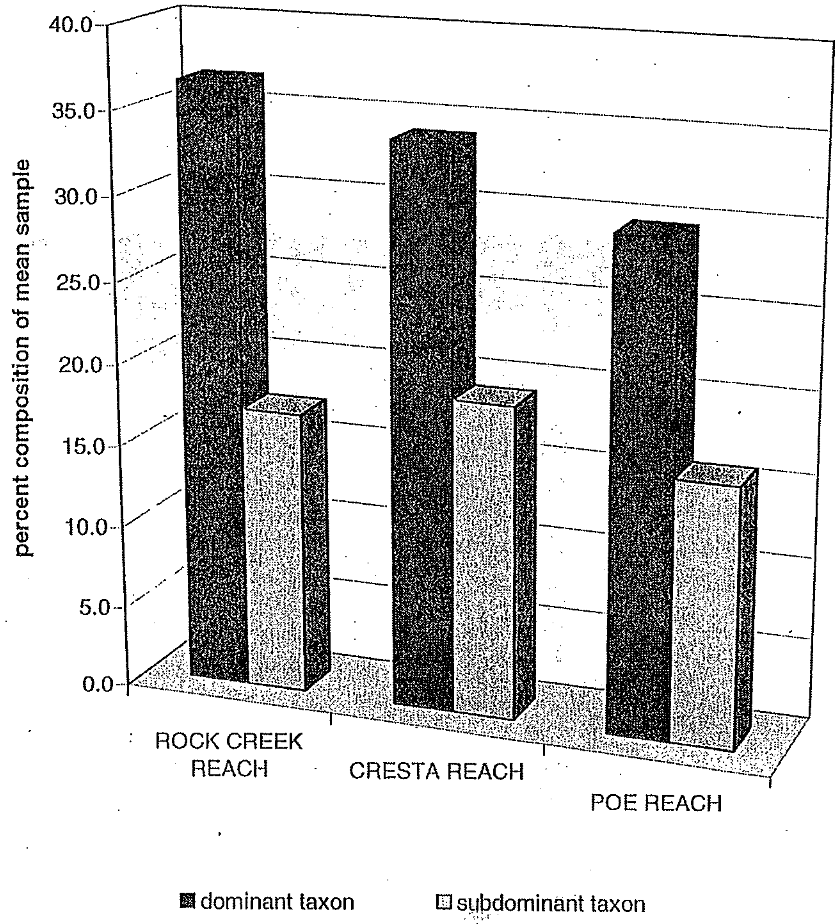
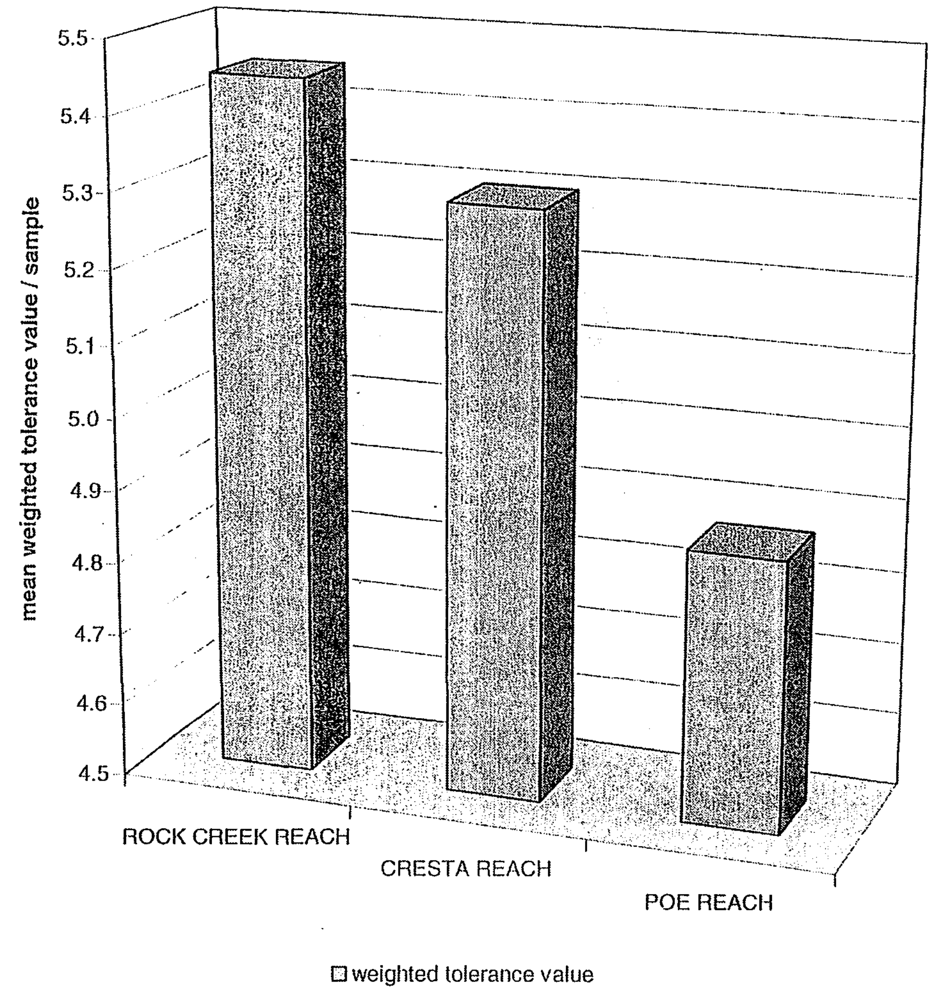


Figure 8. Improvement in Weighted Tolerance Values in Downstream Reaches of the North Fork Feather River: 2002



also increased among these reaches (**Figure 9**). Additionally, the percent composition of predators was higher in the Poe Reach than in the Rock Creek or Cresta reaches (**Figure 10**), which generally indicates a more complex and robust benthic community in the downstream reaches.

GANDA (2002) documented similar trends among consecutive reaches of the Pit River. These trends were reset below each consecutive dam such that increases in the robustness of the benthic community were evident both from top to bottom within a given reach, and from upstream to downstream among various reaches. Based on 2002 bioassessment data, similar trends appear to hold true for these reaches of the Feather River as well.

Upstream to downstream differences among the Rock Creek, Cresta, and Poe reaches were examined using analyses of variance for species richness, Brillouin diversity, estimated density, percent dominant taxon, weighted tolerance value, and percent predators in replicate samples collected from these reaches during 2002. In univariate tests, differences among reaches were significant for Brillouin diversity, estimated density, and weighted tolerance value (ANOVA, $p<0.05$). Differences among reaches were greatest for Brillouin diversity, weighted tolerance value, and estimated density means, respectively. In multivariate tests, differences among reaches were significant for species richness, Brillouin diversity, estimated density, percent dominant taxon, weighted tolerance, and percent predators (MANOVA, $p <0.05$) using these response variables (see **Appendix F**).

4.4 Comparisons with Previous Years (2002 vs. 1999-2001)

The Poe Reach has been sampled since 1999, although only one site, Pulga, was sampled that year. Beginning in 2000, all three sites were sampled consistently in the Poe Reach. Comparisons among sampling years reveal rather variable metric values. No distinct trends between years (either increasing or decreasing) were discernable in richness, composition, tolerance/intolerance, or functional feeding group measures. Mean species richness and diversity at the Pulga site are presented for all four sampling years in **Figures 11 and 12**. Richness and diversity at the Poe Powerhouse and Bardee's Bar sites are presented for 2000-2002 in **Figures 13 through 16.** Complete summaries of biological metrics for the Poe Reach from previous sampling years (1999-2001) are included in **Appendix H** for reference.

Differences among the four sampling years (1999-2002) were examined using analyses of variance for species richness, Brillouin diversity, and estimated density of replicate samples collected from the Pulga site (the only site sampled in all four years). In univariate tests, differences among years were significant for only Brillouin diversity (ANOVA, $p<0.05$); however, as discussed above, no distinct trend among years was discernable. In multivariate tests, no significant differences among years were found (MANOVA, $p<0.05$) using these response variables (see **Appendix F**).

Coefficients of Variation (CVs) for among-year comparisons are presented in **Appendix G.**

Figure 9. Increasing Numbers of Intolerant Organisms in Downstream Reaches of the North Fork Feather River: 2002

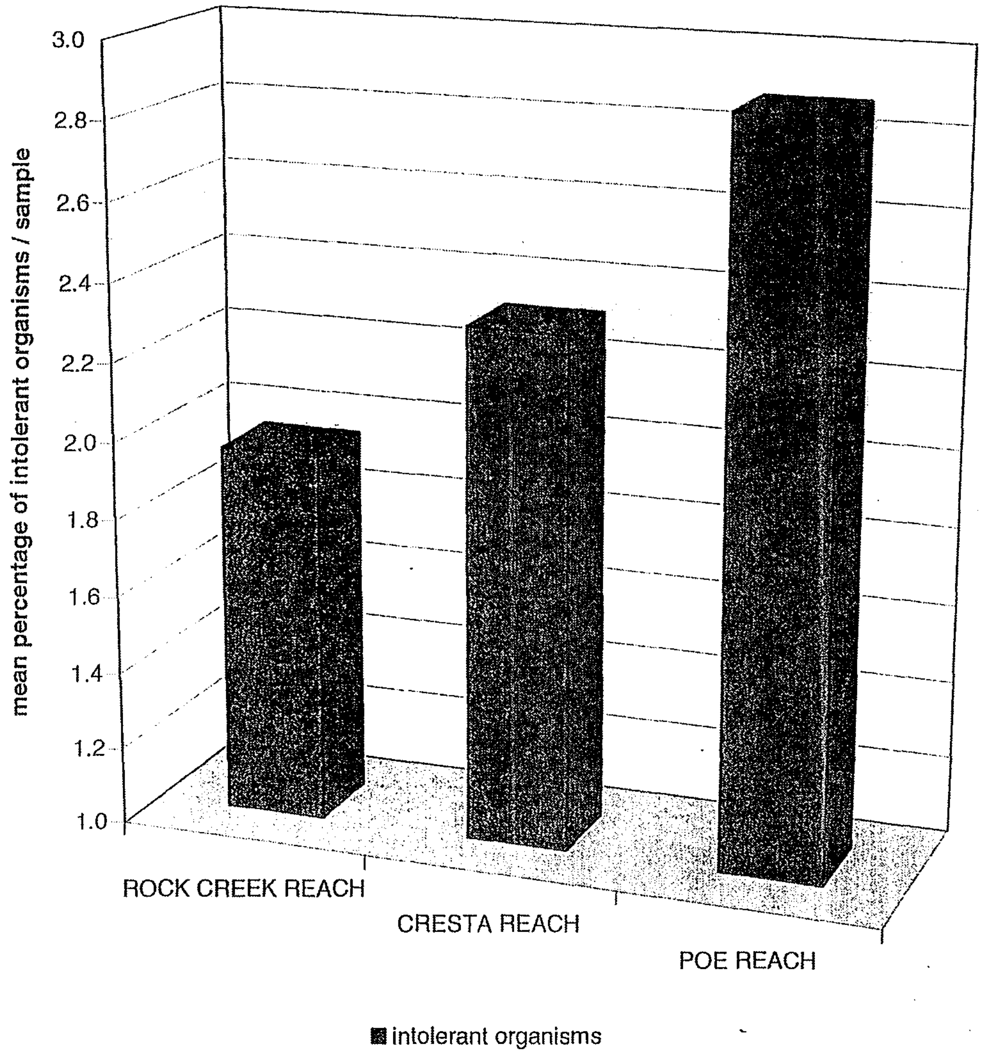


Figure 10. Increases in Predators in Downstream Reaches of the North Fork Feather River: 2002

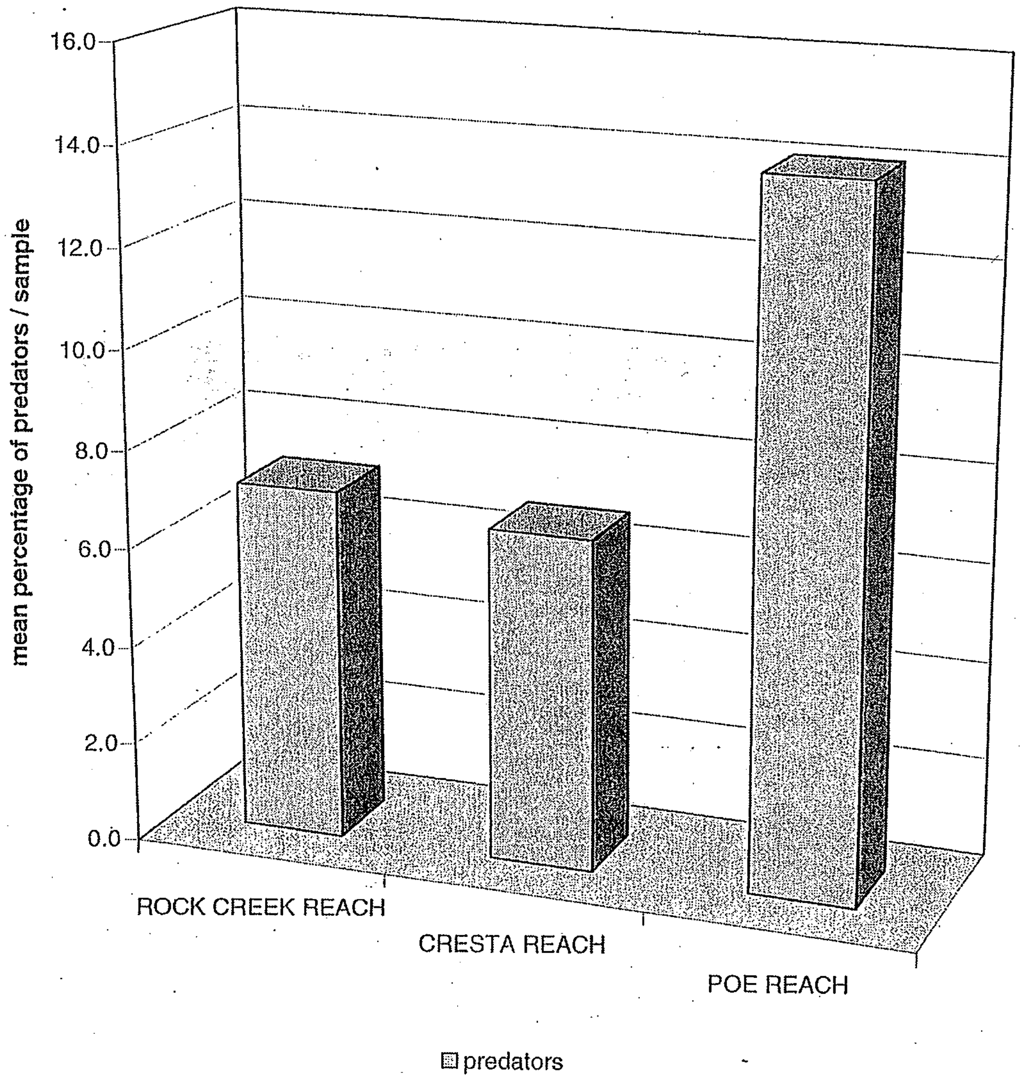


Figure 11. Variable Species Richness between Years in the Poe Reach: Pulga 1999-2002

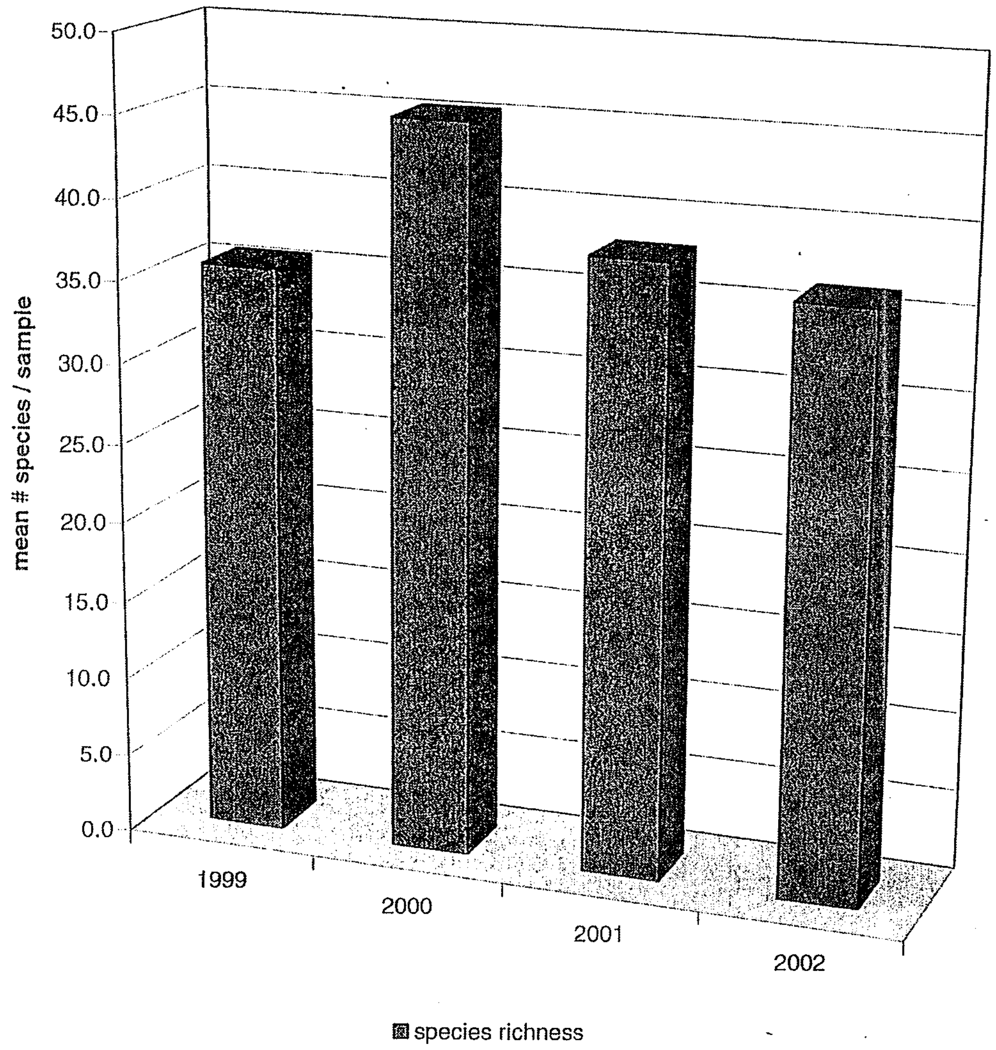


Figure 12. Variable Diversity between Years in the Poe Reach Pulga 1999-2002

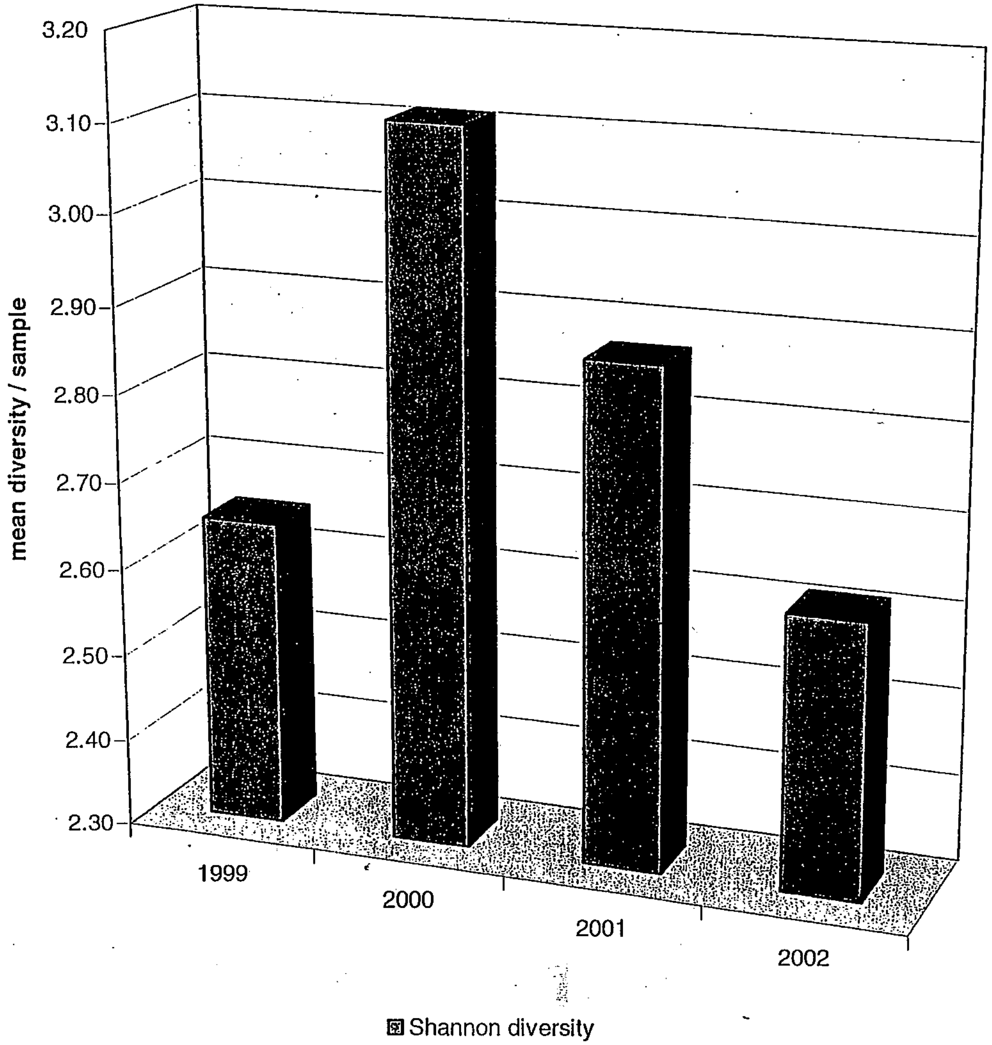


Figure 13. Variable Species Richness between Years in the Poe Reach: Poe PH 2000-2002

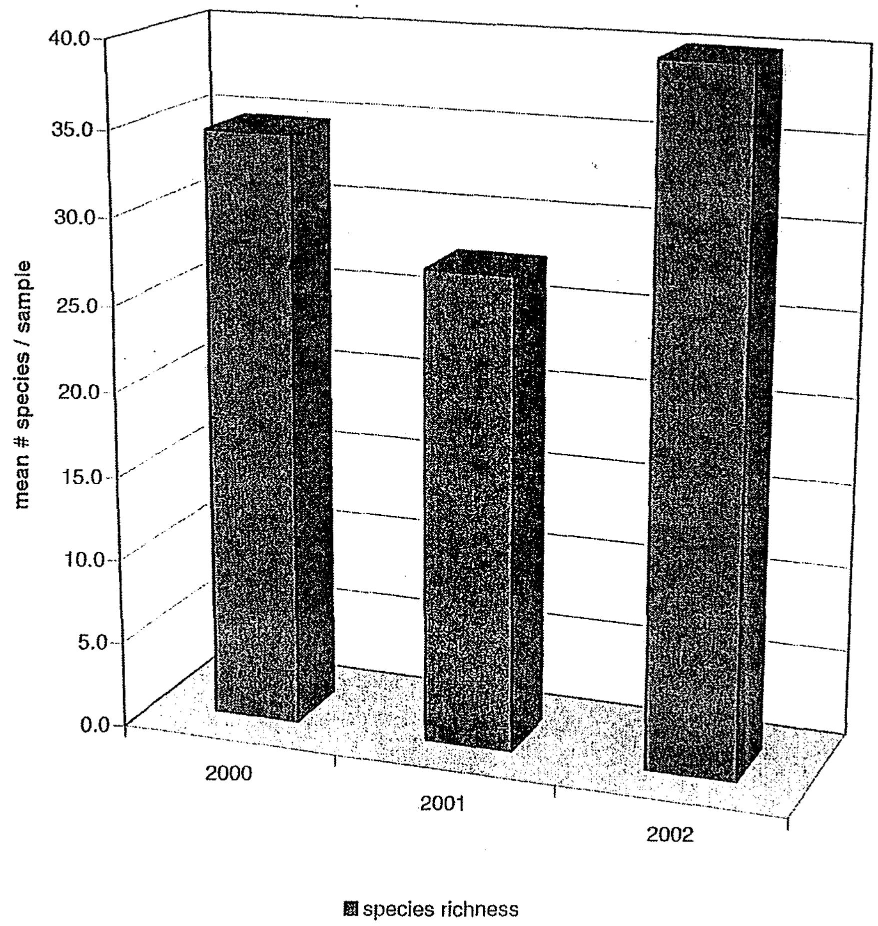


Figure 14. Variable Diversity between Years in the Poe Reach: Poe PH 2000-2002

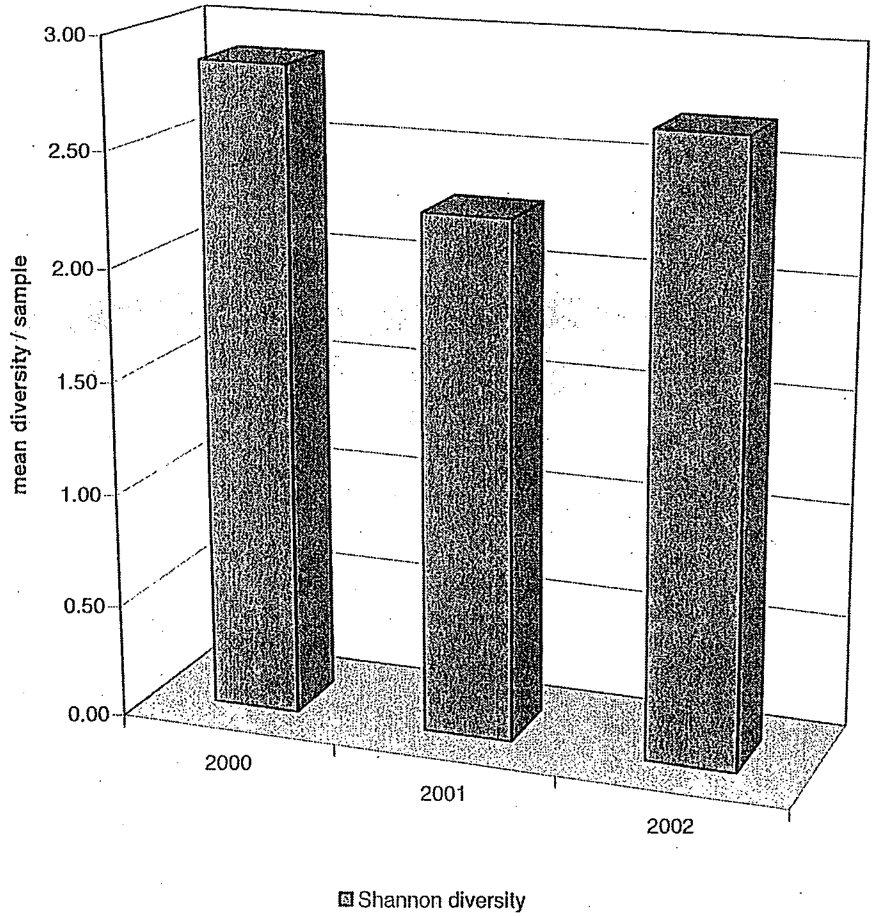


Figure 15. Variable Species Richness between Years in the Poe Reach: Bardee's Bar 2000-2002

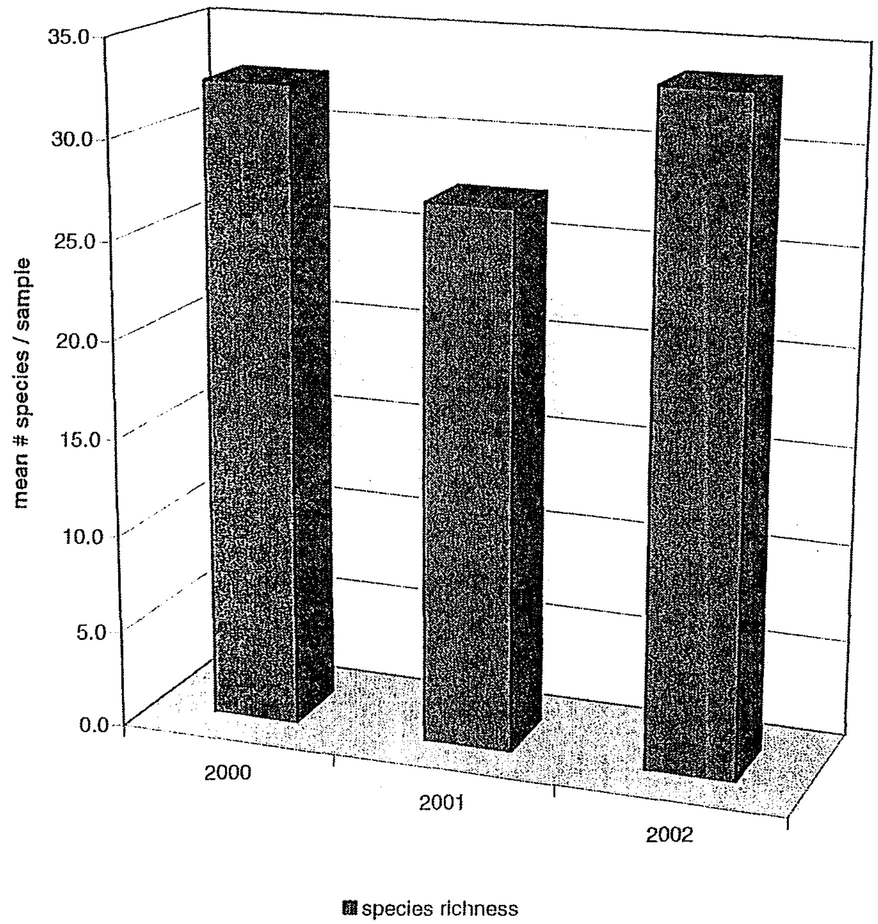
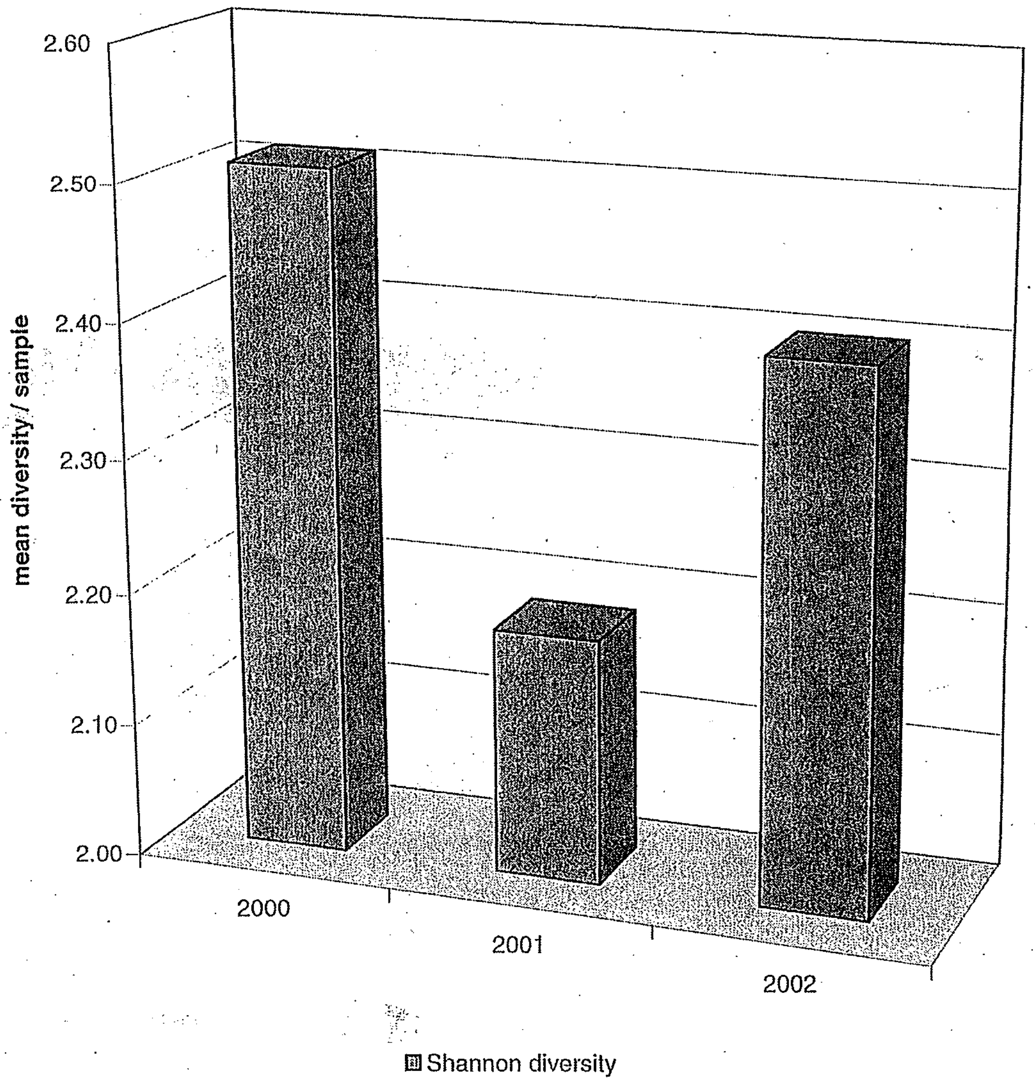


Figure 16. Variable Diversity between Years in the Poe Reach: Bardee's Bar 2000-2002



5.0 Conclusions

The Poe Reach of the North Fork Feather River supports a diverse macroinvertebrate fauna encompassing a variety of biological conditions that rate between "fair" and "good" (sensu Fields 2001). Although a general lack of sampleable riffle habitat constrains the standard sampling approach to an extent, differences in the benthic communities within the Poe Reach, as well as between the Poe Reach and the Cresta and Rock Creek reaches immediately upstream were discernable using CSBP rapid bioassessment techniques as part of a fourth year of annual benthic sampling in 2002. As in other regulated rivers managed for hydroelectricity in California, this portion of the Feather River exhibits a trend toward increasing robustness of the invertebrate community with increasing distance downstream of the dam. This general improvement in benthic community conditions may be attributed to an overall increase in the heterogeneity of the stream environment downstream, as unregulated tributaries provide additional inputs of water, sediment, and allochthonous material to the main stem reach. In univariate and multivariate analyses of variance, upstream to downstream differences within the Poe Reach were not significant, whereas upstream to downstream differences among the Rock Creek, Cresta, and Poe reaches were significant. There were also no major differences among the four sampling years (1999-2002) within the Poe Reach.

6.0 References

Brillouin, L. 1962. Science Information and Theory. Academic Press, New York. 347 pp.

Fields, W. 2001. An Assessment of the Benthic Macroinvertebrate Fauna of Five Reaches of the North and Middle Forks of the Feather River, Plumas and Butte Counties, California. Prepared for MHA Environmental Consulting, Inc. 16 pp.

Garcia and Associates (GANDA). 2002. Benthic Macroinvertebrates: Application of the California Stream Bioassessment Procedure to Reaches of the Pit River Affected by the Pit 3, 4, 5 Hydroelectric Project (FERC No. 233) Shasta County, California. Prepared for Pacific Gas and Electric Company. 46 pp. + appendices.

Garcia and Associates (GANDA). 2003. An Assessment of the Macroinvertebrate Fauna in Reaches of the Feather River Affected and Unaffected by the Rock Creek–Cresta Hydroelectric Project (FERC No. 1962): 2002 Annual Benthic Sampling. Prepared for Pacific Gas and Electric Company. 19 pp. + appendices.

Appendix A:

CSBP Bioassessment Worksheets and Physical Habitat/Water Quality Datasheets

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: NFFR
DATE/TIME: 092302 / 1445
COMPANY/AGENCY: PG&E
SAMPLE ID NO.(S): PULGA 1, 2, 3
SITE DESCRIPTION: 0.3 MI above HWY 70 Bridge @ Pulga to 0.7 MI ABOVE

CREW MEMBERS

W. FIELDS
D. PARKINSON

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: 1480'
Ecoregion:
COMMENTS: LOWEST RIFFLE LOST TO HIGHER FLOWS

CHEMICAL CHARACTERISTICS

Water Temperature: 19.5°C
Specific Conductance:
pH:
Dissolved Oxygen: 9 MG/L

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
1005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.4 mi
Physical/habitat Quality Score: 156

Physical/Habitat Characteristics

	2 riffle 1	3 riffle 2	4 riffle 3
Riffle Length:	20'	30'	70'
Transect Location:	16'	24'	43'
Ave. Riffle Width:	80'	40'	50'
Ave Riffle Depth:	8"	10"	10"
Riffle Velocity:	1.0 f/s	2.0 f/s	1.5 f/s
% Canopy Cover:	0	5%	0
Substrate Complexity:	LOW	MOD	HIGH
Embeddedness:	20%	5%	5%
% Substrate:			
fines (<0.1"):	10%	0	0
gravel (0.1-2"):	40%	30%	30
cobble (2-10"):	30%	40	50
boulder (>10"):	10%	30	20
bedrock (solid):	10%	0	0
Substrate Consolidation:	LOOSE	LOOSE	LOOSE
% Gradient:	0.5%	2%	2%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: NFFR DATE/TIME: 092302/1445
COMPANY/AGENCY: PG&E SAMPLE ID NO.(S): PULGA 1, 2, 3
SITE DESCRIPTION: START 0.3 MI above HWY 70 BRIDGE @ PULGA TO 0.5 Mile above

Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sa... ...ng reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 18	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

86

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 6 (LB)	Left Bank 10 9	8 7 (6)	5 4 3	2 1 0
SCORE 6 (RB)	Right Bank 10 9	8 7 (6)	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 4 (LB)	Left Bank 10 9	8 7 6	5 (4) 3	2 1 0
SCORE 4 (RB)	Right Bank 10 9	8 7 6	5 (4) 3	2 1 0

86

Total Score 70

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: NFFR
DATE/TIME: 092502/ 1200
COMPANY/AGENCY: PG & E
SAMPLE ID NO.(S):
SITE DESCRIPTION: 0.25 MI BELOW TO 0.25 MI ABOVE OLD BRIDGE @ BARKER'S BAR

CREW MEMBERS

W. FIELDS
D. PARKINSON

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: 1140'
Ecoregion:
COMMENTS: FLOWS HIGHER, RIFFLES more marginal

CHEMICAL CHARACTERISTICS

Water Temperature: 16.5°C
Specific Conductance:
pH:
Dissolved Oxygen: 8 mg/L

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.5 mi
Physical/habitat Quality Score: 132

Physical/Habitat Characteristics

	riffle 1 (1)	riffle 2 (2)	riffle 3 (3)
Riffle Length:	MARGIN 24'	MARGIN 30'	MARGIN 20'
Transect Location:	SPOTS	SPOTS	SPOTS
Ave. Riffle Width:	6'	8'	12'
Ave Riffle Depth:	8"	8"	8"
Riffle Velocity:	1.0'	1.5 f/s	2 f/s
% Canopy Cover:	Ø	Ø	Ø
Substrate Complexity:	LOW	HIGH	HIGH
Embeddedness:	10%	5%	Ø
% Substrate			
fines (<0.1")	5%	5%	Ø
gravel (0.1-2")	10%	10%	5%
cobble (2-10")	65%	35%	35%
boulder (>10")	20%	50%	60%
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	LOOSE	MED.	LOOSE
% Gradient:	<1%	2%	3%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: NFFR
DATE/TIME: 092502 /1280
COMPANY/AGENCY: PG&E
SAMPLE ID NO.(S): BARDEE 1, 2, 3
SITE DESCRIPTION: 0.8 MI BELOW TO .2 MI ABOVE OLD BRIDGE @ BARDEES BAR

Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in sampling reach

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 18	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 10	20 19 18 17 16	15 14 13 12 11	(10) 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 3 (LB)	Left Bank 10 9	8 7 6	5 4 (3)	2 1 0
SCORE 5 (RB)	Right Bank 10 9	8 7 6	(5) 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 3 (LB)	Left Bank 10 9	8 7 6	5 4 (3)	2 1 0
SCORE 3 (RB)	Right Bank 10 9	8 7 6	5 4 (3)	2 1 0

70
62
Total Score ______
132

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/STREAM: NFFR
DATE/TIME: 092502/ 9:15
COMPANY/AGENCY: PG&E
SAMPLE ID NO.(S): POE PH 1,2,3
SITE DESCRIPTION: 0.3 MI ABOVE POE PH BRIDGE TO 0.8 MI UPSTREAM

CREW MEMBERS

W. FIELDS
D. PARKINSON

SITE LOCATION

GPS Coordinates
LONG:
LAT:
Elevation: 900'
Ecoregion:
COMMENTS: FLOWS HIGHER, RIFFLES MORE MARGINAL

CHEMICAL CHARACTERISTICS

Water Temperature: 16.5C
Specific Conductance:
pH:
Dissolved Oxygen: 8mg/L

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO: DFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301
Web Site: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:
(Record Physical/Habitat Characteristic values in riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 0.5 mi
Physical/habitat Quality Score: 154

Physical/Habitat Characteristics

	riffle 1 (1)	riffle 2 (2)	riffle 3 (4)
Riffle Length:	50'	MARGIN 30'	MARGIN 20'
Transect Location:	SPOTS	SPOTS	SPOTS
Ave. Riffle Width:	60'	6'	10'
Ave Riffle Depth:	14"	10"	6"
Riffle Velocity:	>3f/s	2f/s	1.5f/s
% Canopy Cover:	Ø	Ø	Ø
Substrate Complexity:	MOD	LOW	LOW
Embeddedness:	10%	5%	5%
% Substrate:			
fines (<0.1")	Ø	5	5
gravel (0.1-2")	5	20	45
cobble (2-10")	20	75	50
boulder (>10")	75	Ø	Ø
bedrock (solid)	Ø	Ø	Ø
Substrate Consolidation:	TIGHT	LOOSE	LOOSE
% Gradient	2.5%	1%	1.5%

PHYSICAL/HABITAT QUALITY

California Stream Bioassessment Procedure

WATERSHED/STREAM: NFFR
DATE/TIME: 092802/9:15
COMPANY/AGENCY: PG&E
SAMPLE ID NO.(S): POEPH 1, 2, 3
SITE DESCRIPTION: 0.3 MI above POE PH BRIDGE TO 0.8 MI UPSTREAM

Circle the appropriate score for all 20 habitat parameters. Record the total score on front page of the CBW)

Parameters to be evaluated in samp...g reach

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 10	20 19 18 17 16	15 14 13 12 11	(10) 9 8 7 6	5 4 3 2 1 0

78

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 11	20 19 18 17 16	15 14 13 12 (11)	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems: <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 7 (LB)	Left Bank 10 9	8 (7) 6	5 4 3	2 1 0
SCORE 8 (RB)	Right Bank 10 9	(8) 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 5 (LB)	Left Bank 10 9	8 7 6	(5) 4 3	2 1 0
SCORE 5 (RB)	Right Bank 10 9	8 7 6	(5) 4 3	2 1 0

78
Total Score 76

Appendix B:

Poe Reach (NFFR) 2002 Species List

POE REACH 2002 ANNUAL CSBP						POE			BARDEE'S BAR			PULGA			TOTAL
PHYLUM	CLASS	ORDER	FAMILY	GENUS	SPECIES	1	2	3	1	2	3	1	2	3	
Annelida	Oligochaeta	Haplotaxida	Haplotaxidae	*Haplotaxis*	*gordioides*					1					1
Annelida	Oligochaeta	Tubificida	Naididae	*Nais*	*bicuspidalis*							4	2		6
Annelida	Oligochaeta	Tubificida	Naididae	*Nais*	*communis/variabilis*				1						1
Annelida	Oligochaeta	Tubificida	Naididae	*Nais*	*pardalis*					1		1			2
Annelida	Oligochaeta	Tubificida	Tubificidae	*Aulodrilus*	*pluriseta*						1				1
Annelida	Oligochaeta	Tubificida	Tubificidae	*Spirosperma*	*nikolskyi*									3	3
Annelida	Oligochaeta	Lumbricina	Lumbricidae	*Eisenella*	*tetraedra*	5	2	2	10	3	1	6	1	1	31
Annelida	Oligochaeta	Lumbriculida	Lumbriculidae	*Eclipidrilus*	*frigidus*	3	1			1				1	6
Mollusca	Gastropoda	Basommatophora	Ancylidae	*Ferrissia*	*californica*	1									1
Mollusca	Gastropoda	Basommatophora	Lymnaeidae	*Fossaria*	sp.	4	2				1				7
Mollusca	Gastropoda	Basommatophora	Physidae	*Physa*	*gyrina*	1		6			1				8
Mollusca	Gastropoda	Basommatophora	Planorbidae	*Menetus*	sp.	1									1
Mollusca	Gastropoda	Basommatophora	Planorbidae	*Rhynchelmis*	*rostrata*				3	7	4	6	1	3	24
Mollusca	Pelecypoda	Veneroida	Corbiculidae	*Corbicula*	*fluminea*	6	4	13	3	1	1	6	1	1	36
Mollusca	Pelecypoda	Veneroida	Sphaeriidae	*Pisidium*	*casertanum*		1								1
Nematoda		Rhabditia	Cephalobidae	*Panagrolaimus*	sp.					1				1	2
Nematodmorpha			Mermithidae	unidentified	species	2	2								4
Nemertea	Enopla	Hoplonemertea	Tetrastemmatidae	*Prostoma*	*graecense*	10	11	2	5	4	4	28	6	2	72
Platyhelminthes	Turbellaria	Tricladida	Planariidae	*Dugesia*	*tigrina*	9	5	11	10	22	27	77	1	15	177
Arthropoda	Arachnida	Acari	Hygrobatidae	*Hygrobates*	sp.	2	3					3			8
Arthropoda	Arachnida	Acari	Lebertiidae	*Lebertia*	sp.	1						1			2
Arthropoda	Arachnida	Acari	Sperchontidae	*Sperchon*	sp. A	1			1		1			2	5
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Acentrella*	*insignificans*	5	3	1	5	5	5				24
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Acentrella*	*turbida*				9		1	1	1	2	14
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Baetis*	*magnus*	1		1							2
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Baetis*	*tricaudatus*	107	84	65	93	99	131	27	34	31	671
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	*Serratella*	*micheneri*	1									1
Arthropoda	Insecta	Ephemeroptera	Heptagenlidae	*Epeorus*	*albertae*	2	1	1	1	1				1	7
Arthropoda	Insecta	Ephemeroptera	Isonychiidae	*Isonychia*	*velma*	4	5	3	1	3	5	4	3	1	29
Arthropoda	Insecta	Ephemeroptera	Leptohyphidae	*Asioplax*	*edmundsi*	2	1								3
Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*	sp. B						1				1
Arthropoda	Insecta	Odonata	Coenagrionidae	*Argia*	*lugens*			1							1
Arthropoda	Insecta	Odonata	Coenagrionidae	*Argia*	*vivida*	2	2	2				2			8
Arthropoda	Insecta	Plecoptera	Perlidae	*Hesperoperla*	*pacifica*		1	1		1		1	1	1	6
Arthropoda	Insecta	Plecoptera	Perlodidae	*Isoperla*	sp.	1			3	2			1	4	11
Arthropoda	Insecta	Plecoptera	Perlodidae	*Skwala*	*parallela*	1					1				2
Arthropoda	Insecta	Megaloptera	Corydalidae	*Corydalus*	*cognatus*	1									1
Arthropoda	Insecta	Trichoptera	Hydropsychidae	*Cheumatopsyche*	*campyla*	12	10	10	32	16	12	14	22	57	185
Arthropoda	Insecta	Trichoptera	Hydropsychidae	*Ceratopsyche*	*cockerelli*				1		3		2		6
Arthropoda	Insecta	Trichoptera	Hydropsychidae	*Hydropsyche*	*californica*	41	45	13	67	49	47	19	18	101	400
Arthropoda	Insecta	Trichoptera	Hydropsychidae	*Hydropsyche*	*occidentalis*	8	13	1	26	19	13	5	21	11	117
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Hydroptila*	sp. A	3			1			1			5
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Hydroptila*	sp. B				2		1				3
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Hydroptila*	sp. C	1									1
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Leucotrichia*	*pictipes*	5	2		6	2	1	1	6	4	27
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Ochrotrichia*	sp. A		2					3			5
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Ochrotrichia*	sp. B	1	4	2			1	1			9
Arthropoda	Insecta	Trichoptera	Philopotamidae	*Chimarra*	*utahensis*	23	26	45	25	29	19	45	10	13	235
Arthropoda	Insecta	Trichoptera	Rhyacophilidae	*Rhyacophila*	*coloradensis*				1						1
Arthropoda	Insecta	Trichoptera	Rhyacophilidae	*Rhyacophila*	*hyalinata group*							1			1
Arthropoda	Insecta	Trichoptera	Rhyacophilidae	*Rhyacophila*	*malkini*		1	2	1			2		1	7

Arthropoda	Insecta	Lepidoptera	Pyralidae	*Petrophila*	sp.	1						1		3	**5**
Arthropoda	Insecta	Coleoptera	Elmidae	*Optioservus*	*quadrimaculatus*		2	2		1		1	2	2	**10**
Arthropoda	Insecta	Coleoptera	Elmidae	*Ordobrevia*	*nubifera*		1					1			**2**
Arthropoda	Insecta	Coleoptera	Elmidae	*Zaitzevia*	*parvula*	3	2	11		1	1	6	4	7	**35**
Arthropoda	Insecta	Coleoptera	Psephenidae	*Psephenus*	*falli*	1	2								**3**
Arthropoda	Insecta	Coleoptera	Ptilodactylidae	*Stenocolus*	*scutellaris*	1		1	1		1				**4**
Arthropoda	Insecta	Diptera	Blephariceridae	*Blepharicera*	sp.	2	1	2	1	1					**7**
Arthropoda	Insecta	Diptera	Chironomidae	*Rheotanytarsus*	sp. A	17	24	20	1	1	6	1	9	1	**80**
Arthropoda	Insecta	Diptera	Chironomidae	*Potthastia*	sp.		1						2		**3**
Arthropoda	Insecta	Diptera	Chironomidae	*Cardiocladius*	sp.	1	4	5	9	2	8	5	11	9	**54**
Arthropoda	Insecta	Diptera	Chironomidae	*Cricotopus*	*flavocinctus*		2	1		2	2		3		**10**
Arthropoda	Insecta	Diptera	Chironomidae	*Cricotopus*	*tremulus group sp. A*	1	2			1	4			3	**11**
Arthropoda	Insecta	Diptera	Chironomidae	*Cricotopus*	*tremulus group sp. B*	1			2			2	2	1	**8**
Arthropoda	Insecta	Diptera	Chironomidae	*Cricotopus*	*trifascia group sp. A*		1					4	1		**6**
Arthropoda	Insecta	Diptera	Chironomidae	*Eukiefferiella*	sp. A		1		1	2		1	2	1	**8**
Arthropoda	Insecta	Diptera	Chironomidae	*Eukiefferiella*	sp. B		1			2			1		**4**
Arthropoda	Insecta	Diptera	Chironomidae	*Eukiefferiella*	sp. C				2			2	2		**6**
Arthropoda	Insecta	Diptera	Chironomidae	*Thienemanniella*	sp.			1							**1**
Arthropoda	Insecta	Diptera	Chironomidae	*Tvetenia*	sp.	8	7			1		2	1	2	**21**
Arthropoda	Insecta	Diptera	Chironomidae	*Tanytarsus*	sp. A			1							**1**
Arthropoda	Insecta	Diptera	Empididae	*Hemerodromia*	sp.							2		1	**3**
Arthropoda	Insecta	Diptera	Simuliidae	*Prosimulium*	sp.	5	14	63	2	15	25	11	77	6	**218**
Arthropoda	Insecta	Diptera	Simuliidae	*Simulium*	*arcticum*						1	4			**5**
Arthropoda	Insecta	Diptera	Simuliidae	*Simulium*	*piperi*			4			1		2		**7**
Arthropoda	Insecta	Diptera	Simuliidae	*Simulium*	*tuberosum*	2	1								**3**
Arthropoda	Insecta	Diptera	Simuliidae	*Simulium*	*virgatum*			7		6	5	1	17	4	**40**
Arthropoda	Insecta	Diptera	Simuliidae	*Simulium*	*vittatum*		14	20	8			1	2	4	**49**
Arthropoda	Insecta	Diptera	Psychodidae	*Maruina*	*lanceolata*				1						**1**
Arthropoda	Insecta	Diptera	Tipulidae	*Antocha*	sp.	5	3	1	2	2	1		3	6	**23**
TOTAL						**315**	**314**	**321**	**337**	**304**	**337**	**304**	**272**	**306**	**2810**

Appendix C:

Results of 20% QA/QC Check of Taxonomy by CDFG Aquatic Bioassessment Laboratory

Comparative Taxonomic Listing of all Submitted Samples

Samples submitted by Wayne Fields for Project: Wayne Fields-NFFR Fall 2002, reference date: 10/1/2002

Report prepared by Andrew Rehn, WPCL, 2/5/2003

Taxonomist	Sample no.	Vial no.	Original ID	Original Count	Stage	ABL Count	ABL ID	
	BB 1							
		1	Planariidae	10		10	Planariidae	
		2	Prostoma	5		5	Prostoma	
		3	Naididae	1		1	Naididae	
		4	Lumbricidae	10		10	Lumbricidae	
		5	Lumbriculidae	3		3	Lumbriculidae	
		6	Sperchon	1		1	Sperchon	
		7	Corbicula	3		3	Corbicula	
		8	Acentrella	14		14	Acentrella	
		9	Baetis	93		93	Baetis	
		10	Epeorus	1		1	Epeorus	
		11	Isonychia velma	1		1	Isonychia velma	
		12	Isoperla	3		3	Isoperla	
		13	Cheumatopsyche	32		[redacted]		MISPLACED
		13	Cheumatopsyche	32		31	Cheumatopsyche	
		14	Hydropsyche	94		[redacted]		MISPLACED
		14	Hydropsyche	94		94	Hydropsyche	
		15	Hydroptila	3		3	Hydroptila	
		16	Leucotrichia pictipes	6		6	Leucotrichia pictipes	
		17	Chimarra	25		25	Chimarra	
		18	Rhyacophila	2		2	Rhyacophila	
		19	Stenocolus scutellaris	1		1	Stenocolus scutellaris	
		20	Blephericera	1		1	Blephericera	
		21	Orthocladiinae	14		14	Orthocladiinae	
		22	Tanytarsini	1		1	Tanytarsini	
		23	[redacted]					MISIDENTIFIED
		24	Simulium	8		8	Simulium	
		25	Maruina lanceolata	1		1	Maruina lanceolata	

Taxonomist	Sample no.	Vial no.	Original ID	Original Count	Stage	ABL Count	ABL ID
	BB 1						
		26	Antocha	2		2	Antocha

Taxonomist	Sample no.	Vial no.	Original ID	Original Count	Stage	ABL Count	ABL ID
	EB 2						
		1	Prostoma	12		12	Prostoma
		2	Naididae	2		2	Naididae
		3	Lebertia	3		3	Lebertia
		4	Sperchon	12		12	Sperchon
		5	Ferrissia	5		5	Ferrissia
		6	Gyraulus	1		1	Gyraulus
		7	Acentrella	6		6	Acentrella
		8	Baetis	13		13	Baetis
		9	Epeorus	2		2	Epeorus
		10	Argia	1		1	Argia
		11	Hesperoperla	2		2	Hesperoperla
		12	Isoperla	3		3	Isoperla
		13	Cheumatopsyche	113		110	Cheumatopsyche
		14	Hydropsyche	81		81	Hydropsyche
		15	Chimarra	2		2	Chimarra
		16	Psychomyia	1		1	Psychomyia
		17	Rhyacophila	2		2	Rhyacophila
		18	Petrophila	2		2	Petrophila
		19	Microcylloepus	3		[redacted]	[redacted] OK. OBSCURE/MIS-ID.
		19	Microcylloepus	3		[redacted]	[redacted]
		20	Optioservus	2		2	Optioservus
		21	Zaitzevia	21		21	Zaitzevia
		22	Orthocladiinae	10		10	Orthocladiinae
		23	Tanytarsini	1		1	Tanytarsini
		24	Simulium	24		24	Simulium
		25	Antocha	1		1	Antocha
		26	Atherix pachypus	1		1	Atherix pachypus
		27	Hemerodromia	1		1	Hemerodromia

Taxonomist	Sample no.	Vial no.	Original ID	Original Count	Stage	ABL Count	ABL ID
	LRC 2						
		1	Planariidae	2		2	Planariidae
		2	Prostoma	16		16	Prostoma
		3	Haplotaxis	1		1	Haplotaxis
		4	Naididae	11		11	Naididae
		5	Lumbricidae	5		5	Lumbricidae
		6	Ocnerodrilidae	1		1	Oligochaeta
		7	Lumbriculidae	1		1	Lumbriculidae
		8	Hygrobates	1		1	Hygrobates
		9	Lebertia	2		2	Lebertia
		10	Sperchon	2		2	Sperchon
		11	Torrenticola	2		2	Torrenticola
		12	Ferrissia	3		3	Ferrissia
		13	Corbicula	16		16	Corbicula
		14	Acentrella	29		29	Acentrella
		15	Baetis	52		52	Baetis
		16	Camelobaetidius	1		1	Camelobaetidius
		17	Epeorus	1		1	Epeorus
		18	Argia	1		1	Argia
		19	Calineuria californica	1		1	Calineuria californica
		20	Isoperla	3		3	Isoperla
		21	Cheumatopsyche	59		59	Cheumatopsyche
		22	Hydropsyche	41		41	Hydropsyche
		23	Hydroptila	3		3	Hydroptila
		24	Chimarra	7		7	Chimarra
		25	Petrophila	1		1	Petrophila
		26	Diamesinae	2		2	Diamesinae
		27	Orthocladiinae	11		11	Orthocladiinae
		28	Tanytarsini	5		5	Tanytarsini
		29	Simulium	2		2	Simulium
		30	Antocha	1		1	Antocha

Taxonomist	Sample no.	Vial no.	Original ID	Original Count	Stage	ABL Count	ABL ID
	MC 1						
				0	x	0	
		1	Planariidae	2		2	Planariidae
		2	Prostoma	4		4	Prostoma
		3	Nematoda	1		1	Nematoda
		4	Naididae	4		4	Naididae
		5	Lumbricidae	2		2	Lumbricidae
		6	Lumbriculidae	2		2	Lumbriculidae
		7	Acentrella	1		1	Acentrella
		8	Baetis	62		62	Baetis
		9	Isonychia velma	1		1	Isonychia velma
		10	Hesperoperla	1		1	Hesperoperla
		11	Isoperla	3		3	Isoperla
		12	Cheumatopsyche	7		7	Cheumatopsyche
		13	Hydropsyche	49		50	Hydropsyche
		14	Hydroptila	1		1	Hydroptila
		15	Ochrotrichia	1		1	Ochrotrichia
		16	Chimarra	10		10	Chimarra
		17	Rhyacophila	1		1	Rhyacophila
		18	Ordobrevia nubifera	2		2	Ordobrevia nubifera
		19	Zaitzevia	1		1	Zaitzevia
		20	Stenocolus scutellaris	1		1	Stenocolus scutellaris
		21	Diamesinae	1		1	Diamesinae
		22	Orthocladiinae	9		9	Orthocladiinae
		23	Tanytarsini	2		2	Tanytarsini
		[redacted]		ALL SIMULIUM			MISID
		25	Simulium	107		107	Simulium
		26	Antocha	3		3	Antocha
		27	Hemerodromia	1		1	Hemerodromia

Taxonomist	Sample no.	Vial no.	Original ID	Original Count	Stage	ABL Count	ABL ID
	NF 2						
		1	Planariidae	5		5	Planariidae
		2	Prostoma	1		1	Prostoma
		3	Nematoda	3		3	Nematoda
		4	Lumbricidae	3		3	Lumbricidae
		5	Sperchon	2		2	Sperchon
		6	Acentrella	6		6	Acentrella
		7	Baetis	43		43	Baetis
		8	Serratella	2		2	Serratella
		9	Epeorus	1		1	Epeorus
		10	Isonychia velma	1		1	Isonychia velma
		11	Calineuria californica	1		1	Calineuria californica
		12	Hesperoperla	1		1	Hesperoperla
		13	Isoperla	1		1	Isoperla
		14	Cheumatopsyche	19		19	Cheumatopsyche
		15	Hydropsyche	63		58	Hydropsyche
		15	Hydropsyche	63		[redacted]	MISPLACED
		16	Chimarra	16		16	Chimarra
		17	Rhyacophila	1		1	Rhyacophila
		18	Microcylloepus	1		1	Microcylloepus
		19	Ordobrevia nubifera	1		1	Ordobrevia nubifera
		20	Zaitzevia	10		10	Zaitzevia
		21	Blephericera	1		1	Blephericera
		22	Orthocladiinae	5		5	Orthocladiinae
		[redacted]					MISID
		24	Simulium	110		110	Simulium
		25	Hemerodromia	1		1	Hemerodromia

Taxonomist	Sample no.	Vial no.	Original ID	Original Count	Stage	ABL Count	ABL ID
	POE PH 2						
		1	Planariidae	5		5	Planariidae
		2	Prostoma	11		11	Prostoma
		3	Nematoda	2		2	Nematoda
		4	Lumbricidae	2		2	Lumbricidae
		5	Lumbriculidae	1		1	Lumbriculidae
		6	Hygrobates	3		3	Hygrobates
		7	Fossaria	2		2	Fossaria
		8	Corbicula	4		4	Corbicula
		9	Pisidium	1		1	Pisidium
		10	Acentrella	3		3	Acentrella
		11	Baetis	84		84	Baetis
		12	Epeorus	1		1	Epeorus
		13	Isonychia velma	5		5	Isonychia velma
		14	Asioplax	1		1	Asioplax
		15	Argia	2		2	Argia
		16	Hesperoperla	1		1	Hesperoperla
		17	Cheumatopsyche	9		9	Cheumatopsyche
		18	Hydropsyche	58		55	Hydropsyche
		19	Leucotrichia pictipes	2		2	Leucotrichia pictipes
		20	Ochrotrichia	6		6	Ochrotrichia
		21	Chimarra	26		26	Chimarra
		22	Rhyacophila	1		1	Rhyacophila
		23	Psephenus falli	2		2	Psephenus falli
		24	Optioservus	2		2	Optioservus
		25	Ordobrevia nubifera	1		1	Ordobrevia nubifera
		26	Zaitzevia	2		2	Zaitzevia
		27	Blephariceria	1		1	Blephariceria
		28	Diamesinae	1		1	Diamesinae
		29	Orthocladiinae	18		18	Orthocladiinae
		30	Tanytarsini	24		24	Tanytarsini

[redacted] MISID

Taxonomist	Sample no.	Vial no.	Original ID	Original Count	Stage	ABL Count	ABL ID
	POE PH 2						
		32	Simulium	15		15	Simulium
		33	Antocha	3		3	Antocha

Taxonomist	Sample no.	Vial no.	Original ID	Original Count	Stage	ABL Count	ABL ID
	URC 3						
		1	Prostoma	1		1	Prostoma
		2	Tubificidae	2		2	Tubificidae
		3	Lumbricidae	1		1	Lumbricidae
		4	Lumbriculidae	1		1	Lumbriculidae
		5	Corbicula	1		1	Corbicula
		6	Acentrella	2		2	Acentrella
		7	Baetis	26		26	Baetis
		8	Argia	1		1	Argia
		9	Cheumatopsyche	5		5	Cheumatopsyche
		10	Hydropsyche	28		28	Hydropsyche
		11	Leucotrichia pictipes	2		2	Leucotrichia pictipes
		12	Chimarra	3		3	Chimarra
		13	Orthocladiinae	7		7	Orthocladiinae
		14	Tanytarsini	1		1	Tanytarsini
		[redacted]					MISID
		16	Simulium	280		280	Simulium
		17	Antocha	1		1	Antocha

Taxonomist	Sample no.	Vial no.	Original ID	Original Count	Stage	ABL Count	ABL ID
	URC 3						

Listing of Taxonomic Discrepancies

Samples submitted by Wayne Fields for Project: Wayne Fields-NFFR Fall 2002, reference date: 10/1/2002

Report prepared by Andrew Rehn, WPCL, 2/5/2003

Sample #	Vial #	Final ID: Original ID	Final ID: QC Final ID	Taxonomic level of dispute	# Organisms Affected	Comments
BB 1						
Disputed ID						
	23	Prosimulium	Simulium	Genus	2	
Probable sorting error						
	13	Cheumatopsyche	Hydropsyche	Genus	1	
	14	Hydropsyche	Cheumatopsyche	Genus	2	
EB 2						
Disputed ID						
	19	Microcylloepus	Zaitzevia	Genus	1	
LRC 2						
Original ID more precise						
	6	Ocnerodrilidae	Oligochaeta		1	
NF 2						
Disputed ID						
	23	Prosimulium	Simulium	Genus	33	
Probable sorting error						
	15	Hydropsyche	Cheumatopsyche	Genus	3	
POE PH 2						
Disputed ID						
	31	Prosimulium	Simulium	Genus	14	
URC 3						
Disputed ID						
	15	Prosimulium	Simulium	Genus	3	

Listing of Enumeration Discrepancies

Samples submitted by Wayne Fields for Project: Wayne Fields-NFFR Fall 2002, reference date: 10/1/2002

Report prepared by Andrew Rehn, WPCL, 2/5/2003

	Sample #	Vial #	Original ID	# Counted Original	# Counted QC	Difference (Original - QC)
Minor Counting Discrepancies						
	BB 1	14	Hydropsyche	94	96	-2
	EB 2	13	Cheumatopsyche	113	110	3
	MC 1	13	Hydropsyche	49	50	-1
	NF 2	15	Hydropsyche	63	61	2
		23	Prosimulium	34	33	1
	POE PH 2	18	Hydropsyche	58	55	3

Summary of Taxonomic and Enumeration Discrepancies

Samples submitted by Wayne Fields for Project: Wayne Fields-NFFR Fall 2002, reference date: 10/1/2002

Report prepared by Andrew Rehn, WPCL, 2/5/2003

		Taxonomic Discrepancies						Counting Discrepancies			
				Taxonomic Precision Relative to QC							
Sample #	Total Taxa	Disputed ID		More precise		Less Precise		Major		Minor	
		*f**	*n***	*f*	*n*	*f*	*n*	*f*	*d****	*f*	*d*
BB 1	25	1	2	-	-	-	-	-	-	1	2
EB 2	27	1	1	-	-	-	-	-	-	1	3
LRC 2	30	-	-	1	1	-	-	-	-	-	-
MC 1	27	-	-	-	-	-	-	-	-	1	1
NF 2	24	1	33	-	-	-	-	-	-	2	3
POE PH 2	32	1	14	-	-	-	-	-	-	1	3
URC 3	16	1	3	-	-	-	-	-	-	-	-

* *f* = the frequency of occurrence of the discrepancy, in number of samples

** *n* = the number of organisms affected (by QC Lab counts)

*** *d* = the sum total of (absolute value of) differences in counts

Appendix D:

Dominant and Subdominant Species of Site Samples

Dominant and Subdominant Species of Replicate Samples: Poe Reach 2002 Annual CSBP				
SAMPLE	**Dominant Taxon**		**Subdominant Taxon**	
	species	**% composition**	**species**	**% composition**
Poe PH 1	*Baetis tricaudatus*	34.0	*Hydropsyche californica*	13.0
Poe PH 2	*Baetis tricaudatus*	26.8	*Hydropsyche californica*	14.3
Poe PH 3	*Baetis tricaudatus*	20.2	*Prosimulium sp.*	19.6
Bardee's Bar 1	*Baetis tricaudatus*	27.6	*Hydropsyche californica*	19.9
Bardee's Bar 2	*Baetis tricaudatus*	32.6	*Hydropsyche californica*	16.1
Bardee's Bar 3	*Baetis tricaudatus*	38.9	*Hydropsyche californica*	13.9
Pulga 1	*Dugesia tigrina*	25.3	*Chimarra utahensis*	14.8
Pulga 2	*Prosimulium sp.*	28.3	*Baetis tricaudatus*	12.5
Pulga 3	*Hydropsyche californica*	33.0	*Cheumatopsyche campyla*	18.6

Appendix E:

Summary of 2002 Biological Metrics based on CDFG Standard Effort: Poe Reach (NFFR)

2002 CSBP: Poe (Std Eff)	Poe PH 1	Poe PH 2	Poe PH 3	Bardee's Bar 1	Bardee's Bar 2	Bardee's Bar 3	Pulga 1	Pulga 2	Pulga 3	**Poe PH**	**Bardee's Bar**	**Pulga**	***AVERAGE***
Richness Measures													
Taxa Richness	38	34	28	29	26	27	32	26	29	**33**	**27**	**29**	***30***
EPT Taxa	14	11	11	14	10	12	12	10	11	**12**	**12**	**11**	***12***
Ephemeroptera Taxa	6	4	5	5	4	4	3	3	4	**5**	**4**	**3**	***4***
Plecoptera Taxa	2	1	1	1	2	1	1	2	2	**1**	**1**	**2**	***1***
Trichoptera Taxa	6	6	5	8	4	7	8	5	5	**6**	**6**	**6**	***6***
Diptera Taxa	8	11	8	9	9	6	9	10	9	**9**	**8**	**9**	***9***
Chironomid Taxa	4	7	4	4	5	3	6	7	5	**5**	**4**	**6**	***5***
Shannon Diversity	2.55	2.61	2.48	2.27	2.20	2.17	2.60	2.45	2.28	**2.55**	**2.21**	**2.44**	***2.40***
Brillouin Diversity	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Shannon Evenness	0.70	0.74	0.74	0.68	0.68	0.66	0.75	0.75	0.68	**0.73**	**0.67**	**0.73**	***0.71***
Est. Total # Indiv.	3780	3780	7704	2696	7296	2696	2432	3264	3672	**5088**	**4229**	**3123**	***4147***
Composition Measures													
EPT Index (%)	69.4	63.1	45.5	81.3	74.3	71.4	41.1	43.8	74.2	**59.3**	**75.7**	**53.0**	***62.7***
Sensitive EPT Index (%)	10.3	10.9	16.3	9.5	11.8	7.4	17.4	5.5	6.9	**12.5**	**9.6**	**9.9**	***10.7***
% Baetidae	36.5	27.9	21.0	31.8	34.2	40.8	9.2	12.9	10.8	**28.4**	**35.6**	**11.0**	***25.0***
% Hydropsychidae	19.7	21.8	7.5	37.4	27.6	22.3	12.5	23.2	55.2	**16.3**	**29.1**	**30.3**	***25.2***
% Dominant taxon	34.5	26.9	20.4	27.6	32.6	39.0	25.3	28.3	36.6	**27.3**	**33.1**	**30.1**	***30.1***
% Sub-dominant taxon	15.8	18.6	19.7	27.6	22.4	17.9	14.8	14.3	18.6	**18.0**	**22.6**	**15.9**	***18.9***
% Insects	85.5	90.4	89.3	90.2	86.5	87.8	56.6	95.6	90.5	**88.4**	**88.2**	**80.9**	***85.8***
Tolerance / Intolerance Measures													
% Tolerant Organisms	7.4	4.5	6.6	6.2	5.9	3.0	9.9	3.7	3.9	**6.2**	**5.0**	**5.8**	***5.7***
% Intolerant Organisms	3.9	3.2	3.1	3.0	2.6	2.1	2.6	2.6	2.6	**3.4**	**2.6**	**2.6**	***2.9***
Weighted Tolerance value	5.0	4.7	4.6	4.9	4.8	4.9	4.3	4.4	4.6	**4.8**	**4.9**	**4.4**	***4.7***
Functional Feeding Groups													
% Filterers	38.1	50.0	62.4	49.3	45.7	41.1	36.5	67.6	65.0	**50.1**	**45.4**	**56.4**	***50.6***
% Scrapers	6.5	4.2	6.9	2.7	2.0	1.2	3.3	4.4	5.6	**5.8**	**1.9**	**4.4**	***4.1***
% Collectors	44.2	34.0	22.6	37.1	40.5	44.6	17.4	18.8	17.3	**33.6**	**40.7**	**17.8**	***30.7***
% Shredders	0.3	0.0	0.3	0.3	0.0	0.3	0.0	0.0	0.0	**0.3**	**0.3**	**0.0**	***0.3***
% Predators	6.5	5.8	6.6	7.4	9.2	11.0	30.9	5.1	11.1	**6.3**	**9.2**	**15.7**	***10.4***

Appendix F:

Statistical Analyses of 2002 Biological Metrics: Poe Reach (NFFR)

WITHIN Poe Reach Analysis:

The "WITHIN Poe Reach" analysis was performed to determine if there are significant differences between the Pulga and Poe PH sites with regards to their taxa richness, Brillouin diversity, and estimated totals. First, a separate analysis was run for each of the three response variables (taxa richness, Brillouin diversity, and estimated totals). Please note there were not enough degrees of freedom to include the interaction term (Site x Sample) in the model. Pulga and Poe PH were the only sites included in this analysis, so the p-value for "Site" is actually testing for any difference between the two sites (Pulga and Poe PH). The factor "Sample" was included in the model to potentially reduce the error variability, which in turn allows for easier detection of site differences.

By looking at the following output, you can see the p-value for 'Site' is greater than the significance level of 0.05 in each analysis. Using taxa richness as the response variable generated a 'Site' p-value of 0.341, which indicates there is no significant difference between the Pulga and Poe PH sites in regards to their taxa richness. Using Brillouin diversity as the response variable generated a "Site" p-value of 0.378, which indicates there is no significant difference between the Pulga and Poe PH sites in regards to their Brillouin diversity. Using estimated totals as the response variable generated a 'Site' p-value of 0.205, which indicates there is no significant difference between the Pulga and Poe PH sites in regards to their estimated totals.

General Linear Model: Taxa Richness versus Site, Sample

Analysis of Variance for Taxa Richness, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Site	1	20.17	20.17	20.17	1.53	**0.341**
Sample	2	72.33	72.33	36.17	2.75	0.267
Error	2	26.33	26.33	13.17		
Total	5	118.83				

General Linear Model: Brillouin Diversity versus Site, Sample

Analysis of Variance for Diversity, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Site	1	0.01707	0.01707	0.01707	1.26	**0.378**
Sample	2	0.07210	0.07210	0.03605	2.67	0.273
Error	2	0.02703	0.02703	0.01352		
Total	5	0.11620				

General Linear Model: Estimated Totals versus Site, Sample

Analysis of Variance for Est. Totals, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Site	1	5793803	5793803	5793803	3.43	**0.205**
Sample	2	7687557	7687557	3843779	2.28	0.305
Error	2	3376389	3376389	1688195		
Total	5	16857749				

There is a school of thought that would suggest the inclusion of all response variables in one multivariate analysis to account for potential correlations among the response variables, which cannot be revealed by the univariate analyses given above. The following output was generated using taxa richness, Brillouin diversity, and estimated totals as the response variables (dependent variables) and Site as the factor (independent variable). There were not enough degrees of freedom to include Sample or the interaction term (Site x Sample) in the model. Again, Pulga and Poe PH were the only sites included in this analysis, so the p-values are actually testing for any difference between the two sites (Pulga and Poe PH). The p-values of 0.105 indicate there is no significant difference between the Pulga and Poe PH sites in regards to their taxa richness, Brillouin diversity, and estimated totals. The output labeled "Partial Correlations for the Error SSCP Matrix" can be used to assess how related the response variables are. These are the correlations among the residuals or, equivalently, the correlations among the responses conditioned on the model. Examine the off-diagonal elements (bold). The partial correlations between taxa richness and Brillouin diversity of 0.51905 and between taxa richness and estimated totals of −0.94015 and between Brillouin diversity and estimated totals of −0.57182 are relatively large. Because the correlation structure is moderate to strong, the multivariate analysis does seem more appropriate than the univariate analyses, although the final conclusion was the same either way (univariate or multivariate).

The output labeled "EIGEN Analysis for Site" can be used to assess how the response means differ between the Pulga and Poe PH sites. Place the highest importance on the eigenvectors that correspond to high eigenvalues. Eigenvectors corresponding to zero eigenvalues are meaningless. The highest absolute value (bold) within the eigenvector is for the response Brillouin diversity. This implies that the Brillouin diversity means has the largest difference between the Pulga and Poe PH sites. Taxa richness have the next largest difference between the Pulga and Poe PH sites and the estimated totals means have very small differences between the Pulga and Poe PH sites. This is found by looking at Eigenvector 1 corresponding to the only non-zero eigenvalue.

ANOVA: Taxa Richness, Brillouin Diversity, Estimated Totals versus Site

```
MANOVA for Site                    s =  1     m =  0.5     n =     0.0

Criterion         Test Statistic          F              DF          P
Wilk's                   0.07098      8.726    (  3,      2)  0.105
Lawley-Hotelling        13.08917      8.726    (  3,      2)  0.105
Pillai's                 0.92902      8.726    (  3,      2)  0.105
Roy's                   13.08917

Partial Correlations for the Error SSCP Matrix

          Taxa Ric  Diversit  Est. Tot
Taxa Ric   1.00000   0.51905  -0.94015
Diversit   0.51905   1.00000  -0.57182
Est. Tot  -0.94015  -0.57182   1.00000

EIGEN Analysis for Site

Eigenvalue     13.089     0.0000     0.0000
Proportion      1.000     0.0000     0.0000
Cumulative      1.000     1.0000     1.0000

Eigenvector         1          2          3
Taxa Ric     0.27808      0.098      0.027
Diversit     1.32261     -3.367      1.402
Est. Tot     0.00091      0.000     -0.000
```

AMONG Reaches Analysis:

The "AMONG Reaches" analysis was performed to determine if there are significant differences among the Rock Creek, Cresta, and Poe reaches with regards to their taxa richness, Brillouin diversity, estimated totals, % dominant taxon, weighted tolerance, and % predator. First, a separate analysis was run for each of the six response variables (taxa richness, Brillouin diversity, estimated totals, % dominant taxon, weighted tolerance, and % predator). There are three sites in the Rock Creek and Poe reaches and two sites in the Cresta reach, which were used in this analysis. The factors "Site within Reach" and "Sample" were included in the model to potentially reduce the error variability, which in turn allows for easier detection of reach differences. The factor "Sample" was found to not contribute significantly to the model and was therefore removed.

By looking at the following output, you can see the p-value for Reach is greater than the significance level of 0.05 in the analyses using taxa richness, % dominant taxon, and % predator as the response variable. The p-value for Reach is less than the significance level of 0.05 in the analyses using Brillouin diversity, estimated totals, and weighted tolerance. Using taxa richness as the response variable generated a p-value of 0.517, which indicates there is no significant difference among the reaches (Rock Creek, Cresta, and Poe) in regards to their taxa richness. Using Brillouin diversity as the response variable generated a p-value of 0.041, which indicates there are significant differences among the reaches in regards to their Brillouin diversity. The Tukey's multiple comparison test (MCT) results show that the Poe reach has significantly higher Brillouin diversity compared to the Rock Creek reach. Using estimated totals as the response variable generated a p-value of 0.023, which indicates there are significant differences among the reaches in regards to their estimated totals. The Tukey's MCT results show that the Cresta reach has significantly higher estimated totals compared to the Poe reach. Using % dominant taxon as the response variable generated a p-value of 0.233, which indicates there is no significant difference among the reaches in regards to their % dominant taxon. Using weighted tolerance as the response variable generated a p-value of 0.000, which indicates there are significant differences among reaches in regards to their weighted tolerance. The Tukey's MCT results show that the Rock Creek and Cresta reaches have significantly higher weighted tolerance compared to the Poe reach. Using % predators as the response variable generated a p-value of 0.120, which indicates there is no significant difference among reaches in regards to their % predators.

General Linear Model: <u>Taxa Richness</u> versus Reach, Site

Analysis of Variance for Taxa Richness, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Reach	2	34.74	34.74	17.37	0.69	**0.517**
Site(Reach)	5	452.22	452.22	90.44	3.58	0.023
Error	16	404.00	404.00	25.25		
Total	23	890.96				

General Linear Model: <u>Brillouin Diversity</u> versus Reach, Site

Analysis of Variance for Diversity, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Reach	2	0.8842	0.8842	0.4421	3.91	**0.041**
Site(Reach)	5	3.3672	3.3672	0.6734	5.96	0.003
Error	16	1.8094	1.8094	0.1131		
Total	23	6.0609				

```
Tukey Simultaneous Tests
Response Variable Brillouin Diversity
All Pairwise Comparisons among Levels of Reach

Reach = Cresta subtracted from:

Level       Difference       SE of                  Adjusted
Reach         of Means   Difference    T-Value       P-Value
```

Poe	0.35444	0.1772	1.9998	0.1444
Rock Cre	-0.06444	0.1772	-0.3636	0.9300

Reach = Poe subtracted from:

Level Reach	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Rock Cre	-0.4189	0.1585	-2.642	**0.0444**

General Linear Model: Estimated Totals versus Reach, Site

Analysis of Variance for Est. Tot, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Reach	2	33603195	33603195	16801597	4.84	**0.023**
Site(Reach)	5	46638163	46638163	9327633	2.69	0.060
Error	16	55580493	55580493	3473781		
Total	23	135821851				

Tukey Simultaneous Tests
Response Variable Estimated Totals
All Pairwise Comparisons among Levels of Reach

Reach = Cresta subtracted from:

Level Reach	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Poe	-3017	982.3	-3.072	**0.0189**
Rock Cre	-2194	982.3	-2.234	0.0957

Reach = Poe subtracted from:

Level Reach	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Rock Cre	823.3	878.6	0.9371	0.6255

General Linear Model: % Dominant Taxon versus Reach, Site

Analysis of Variance for Dom. Tax, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Reach	2	229.18	229.18	114.59	1.60	**0.233**
Site(Reach)	5	1654.34	1654.34	330.87	4.61	0.009
Error	16	1148.47	1148.47	71.78		
Total	23	3031.99				

General Linear Model: Weighted Tolerance versus Reach, Site

Analysis of Variance for Wgt. Tol, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Reach	2	1.61611	1.61611	0.80806	24.55	**0.000**
Site(Reach)	5	0.45722	0.45722	0.09144	2.78	0.054
Error	16	0.52667	0.52667	0.03292		
Total	23	2.60000				

Tukey Simultaneous Tests
Response Variable Weighted Tolerance
All Pairwise Comparisons among Levels of Reach

Reach = Cresta subtracted from:

Level Reach	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Poe	-0.4056	0.09562	-4.241	0.0017
Rock Cre	0.1833	0.09562	1.917	0.1660

Reach = Poe subtracted from:

Level Reach	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Rock Cre	0.5889	0.08553	6.885	0.0000

General Linear Model: % Predators versus Reach, Site

Analysis of Variance for % Predat, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Reach	2	202.38	202.38	101.19	2.43	0.120
Site(Reach)	5	360.73	360.73	72.15	1.73	0.184
Error	16	666.22	666.22	41.64		
Total	23	1229.33				

There is a school of thought that would suggest the inclusion of all response variables in one multivariate analysis to account for potential correlations among the response variables, which cannot be revealed by the univariate analyses given above. The following output was generated using taxa richness, Brillouin diversity, estimated totals, % dominant taxon, weighted tolerance, and % predator as the response variables (dependent variables) and Reach and Site(Reach) as the factors (independent variables). The p-values of 0.000 indicate there are significant differences among the reaches in regards to their taxa richness, Brillouin diversity, estimated totals, % dominant taxon, weighted tolerance, and % predator. The output labeled "Partial Correlations for the Error SSCP Matrix" can be used to assess how related the response variables are. These are the correlations among the residuals or, equivalently, the correlations among the responses conditioned on the model. Examine the off-diagonal elements (bold). The partial correlations vary between weak and strong. Because the correlation structure has at least one strong correlation component, the multivariate analysis does seem more appropriate than the univariate analyses. Although, there are always trade-offs, namely that the power of the test decreases as the number of response variables increase. This does not seem to be a problem here though.

The output labeled "EIGEN Analysis for Reach" can be used to assess how the response means differ among the reaches. The highest absolute values (bold) within these eigenvectors is for the response weighted tolerance. This implies that the weighted tolerance means has the largest differences among the reaches. Brillouin diversity have the next largest differences among the reaches and so on.

General Linear Model: Taxa Richness, Diversity, ... versus Reach, Site

MANOVA for Reach   s = 2   m = 1.5   n = 4.5

Criterion	Test Statistic	F	DF		P
Wilk's	0.05036	6.336	(12,	22)	0.000
Lawley-Hotelling	9.34496	7.787	(12,	20)	0.000
Pillai's	1.42862	5.001	(12,	24)	0.000
Roy's	8.18273				

Partial Correlations for the Error SSCP Matrix

	Taxa Ric	Diversit	Est. Tot	Dom. Tax	Wgt. Tol	% Predat
Taxa Ric	1.00000	0.59536	-0.71890	-0.02114	0.17139	0.35511
Diversit	**0.59536**	1.00000	-0.56346	-0.72755	-0.28580	0.22493
Est. Tot	**-0.71890**	**-0.56346**	1.00000	0.08112	-0.07590	-0.17301
Dom. Tax	**-0.02114**	**-0.72755**	**0.08112**	1.00000	0.52615	-0.10323
Wgt. Tol	**0.17139**	**-0.28580**	**-0.07590**	**0.52615**	1.00000	0.45965

% Predat	**0.35511**	**0.22493**	**-0.17301**	**-0.10323**	**0.45965**	1.00000

EIGEN Analysis for Reach

Eigenvalue	8.1827	1.1622	0.00000	0.00000	0.00000	0.00000
Proportion	0.8756	0.1244	0.00000	0.00000	0.00000	0.00000
Cumulative	0.8756	1.0000	1.00000	1.00000	1.00000	1.00000

Eigenvector	1	2	3	4	5	6
Taxa Ric	-0.028	0.061	-0.020	0.050	-0.043	0.036
Diversit	0.579	-0.032	0.274	-1.791	1.050	0.240
Est. Tot	-0.000	0.000	0.000	-0.000	0.000	-0.000
Dom. Tax	0.037	-0.003	0.011	-0.063	-0.000	-0.000
Wgt. Tol	**-1.922**	**-0.317**	0.253	-0.114	0.459	0.340
% Predat	0.037	-0.007	0.035	0.007	-0.004	-0.001

AMONG Years Analysis:

The "AMONG Years" analysis was performed to determine if there are significant differences among the years 1999, 2000, 2001, and 2002 at the Pulga site with regards to their taxa richness, Brillouin diversity, and estimated totals. First, a separate analysis was run for each of the three response variables (taxa richness, Brillouin diversity, and estimated totals). Again, the factor "Sample" was found to not contribute significantly to the model and was therefore not included in the model.

By looking at the following output, you can see the p-value for Year is greater than the significance level of 0.05 when using taxa richness or estimated totals as the response variable, whereas the p-value for Year is less than the significance level of 0.05 when using Brillouin diversity as the response variable. Using taxa richness as the response variable generated a p-value of 0.271, which indicates there is no significant difference among the years (1999 through 2002) in regards to their taxa richness. Using Brillouin diversity as the response variable generated a p-value of 0.019, which indicates there are significant differences among the years in regards to their Brillouin diversity. The Tukey's MCT results showed the year 2000 having significantly greater Brillouin diversity compared to the years 1999 and 2002 at the Pulga site. Using estimated totals as the response variable generated a p-value of 0.170, which indicates there is no significant difference among the years in regards to their estimated totals.

General Linear Model: Taxa Richness versus Year

```
Analysis of Variance for Taxa Richness, using Adjusted SS for Tests

Source     DF     Seq SS     Adj SS     Adj MS       F      P
Year        3     177.67     177.67      59.22    1.57  0.271
Error       8     302.00     302.00      37.75
Total      11     479.67
```

General Linear Model: Brillouin Diversity versus Year

```
Analysis of Variance for Diversit, using Adjusted SS for Tests

Source     DF     Seq SS     Adj SS     Adj MS       F      P
Year        3    0.83313    0.83313    0.27771    6.03  0.019
Error       8    0.36847    0.36847    0.04606
Total      11    1.20160

Tukey Simultaneous Tests
Response Variable Brillouin Diversity
All Pairwise Comparisons among Levels of Year

Year = 1999 subtracted from:

Level    Difference       SE of              Adjusted
Year       of Means  Difference   T-Value     P-Value
2000        0.59667      0.1752    3.4050      0.0376
2001        0.28667      0.1752    1.6359      0.4127
2002       -0.07000      0.1752   -0.3995      0.9770

Year = 2000 subtracted from:

Level    Difference       SE of              Adjusted
Year       of Means  Difference   T-Value     P-Value
2001        -0.3100      0.1752    -1.769      0.3527
2002        -0.6667      0.1752    -3.805      0.0217

Year = 2001 subtracted from:

Level    Difference       SE of              Adjusted
Year       of Means  Difference   T-Value     P-Value
```

2002	-0.3567	0.1752	-2.035	0.2522

General Linear Model: Estimated Totals versus Year

Analysis of Variance for Estimated Totals, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Year	3	9198532	9198532	3066177	2.17	0.170
Error	8	11309376	11309376	1413672		
Total	11	20507908				

There is a school of thought that would suggest the inclusion of all response variables in one multivariate analysis to account for potential correlations among the response variables, which cannot be revealed by the univariate analyses given above. The following output was generated using taxa richness, Brillouin diversity, and estimated totals as the response variables (dependent variables) and Year as the factor (independent variable). Again, the Pulga site is the only site included in this analysis. The p-values of 0.096, 0.123, and 0.087 indicate there are no significant differences among the years (1999 through 2002) in regards to their taxa richness, Brillouin diversity, and estimated totals. The output labeled "Partial Correlations for the Error SSCP Matrix" can be used to assess how related the response variables are. These are the correlations among the residuals or, equivalently, the correlations among the responses conditioned on the model. Examine the off-diagonal elements (bold). The partial correlations between taxa richness and Brillouin diversity of 0.78745 and between taxa richness and estimated totals of –0.21261 and between Brillouin diversity and estimated totals of –0.35983 vary between weak and strong. Because the correlation structure has at least one strong correlation component, the multivariate analysis does seem more appropriate than the univariate analyses. The final conclusions based on the univariate analyses and the multivariate analysis are not the same. The univariate analyses using taxa richness and estimated totals showed no significant differences among the years, but the univariate analysis using Brillouin diversity did show significant differences among the years. Now the multivariate analysis including all three responses shows no significant differences among the years. These opposing conclusions can occur when the correlation of variables differs in its sign within and among groups. Thus, more faith should be placed in the results of the multivariate analysis.

The output labeled "EIGEN Analysis for Year" can be used to assess how the response means differ among the years. The highest absolute values (bold) within these eigenvectors is for the response Brillouin diversity. This implies that the Brillouin diversity means have the largest differences among the years. Taxa richness have the next largest differences among the years and the estimated totals means have very small differences among the years.

General Linear Model: Taxa Richness, Diversity, Est. Totals versus Year

MANOVA for Year s = 3 m = -0.5 n = 2.0

Criterion	Test Statistic	Approx F	DF		P
Wilk's	0.13020	2.149	(9,	14)	**0.096**
Lawley-Hotelling	3.79723	1.969	(9,	14)	**0.123**
Pillai's	1.27991	1.984	(9,	24)	**0.087**
Roy's	2.93741				

Partial Correlations for the Error SSCP Matrix

	Taxa Ric	Diversit	Est. Tot
Taxa Ric	1.00000	0.78745	-0.21261
Diversit	**0.78745**	1.00000	-0.35983
Est. Tot	**-0.21261**	**-0.35983**	1.00000

EIGEN Analysis for Year

Eigenvalue	2.9374	0.7366	0.12326
Proportion	0.7736	0.1940	0.03246
Cumulative	0.7736	0.9675	1.00000

Eigenvector	1	2	3
Taxa Ric	-0.04582	-0.01717	0.0803
Diversit	**2.57496**	**0.60946**	**-0.9765**
Est. Tot	0.00006	0.00031	0.0001

Appendix G:

Coefficients of Variation (CVs) for Within-Site, Among-Site, and Among-Year Comparisons

2002 CSBP: Poe Reach

Coefficients of Variation (CVs)	*CVs within sites (2002)* Poe PH	Bardee's Bar	Pulga	*CV among sites (2002)* All	*CVs among years (1999/2000-2002)* Poe PH	Bardee's Bar	Pulga
Richness Measures							
Taxa Richness	15.6%	1.7%	8.8%	15.0%	31.4%	18.9%	19.8%
EPT Taxa	17.6%	18.4%	12.4%	13.1%	65.4%	27.0%	37.3%
Ephemeroptera Taxa	20.4%	12.4%	17.3%	44.5%	49.6%	44.5%	51.6%
Plecoptera Taxa	43.3%	43.3%	34.6%	23.1%	165.9%	98.3%	84.4%
Trichoptera Taxa	15.7%	32.8%	31.5%	4.5%	59.9%	14.3%	18.6%
Diptera Taxa	22.2%	10.0%	16.4%	20.4%	50.3%	25.2%	35.2%
Chironomid Taxa	36.5%	28.6%	27.2%	31.5%	39.0%	32.7%	23.3%
Shannon Diversity	3.3%	3.5%	5.7%	10.3%	20.1%	12.1%	14.1%
Brillouin Diversity	2.8%	3.5%	5.6%	9.5%	19.4%	11.5%	13.9%
Shannon Evenness	2.6%	3.5%	4.5%	6.7%	14.8%	7.7%	9.5%
Est. Total # Indiv.	44.5%	62.8%	20.2%	41.2%	70.8%	37.8%	48.3%
Composition Measures							
EPT Index (%)	21.1%	6.7%	34.7%	32.5%	8.4%	22.3%	31.4%
Sensitive EPT Index (%)	13.4%	12.8%	19.2%	18.0%	124.6%	147.0%	105.4%
% Baetidae	26.7%	12.9%	16.7%	87.8%	38.5%	22.7%	27.0%
% Hydropsychidae	47.1%	26.4%	73.4%	53.9%	51.0%	49.9%	50.4%
% Dominant taxon	25.4%	17.1%	13.4%	18.0%	60.4%	26.3%	54.0%
% Sub-dominant taxon	22.3%	18.0%	20.2%	7.6%	23.9%	12.2%	27.6%
% Insects	2.9%	2.1%	26.2%	8.6%	10.1%	5.8%	14.5%
Tolerance / Intolerance Measures							
% Tolerant Organisms	12.2%	14.8%	91.7%	69.4%	20.6%	22.2%	27.5%
% Intolerant Organisms	16.3%	17.6%	1.1%	31.0%	103.6%	131.5%	91.9%
Weighted Tolerance Value	4.2%	1.4%	4.3%	6.2%	10.9%	10.1%	8.7%
Functional Feeding Groups							
% Filterers	24.9%	9.2%	30.6%	19.1%	29.2%	11.8%	26.2%
% Scrapers	25.7%	38.2%	25.6%	84.5%	56.5%	134.3%	46.6%
% Collectors	32.2%	8.2%	6.9%	66.4%	36.8%	21.8%	51.1%
% Shredders	35.5%	96.2%	173.2%	62.8%	222.0%	201.5%	209.3%
% Predators	10.4%	15.4%	90.1%	80.3%	69.5%	19.1%	68.9%

Appendix H:

Summary of 1999-2001 CSBP Metrics for the Poe Reach

1999 CSBP: Poe	Pulga 1	Pulga 2	Pulga 3	**Pulga**
Richness Measures				
Taxa Richness	38	33	36	**35.7**
EPT Taxa	17	15	16	**16.0**
Ephemeroptera Taxa	5	5	5	**5.0**
Plecoptera Taxa	3	4	4	**3.7**
Trichoptera Taxa	9	6	7	**7.3**
Diptera Taxa	11	11	12	**11.3**
Chironomid Taxa	7	8	8	**7.7**
Shannon Diversity	2.67	2.46	2.81	**2.65**
Brillouin Diversity	3.60	3.36	3.80	**3.59**
Shannon Evenness	0.74	0.70	0.79	**0.74**
Est. Total # Indiv.	7344	4440	3624	**5136**
Composition Measures				
EPT Index (%)	79.7	79.7	68.9	**76.1**
Sensitive EPT Index (%)	9.2	4.9	4.6	**6.2**
% Baetidae	8.5	13.0	10.3	**10.6**
% Hydropsychidae	51.3	53.5	34.1	**46.3**
% Dominant taxon	24.2	27.8	17.5	**23.2**
% Sub-dominant taxon	19.6	16.5	15.9	**17.3**
% Insects	92.8	95.4	93.4	**93.9**
Tolerance / Intolerance Measures				
% Tolerant Organisms	5.2	4.3	6.3	**5.3**
% Intolerant Organisms	8.8	4.6	5.0	**6.1**
Weighted Tolerance value	4.4	4.7	4.8	**4.7**
Functional Feeding Groups				
% Filterers	62.7	65.9	59.3	**62.7**
% Scrapers	8.2	3.8	5.0	**5.6**
% Collectors	18.0	23.0	21.2	**20.7**
% Shredders	0.0	0.0	0.0	**0.0**
% Predators	5.9	5.1	7.9	**6.3**

2000 CSBP: Poe	Poe PH 1	Poe PH 2	Poe PH 3	Bardee's Bar 1	Bardee's Bar 2	Bardee's Bar 3	Pulga 1	Pulga 2	Pulga 3	**Poe PH**	**Bardee's Bar**	**Pulga**	**AVERAGE**
Richness Measures													
Taxa Richness	38	25	41	28	39	31	40	38	58	**35**	**33**	**45**	**38**
EPT Taxa	20	13	19	16	18	15	17	17	22	**17**	**16**	**19**	**17**
Ephemeroptera Taxa	7	6	7	6	6	5	5	6	7	**7**	**6**	**6**	**6**
Plecoptera Taxa	3	2	2	5	4	3	2	4	5	**2**	**4**	**4**	**3**
Trichoptera Taxa	10	5	10	5	8	7	10	7	10	**8**	**7**	**9**	**8**
Diptera Taxa	6	4	9	6	10	8	11	10	18	**6**	**8**	**13**	**9**
Chironomid Taxa	5	1	6	4	7	4	9	7	14	**4**	**5**	**10**	**6**
Shannon Diversity	3.04	2.63	2.94	2.39	2.68	2.46	3.05	2.90	3.39	**2.87**	**2.51**	**3.11**	**2.83**
Brillouin Diversity	4.10	3.59	3.94	3.26	3.60	3.34	4.12	3.93	4.50	**3.88**	**3.40**	**4.18**	**3.82**
Shannon Evenness	0.84	0.82	0.79	0.72	0.73	0.72	0.83	0.80	0.83	**0.82**	**0.72**	**0.82**	**0.79**
Est. Total # Indiv.	1402	3432	2248	7968	1025	7416	2560	3972	2440	**2361**	**5470**	**2991**	**3607**
Composition Measures													
EPT Index (%)	61.6	50.0	70.5	83.4	75.6	77.3	55.6	66.2	63.6	**60.7**	**78.8**	**61.8**	**67**
Sensitive EPT Index (%)	3.8	8.4	3.6	9.9	5.0	6.8	4.1	8.8	7.2	**5.2**	**7.3**	**6.7**	**6**
% Baetidae	20.2	23.1	24.6	29.8	38.8	17.8	17.2	11.8	10.2	**22.6**	**28.8**	**13.0**	**21**
% Hydropsychidae	25.0	7.0	29.9	19.3	13.0	39.2	16.3	27.2	29.5	**20.6**	**23.8**	**24.3**	**23**
% Dominant taxon	13.4	18.2	17.4	25.9	28.1	23.3	14.1	16.6	11.8	**16.3**	**25.8**	**14.2**	**19**
% Sub-dominant taxon	11.0	15.0	15.7	23.5	15.7	17.5	13.1	12.4	10.2	**13.9**	**18.9**	**11.9**	**15**
% Insects	79.8	71.7	86.1	95.2	87.0	93.2	83.8	82.8	82.0	**79.2**	**91.8**	**82.8**	**85**
Tolerance / Intolerance Measures													
% Tolerant Organisms	11.0	6.3	9.6	3.0	7.0	1.0	6.6	2.4	7.9	**9.0**	**3.7**	**5.6**	**6**
% Intolerant Organisms	6.5	8.4	6.0	9.9	5.4	6.8	6.3	9.4	8.5	**7.0**	**7.4**	**8.0**	**7**
Weighted Tolerance value	4.9	4.7	4.8	4.5	5.0	4.6	5.1	4.5	4.7	**4.8**	**4.7**	**4.7**	**4.8**
Functional Feeding Groups													
% Filterers	36.6	41.3	43.8	52.1	35.8	62.5	43.4	51.7	47.2	**40.6**	**50.1**	**47.4**	**46**
% Scrapers	11.3	6.3	9.6	8.4	6.0	5.2	5.0	4.5	10.2	**9.1**	**6.5**	**6.6**	**7**
% Collectors	30.5	26.9	32.0	30.1	44.5	21.0	35.3	22.7	27.5	**29.8**	**31.9**	**28.5**	**30**
% Shredders	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.3	**0.0**	**0.1**	**0.2**	**0**
% Predators	19.9	25.5	13.5	8.7	12.7	11.0	11.9	19.9	14.1	**19.6**	**10.8**	**15.3**	**15**

POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX E3-8

Results of Preliminary Surveys for Foothill Yellow-Legged Frogs and an Evaluation of the Effects of Test Flows on Foothill Yellow-Legged Frogs and Associated Habitat, Along the North Fork Feather River Within the Poe Project Area

Results of Preliminary Surveys for Foothill Yellow-Legged Frogs (*Rana boylii*), And An Evaluation of the Effects of Test Flows on Foothill Yellow-Legged Frogs and Associated Habitat, Along the North Fork Feather River Within the Poe Project Area

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April
2001

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1.0 INTRODUCTION

Pacific Gas and Electric Company's Poe Project (FERC License No. 2107) is located on the North Fork Feather River (NFFR), near Pulga, California. Water is diverted from the NFFR at Poe Reservoir and transported through a tunnel and penstocks to Poe Powerhouse (PH), approximately 7.6 miles downstream. The Poe Project is an integral part of the Licensee's hydroelectric development in the NFFR drainage and is hydraulically coordinated with flow from the Licensee's Upper NFFR Project (FERC 2105), Bucks Creek Project (FERC 619), and the Rock Creek-Cresta Project (FERC 1962), as well as with flow from the NFFR and its tributaries. During normal operations, the NFFR powerhouses are typically scheduled to meet load during peak periods when energy values are highest. During wet months, the powerhouses are operated at full capacity to utilize available water and minimize spilling. During periods with decreased flows, the powerhouses are operated primarily with water from Licensee's main upstream storage reservoir, Lake Almanor.

The Poe Project is located on the west slope of the Sierra Nevada in northern California. The Project area is entirely within Butte County, with Plumas County to the east and Tehama County to the west. Portions of Plumas National Forest and Lassen National Forest occur adjacent to or within the Poe Project area. Elevations in the Project range from approximately 900 ft (290 meters) at Big Bend Dam up to approximately 1,400 ft (450 meters) at Poe Dam.

1.1 Background

This report addresses the results of preliminary surveys for amphibians within the Poe Project area, and an evaluation of the effects of test flows on foothill yellow-legged frogs (*Rana boylii*) (FYLF) occurring along the NFFR. The initial survey efforts were directed towards determining presence of amphibians in the Project area, and were not species-specific for FYLF. However, based on the observed presence of FYLF along the NFFR and in selected tributaries, subsequent surveys and monitoring efforts were focused on FYLF. The FYLF is a federal and state species of concern and is designated as sensitive by the U.S. Forest Service for Region 5.

Specific locations within the Project area included in this study were:

- NFFR in the vicinity of Flea Valley Creek (FVC),
- NFFR at Bardee's Bar,
- NFFR approximately ½-mile upstream of Poe PH,
- NFFR at Poe PH,
- FVC,
- Mill Creek, and
- Perennial unnamed tributary to the NFFR, downstream of Bardee's Bar.

2.0 SPECIAL-STATUS SPECIES

2.1 Foothill Yellow-Legged Frog (*Rana boylii*)

Status:	*Federal*	Species of Concern
	State	Protected/Species of Special Concern
	Forest Service	Sensitive

Distribution: The FYLF occurs in the Coast Ranges from the Oregon border south to the Transverse Mts. in Los Angeles Co., in most of northern California west of the Sierra Cascade crest, and along the Coast Ranges north of Monterey. Livezey (1963) reported an isolated population in San Joaquin Co. on the floor of the Central Valley. Its elevation range extends from sea level to 5,000 ft or higher (1,548 m +) in the Sierras.

Habitat Requirements: The FYLF is found in or near rocky streams in a variety of habitats, including valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, ponderosa pine, mixed conifer, coastal scrub, mixed chaparral, and wet meadow types. FYLF require shallow, flowing water in small to moderate streams with some cobble-sized substrate. This species has also been found in streams lacking a cobble or larger sized substrate (Fitch, 1938; Zweifel, 1955), but it is unknown if these habitats are regularly used (Hayes and Jennings, 1988). FYLF require sunny and partly shaded banks for basking. Adults are usually found in close proximity to water and prefer riffle or cascade/pool areas with rocky banks.

Adults often bask on exposed rock surfaces near streams. When disturbed, they dive into the water and take refuge among stones, silt, or vegetation (Stebbins, 1985). During periods of inactivity, especially during cold weather, individuals seek cover under rocks in streams or on shore within a few meters of water. FYLF are infrequent or absent in habitats where introduced aquatic predators (i.e., Centrarchid fish species, and bullfrogs) are present (Jennings and Hayes, 1994).

Life History: Adult frogs are primarily diurnal and occupy home ranges of less than 33 ft (10 m) in diameter; however, adult frogs may move greater distances to breed. Frogs may be active all year in the warmest localities, but may become inactive or hibernate in colder areas. Significant seasonal movements or migrations from breeding areas have not been reported. Nussbaum et al. (1983) found frogs underground and beneath surface objects more than 50 m (155 ft) from water in April. These frogs probably spend most of their time in or near streams at all seasons.

Egg laying follows the period of high-flow discharge associated with winter rainfall and snowmelt, usually between late March and early June (Storer, 1925; Grinnell et al., 1930; Wright and Wright, 1949; unpubl. data). Females deposit eggs in clusters of 300-1,200 attached on the downstream side of cobbles and boulders over which a gentle flow of water exists (Storer, 1925; Fitch, 1936; Zweifel, 1955). Eggs hatch in about 5-30 days (depending on water temperature), and tadpoles metamorphose in 3 to 4 months. Tadpoles are infrequently observed because they are cryptic against the substrates of rocky pools in which they occur. Like all frogs, tadpoles are herbivorous (probably feeding on algae and diatoms) and switch to carnivory after metamorphosis. Although no data are available regarding longevity, two years are thought to be required to reach adult size (Storer, 1925). Adults prey on terrestrial and aquatic insects, crustaceans and molluscs. The daily and seasonal movement ecology and behavior of adult FYLF is essentially unknown.

The FYLF coexists with the Cascades frog and the red-legged frog at some localities, but different microhabitat preferences likely diminish competition. Moyle (1973) implicated the bullfrog in the observed reduction of FYLF populations in the Sierra. Centrarchid fishes readily eat Ranid eggs (Werschkul and Christensen, 1977), and, where introduced into foothill streams, may also contribute to the elimination of FYLF.

2.1.1 Occurrence in the Project Area

In the Poe Project area, FYLF were initially observed on both Mill Creek and FVC during electrofishing surveys in August 1999 (Pacific Gas and Electric Company, 1999). Tadpoles, juveniles, and adults were documented in both creeks. FYLF were also documented during the spring and summer of 2000 at multiple locations along the NFFR within the Project area (Pers. Com., Stuart Moock, 2000; Craig Seltenrich, 2000). These locations are: 1) at the mouth of Mill Creek, and downstream of the mouth of Mill Creek; 2) in the vicinity of the mouth of FVC, and downstream of the mouth of FVC; 3) Bardee's Bar; 4) approximately ½ mile upstream of the Poe PH; and 5) adjacent to the Poe PH. Sightings at these locations included tadpoles, metamorphs (transforming tadpoles), juveniles, subadults, and adults.

In April 2000, Ron Jackman of Garcia and Associates observed an adult FYLF at a stream crossing along Bardee's Bar Road. During whitewater test flows in May 2000, Pacific Gas and Electric Company biologists and kayakers observed FYLF tadpoles and adults along portions of the NFFR. Surveys conducted by Craig Seltenrich of Pacific Gas and Electric Company in June 2000 confirmed presence of adult and subadult FYLF on FVC. Additional occurrences of FYLF have been reported on FVC (Paul Kubicek, Pacific Gas and Electric Company, 2000, personal communication; Stuart Moock, Pacific Gas and Electric Company, 2000, personal communication). These sightings were documented during fisheries surveys on FVC, and included subadult and adult frogs. Juvenile, subadult, and adult FYLF were observed again along the NFFR in October 2000. Surveys conducted on December 8, 2000, documented very few juvenile or subadult FYLF at sites along the NFFR. During the December 2000 surveys, frogs were not observed anywhere on FVC. Both of these later surveys were conducted by Craig Seltenrich (Senior Aquatic Biologist, Pacific Gas and Electric Company) and Alicia Pool (Wildlife Ecologist, EA Engineering).

3.0 METHODS

Preliminary surveys were conducted in August and September 2000 to determine: presence, general distribution, and approximate numbers and life stage of amphibians (especially FYLF), at selected locations along the NFFR between Poe Dam and Poe Powerhouse; and in several perennial tributaries. Survey sites and monitoring stations were chosen primarily based on recent FYLF sightings along the NFFR, including observations obtained during whitewater test flows conducted in May 2000. Additionally, some sites were included because they were representative of the range and distribution of suitable habitat for FYLF present within the Project area.

Tributaries surveyed within the Project area were not used for monitoring and evaluating the potential effects of test flows on amphibians along the NFFR.

3.1 NFFR Surveys

Initial amphibian surveys were conducted at several different locations along the NFFR where FYLF had been observed during the summer of 2000. Visual encounter surveys were conducted following basic survey techniques as described in Lind (1997). These surveys were performed on August 30 and 31, and on September 1, 2000, by Craig Seltenrich and Alicia Pool. The species targeted for this study was FYLF because of known occurrences along the NFFR within the Project area. Based on the results of the initial surveys, the following sites on the NFFR were chosen for monitoring the effects of test flows on FYLF:

- Site 1 – the area around the mouth of FVC,
- Site 2 - Bardee's Bar area,
- Site 3 – the swimmer's beach area approximately ½ mile upstream of Poe PH, and
- Site 4 – the side channel adjacent to Poe PH.

Aquatic habitat features, approximate numbers and distribution of FYLF observed, upland habitat, and other important habitat parameters were collected at all sites along the NFFR. During the initial site surveys along the NFFR, discreet stations (transects) were selected for monitoring the effects of test flows based on presence of FYLF and habitat type. These stations were selected for monitoring primarily because tadpoles, metamorphs, juveniles, and adult FYLF had recently been observed at these locations. In addition, an attempt was made to choose stations that represented the range of habitat types (i.e., sand/gravel bar, cobble bar, cobble/boulder bars, side channels and isolated pools, spring-fed pools, etc.) along the NFFR that were occupied by FYLF tadpoles, juveniles, or adults. At least two monitoring stations were chosen at each of the four sites. Habitat features and species information collected during the initial surveys at the four river sites (all stations) was used as baseline for monitoring and evaluating the potential effects of test flows on amphibians along the NFFR.

Surveys were conducted by two surveyors walking in tandem through the habitat beginning at either the upstream or downstream end of a transect. One surveyor walked along the edge of the river and the other walked through the upper portion of the habitat. Surveyors visually examined all available habitat along each transect, and randomly turned over cobble and boulders along the shoreline. Shallow water edge habitat was randomly searched for presence of tadpoles, by moving cobble and boulders and algal mats. Information obtained at each station included: the shoreline location and linear distance surveyed; a description of the key habitat features; and numbers of FYLF observed including life stage, and distribution (microhabitat).

Monitoring the effects of test flows on FYLF, and on amphibian habitat along the NFFR, was associated with Instream Flow Incremental Methodology (IFIM) studies conducted on September 8, 9, and 10, 2000 (500 cfs for two days, and 250 cfs for one day). Monitoring efforts were focused on evaluating the effects of test flows on tadpole, metamorph, and juvenile FYLF and their habitat, since these life stages were present and the most likely to be affected. Visual encounter surveys (including numbers of frogs observed and descriptions of macro- and micro- habitat conditions) were conducted, and photographs were taken at each station to document pre- test flow (baseline/existing) conditions, test flow conditions (maximum 500 cubic feet/second [cfs]), and post- test flow conditions associated with instream and side channel amphibian habitat. Changes in FYLF habitat conditions and in the numbers of frogs observed were documented at each station. One to two staff gauges were installed at each of the four sites, depending on habitat variability, to evaluate changes in water depth associated with the IFIM test flow.

3.2 Tributary Surveys

Preliminary amphibian surveys were also conducted in several tributary streams in the Project area where FYLF had been observed during the summer of 2000, or during previous amphibian surveys (Pacific Gas and Electric Company, 1999). Visual encounter surveys were conducted following basic survey techniques as described in Crump and Scott (1994). These surveys were performed on August 30 and 31, and on September 7, 2000, by Craig Seltenrich (Senior Aquatic Biologist, Pacific Gas and Electric Company), and Alicia Pool and Regina Argo (Wildlife Ecologists, EA Engineering). FYLF was the target species because of documented previous occurrences; however, the surveys were not species-specific. The three largest perennial tributaries within the Project area were selected to be surveyed: FVC, Mill Creek, and an unnamed tributary located approximately 1/2-mile downstream of Bardee's Bar.

Visual encounter surveys were conducted along these three tributaries. Aquatic habitat features, approximate numbers and distribution of frogs observed, upland habitat, and other important parameters were collected. Surveys along FVC and Mill Creek began at the confluence with the NFFR and extended approximately ½-mile upstream. The survey along the unnamed creek began at the railroad crossing above the NFFR and extended upstream approximately ¼ mile. Tributaries were surveyed by two surveyors walking slowly upstream on opposite banks, using binoculars to scan at least 50-75 feet upstream for presence of adults, subadults, and juveniles. While moving upstream, surveyors also examined appropriate aquatic habitat for presence of tadpoles. All three tributaries were surveyed to document occurrence and obtain macro- and microhabitat information associated with juveniles, subadults, and adults. During these surveys, data were collected on the following parameters along the entire length of stream surveyed, as well as at locations where frogs were observed: microhabitat features such as stream gradient, substrate, and flow; instream aquatic habitat type; percent overhanging vegetation and canopy cover; water temperature and turbidity;

presence of fish; and upland habitat type. Photographs were taken along the tributaries where there were distinct changes in habitat and at locations that exhibited representative habitat features. In addition, photographs of captured frogs, and descriptions of dorsal and ventral coloration were documented. When possible, frogs were captured and snout-vent lengths (SVL) were recorded. Frogs were handled carefully, and precautions were taken to avoid potential transference of amphibian fungal infections between captured individuals.

4.0 RESULTS

The following section describes amphibian habitats and numbers of FYLF observed in selected tributaries, and at all monitoring stations along the NFFR prior to the test flow event. Habitat changes observed at NFFR monitoring stations during and after the test flows are described, including changes in the numbers of FYLF observed. FYLF habitat as described in this document pertains to all of the different types of habitat where FYLF were observed at the nine monitoring stations along the NFFR.

At the time of year that the IFIM test flow and amphibian monitoring was conducted, three life stages (metamorphs, juveniles, and subadults) of FYLF were observed along the NFFR. Frogs were arbitrarily classified according to size (SVL); juveniles (up to 35 mm), subadults (35-50 mm), and adults (50-70 mm). Juvenile frogs were the most abundant life stage present at all of the stations, with far fewer metamorphs, and subadults. As a result, data collection was focused towards evaluating the effects of the test flows on juveniles. However, when metamorphs or subadults were observed, information on microhabitat use, distribution, and approximate numbers was collected.

4.1 NFFR Habitat Descriptions and Monitoring Results Associated with the Test Flows

4.1.1 Site 1

Site 1 is located in the vicinity of the mouth of FVC, and includes three monitoring stations. Station locations are shown in Figure 1.

4.1.1.1 Habitat Description and FYLF Occurrence Prior to the Test Flow

The following descriptions reflect habitat conditions observed during minimum instream flows of 110 cfs, prior to the test flows.

- **Station 1A**. Located along the right bank of the NFFR from the mouth of FVC upstream approximately 500 ft.

Station 1A includes several microhabitats. The bottom 60 ft consists primarily of cobble deposited around the mouth of FVC. The moderately sloping cobble bar is sparsely vegetated with small clumps of herbaceous cover and scattered clumps of sedges along the shoreline.

Upstream of the cobble bar is a boulder/cobble shoreline approximately 110 ft long. The riverbank is moderately sloping with some herbaceous riparian plants, sedges, and overhanging willow and alder. There is also a permanent seep above the shoreline, immediately up-river of FVC. Adjacent NFFR habitat along this section was primarily a moderately deep, slow moving run. At the upper end of the boulder/cobble shoreline was a backwater pool with a sand and boulder shoreline and some sedge clumps.

The area upstream of the backwater pool consisted of a low-relief cobble/boulder bar 330 ft long ranging from 10 ft wide at the downstream end to 125 ft wide at the up stream end.

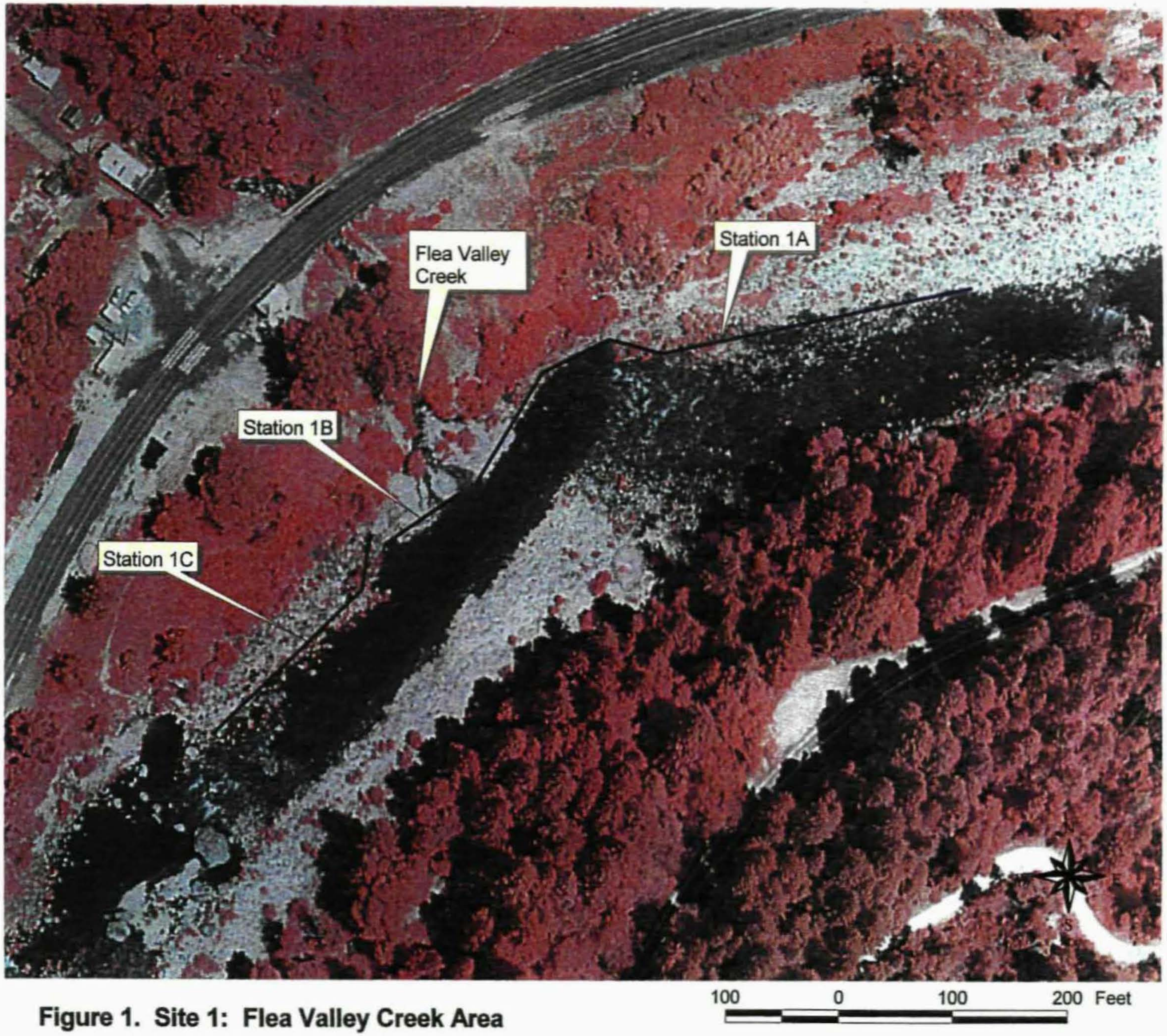

Figure 1. Site 1: Flea Valley Creek Area

The middle and lower portions of the bar had multiple flowing side channels. These side channels were shallow (4 - 6" deep) and narrow, and partially isolated from the main river flow. The willow/side channel habitat extended from the backwater pool upstream to the top of the adjacent NFFR high gradient riffle. Willow and sedge clumps provided dense canopy and overhanging cover in the willow/side channel area. A staff gauge was installed at the top of the willow/side channel habitat in about 4 inches of water.

The uppermost portion of Station 1A, above the willow/side channel habitat, consisted of a sparsely vegetated cobble/boulder area with interconnecting small channels and pools that were isolated or partially isolated from the NFFR. There was little or no flow in this area, and there were abundant exposed cobbles and boulders. Vegetation in this section consisted of scattered sedge clumps. The adjacent mainstream habitat along the cobble/boulder area was low gradient riffle.

Occurrence of FYLF within Station 1A: Juvenile FYLF were found on dry and wet rocks, wet soil, and in the water. When disturbed, FYLF escaped under vegetative cover or into small pools taking refuge in crevices or in silt. The highest density of frogs occurred in the willow/side channel habitat adjacent to the high gradient riffle. No fish were observed in these side channels.

- **Station 1B**. Located along the right bank of the NFFR from the mouth of FVC downstream approximately 75 ft.

Station 1B includes the lower portion of the cobble deposit (bar) at the mouth of FVC, downstream approximately 75 ft to several large boulders. The primary substrate of the bar is cobble with scattered small boulders. There was a sparse vegetative cover of herbaceous riparian plants along the edge of the NFFR. Adjacent NFFR habitat was a slow-moving run, including a side pool at the base of the station.

Occurrence of FYLF within Station 1B: Juvenile FYLF were found on and under cobble along the shoreline.

- **Station 1C**. Located along the right bank of the NFFR from the downstream end of Site 1B to approximately 220 ft downstream.

Station 1C consisted of a cobble/boulder area approximately 220 ft long and 30 to 50 ft wide. A staff gauge was placed at the top of the station. Isolated and partially isolated pools and side channels similar to the uppermost section of Station 1A characterized this station. There were abundant exposed rocks and dense patches of sedges with few willow saplings. This station also included several elevated spring-fed pools isolated from the NFFR. One large pool (about 7 ft long and 10 ft wide) and one small pool (about 3 ft long and 6 ft wide) contained abundant algae. The average depth of these elevated pools was approximately 4 inches. A small amount of vegetative cover, consisting of blackberry vines and overhanging willow, occurred around the pools. Adjacent NFFR habitat was a slow-moving run, including a side pool at the base of the station.

Occurrence of FYLF within Station 1C: The majority of juvenile FYLF were observed in isolated or partially isolated small pools basking on wet/moist surfaces such as wet or algae covered rocks, moist soil at the base of sedge clumps, and in algal mats. FYLF metamorphs and juveniles were also observed in the elevated spring-fed pools.

Life stage and numbers of FYLF recorded at each station prior to the test flow are provided in Table 1.

TABLE 1. SUMMARY OF SURVEY RESULTS AT SITE 1 PRIOR TO THE TEST FLOWS.

Station	Date of Survey	FYLF Observations	Location
1A	8/30/00	46 Juveniles (21-25 mm SVL)	In willow side-channel habitat and along high gradient riffle
1A	8/30/00	4 Metamorphs (hind legs only)	Right bank NFFR in stranded pools, and along low gradient riffle
Total Juveniles: 46		Total Metamorphs: 4	Total Adults: 0
1B	8/31/00	17 Juveniles (21-25 mm SVL)	Found under cobble along wetted bank of NFFR
1B	8/31/00	8 Metamorphs (hind legs only)	Found under cobble along wetted bank of NFFR
Total Juveniles: 17		Total Metamorphs: 8	Total Adults: 0
1C	8/31/00	6 Juveniles (23-25 mm SVL)	Elevated spring-fed pool ~80 ft downstream of gravel bar
1C	8/31/00	2 Metamorphs	Elevated spring-fed pool ~80 ft downstream of gravel bar
1C	8/31/00	88 Juveniles (23-25 mm SVL)	Boulder sedge habitat downstream of elevated pool
1C	8/31/00	6 Metamorphs	Boulder sedge habitat downstream of elevated pool
Total Juveniles: 94		Total Metamorphs: 8	Total Adults: 0

4.1.1.2 Habitat Description and FYLF Occurrence During the Test Flows

During the highest test flow, visual encounter surveys were repeated and changes in habitat were documented. The following station descriptions reflect changes in habitat conditions observed during the 500-cfs test flow.

- **Station 1A**

The test flow inundated some of the herbaceous cover and sedge clumps along the shoreline in the bottom 60 ft of the station and along the upstream cobble/boulder bar. Adjacent NFFR habitat under test flow became a moderate- to fast-flowing deep run. The backwater pool at the top of the boulder/cobble shoreline now had flowing water, and the sedge clumps around the pool margin were inundated.

The willow/side channel habitat above the backwater pool was flooded. At 500 cfs, formerly dry areas had isolated pools, and the willow/side channel habitat that previously had little flow was completely inundated with a moderate to fast current. A few isolated side channel pools were created. The staff gauge showed an increase in depth of 12 inches. Young willow sprouts provided a relatively dense cover and partial canopy. The willow/side channel habitat changed to primarily fast flowing water (1-1 ½ f/s) with willow branches and scattered boulders remaining as habitat.

The cobble/boulder area in the upper portion of the station had scattered boulders remaining that were still above the water, but the total number of exposed boulders was significantly reduced (70-80%). The area characterized previously by isolated pools and small channels was reduced, and there was water flowing through the pools and channels.

Occurrence of FYLF within Station 1A: No frogs were observed under cobble along the right bank at the mouth of FVC; only one large aquatic garter snake was observed along the NFFR. The majority of frogs observed were in the uppermost portion of the station associated with the cobble/boulder bar. Frogs in this area were found on exposed wet and dry rocks isolated from shore, some up to 50 ft away from shore.

- **Station 1B**

The primary change in this habitat during the test flow was higher water levels that inundated the cobble deposit and some of the vegetation on the bar. Water along the shore was relatively calm. The side pool at the base of the station was slightly larger and had some flow, but overall was similar to conditions prior to the test flow.

Occurrence of FYLF within Station 1B: Frogs were observed along the edge of the water on wet boulders and sand.

- **Station 1C**

The most prominent change in habitat at this station was associated with the shallow pools that had little or no flow at 110 cfs. These previously calm or isolated pools were now flowing channels, and the isolated pools became connected to the main river. Sedges throughout much of the upper portion of boulder habitat were at or below the water line and were laying flat. Water velocities through the boulder/sedge habitat were visually estimated at ~¼ f/s near the shoreline and 2½ f/s at the outside edge of the habitat, which was now closer to the center of the river. Very few exposed boulders remained at 500 cfs.

The bottom portion of Station 1C consisted of calm water along the shore and slow-moving water through sedge clumps, up to 15-20 ft from shore. Changes in this area were similar to the upper section except the area influenced was not as wide. At 500 cfs, there were few exposed boulders since most were now under water.

The staff gauge at the top of this station showed an increase of about 12 inches in water depth. The elevated spring-fed pools at the upper portion of the station were not inundated at 500 cfs.

Occurrence of FYLF within Station 1C: Some FYLF juveniles and metamorphs were observed in the elevated spring-fed pools, but most frogs were found in the boulder/sedge habitat. FYLF juveniles in the boulder/sedge habitat were found on vegetation (sedges and willow saplings) that was inundated and laying flat. All FYLF observations were within 15 to 20 ft from shore. Frogs were observed on both wet and dry boulders as well as on sedges. No frogs were found in higher velocity areas away from shore. Chorus frogs (*Pseudacris regilla*) were more commonly observed during this survey (at this station), than on previous occasions. Chorus frogs were found in sedges and at the top of willow saplings.

Life stage and numbers of FYLF recorded at each station during the 500-cfs test flow are provided in Table 2.

TABLE 2. SUMMARY OF SURVEY RESULTS AT SITE 1 DURING THE 500-CFS TEST FLOW.

Station	Date of Survey	FYLF Observations	Location
1A	9/8/00	10 Juveniles (21-25 mm SVL)	Right bank NFFR along high gradient riffle
1A	9/8/00	12 Juveniles (21-25 mm SVL)	Right bank NFFR in stranded pools, and along low gradient riffle
Total Juveniles: 22		Total Metamorphs: 0	Total Adults: 0
1B	9/8/00	8 Juveniles (21-25 mm SVL)	Along shoreline
Total Juveniles: 8		Total Metamorphs: 0	Total Adults: 0
1C	9/8/00	17 Juveniles (21-25 mm SVL)	Elevated spring-fed pool ~80 ft downstream of gravel bar
1C	9/8/00	1 Metamorph	Elevated spring-fed pool ~80 ft downstream of gravel bar
1C	9/8/00	30 Juveniles (21-25 mm SVL)	Boulder sedge habitat downstream of elevated pool, habitat ranged from slow water along shore with moderate to fast water offshore within the boulder/sedge habitat.
Total Juveniles: 47		Total Metamorphs: 1	Total Adults: 0

4.1.1.3 Habitat Description and FYLF Occurrence Following the Test Flows

Following the test flows, instream flow releases were returned to pre-test flow conditions of approximately 110 cfs. Visual encounter surveys were repeated and changes in habitat were documented. The following station descriptions reflect changes in habitat conditions observed following the test flows.

- **Station 1A**

Habitat conditions were similar to those observed prior to the test flows. Some vegetation along shore and in the willow/side channel habitat was flattened from test flow. The backwater pool at the base of the willow/side channel habitat was calm, and the underwater branches were still present. In the cobble/boulder habitat at the top of the station, numerous exposed rocks were present along the shore with shallow pools, as observed prior to the test flow.

Occurrence of FYLF within Station 1A: From FVC upstream along the boulder/cobble shoreline, frogs were found primarily on wet boulders and sediment (in the sun). In the willow/side channel habitat, frogs were observed on wet rocks and earth, generally back from the edge of the main river. In the cobble/boulder habitat at the top of the station, frogs were observed in shallow areas along shore on boulders and sedges, and on other wet surfaces. Most frogs were within 5 ft of the shore with few observed more than 10-12 ft from shore.

- **Station 1B**

Habitat conditions were similar to those observed prior to the test flows. The deposits of silt and algae were still present in the backwater pool at the bottom of the station.

Occurrence of FYLF within Station 1B: Metamorphs were observed in the main channel backwater pool at the top of the habitat. Juvenile frogs were observed along the shoreline on wet cobble or gravel substrate.

- **Station 1C**

The cobble/boulder habitat returned to pre-test flow conditions of isolated and partially isolated pools (with a slow current) and numerous exposed rocks. The sedges and willows that had been inundated were still bent over, but there were no significant changes to vegetation.

Occurrence of FYLF within Station 1C:. Numerous juveniles were found in the elevated spring-fed pool. Juveniles were also observed in isolated pools in the boulder/sedge habitat primarily within 15 ft of the shoreline. Most frogs were basking on wet rocks or mud.

Life stage and numbers of FYLF recorded at each station following the test flows are provided in Table 3.

TABLE 3. SUMMARY OF SURVEY RESULTS AT SITE 1 FOLLOWING THE TEST FLOWS.

Station	Date of Survey	FYLF Observations	Location
1A	09/12/00	18 Juveniles (21-25 mm SVL)	Cobble shoreline from FVC upstream to high gradient riffle
1A	09/12/00	62 Juveniles (21-25 mm SVL)	Right bank NFFR along high gradient riffle
1A	09/12/00	33 Juveniles (21-25 mm SVL)	Right bank NFFR in stranded pools, and along low gradient riffle
Total Juveniles: 113		Total Metamorphs: 0	Total Adults: 0
1B	09/12/00	12 Juveniles (21-25 mm SVL)	Along shoreline
1B	09/12/00	8 Metamorphs	In backwater pool at bottom of station
Total Juveniles: 12		Total Metamorphs: 8	Total Adults: 0
1C	09/12/00	30 Juveniles (21-25 mm SVL)	Elevated spring-fed pool ~80 ft downstream of gravel bar
1C	09/12/00	68 Juveniles (21-25 mm SVL)	Boulder sedge habitat downstream of elevated pool
1C	09/12/00	9 Metamorphs	Boulder sedge habitat downstream of elevated pool
Total Juveniles: 98		Total Metamorphs: 9	Total Adults: 0

4.1.2 Site 2

Site 2 is located in the vicinity of Bardee's Bar, and includes two monitoring stations. Station locations are shown in Figure 2.

4.1.2.1 Habitat Description and FYLF Occurrence Prior to the Test Flows

The following descriptions reflect habitat conditions observed during minimum instream flows of 110 cfs, prior to the test flows.

- **Station 2A**. Located on the cobble bar along the right bank of the NFFR from under the railroad bridge to approximately 175 ft downstream.

Station 2A consists of the downstream portion of a large cobble/gravel bar. The bar is approximately 200 ft wide and steeply sloping with sparse herbaceous vegetation. The adjacent mainstream habitat consists of a large pool greater than 10 ft deep. The downstream end of Station 2A was at the top of a section of large boulders.

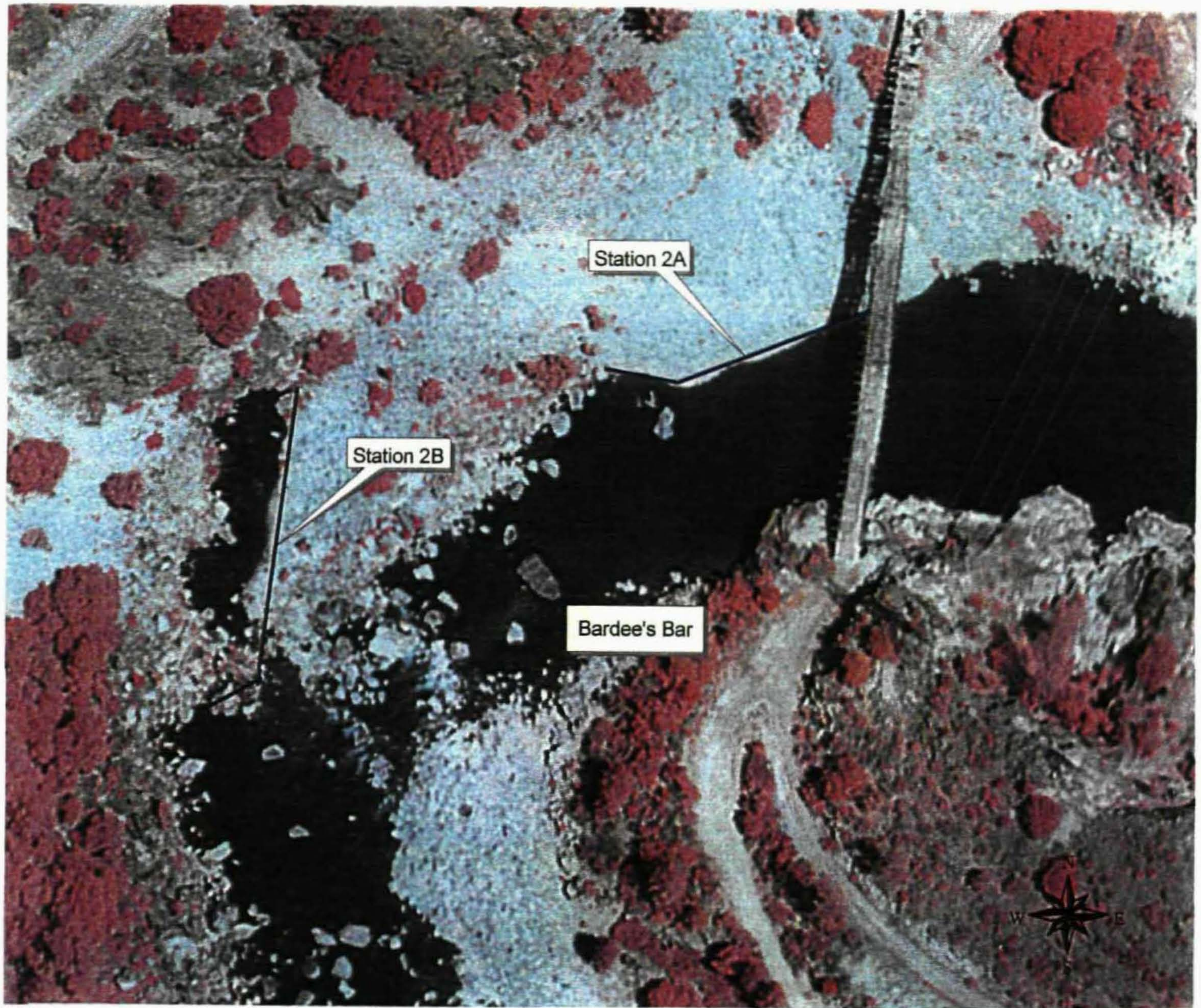

Figure 2. Site 2: Bardee's Bar Area

Occurrence of FYLF within Station 2A: Juvenile FYLF were found along the shoreline on or under wet cobble.

- **Station 2B**. Backwater pool and tail-out, and downstream boulder/sedge habitat (approximately 215 linear ft) located on the right bank of the NFFR approximately 200 ft downstream of Site 2A.

Station 2B included a large right bank backwater pool surrounded primarily by boulders and bedrock with some areas of exposed cobble and gravel. Herbaceous riparian plants, sedge clumps, and some willow surrounded the pool margin. The pool contained a moderate amount of floating algae and numerous bass and several trout were observed. Water temperature in the pool near the surface was 22° C. The pool was connected to the main river by a narrow boulder/cobble tail-out. The pool tail-out was characterized by shallow (4-6 inches deep), standing water with numerous exposed rocks. Downstream of the pool tail-out, was a boulder/sedge habitat with isolated and partially isolated pools. This area had abundant vegetative cover consisting of sedges, willow, and grass. There was no flowing water through the boulder/sedge habitat. A staff gauge was installed in the boulder/sedge habitat just downstream of the pool tail-out.

Occurrence of FYLF within Station 2B: No frogs were found around the margin of the right bank backwater pool. One juvenile and one subadult were observed in shallow water near the tail-out of the pool.

Life stage and numbers of FYLF recorded at each station prior to the test flows is provided in Table 4.

TABLE 4. SUMMARY OF SURVEY RESULTS AT SITE 2 PRIOR TO THE TEST FLOWS.

Station	Date of Survey	FYLF Observations	Location
2A	9/07/00	8 Juveniles (~23 mm SVL)	Along water's edge on wet rocks
Total Juveniles: 8		Total Metamorphs: 0	Total Adults: 0
2B	9/07/00	1 Juvenile	Found near tail-out of the backwater pool in boulder/sedge habitat
2B	9/07/00	1 Subadult	Found near tail-out of the backwater pool in boulder/sedge habitat
Total Juveniles: 1		Total Metamorphs: 0	Total Subadults: 1

4.1.2.2 Habitat Description and FYLF Occurrence During the Test Flows

During the highest test flow, visual encounter surveys were repeated and changes in habitat were documented. The following station descriptions reflect changes in habitat conditions observed during the 500-cfs test flow.

- **Station 2A**

The river level along the cobble bar was slightly higher at 500 cfs. There were no significant changes in habitat at this station.

Occurrence of FYLF at Station 2A: One juvenile FYLF was observed on cobble along the shore.

- **Station 2B**

The water level in the backwater pool was slightly higher, inundating the vegetation around the perimeter. Most of the algae present in the pool prior to the test flow was gone. Depth at the pool tail-out increased to the same level of the main river, and there was a slight flow of water out of pool. Most of the bedrock in the boulder/sedge habitat immediately downstream of the tail-out was under water. There were few exposed rocks remaining, and the majority of the vegetation was partially or completely inundated. The staff gauge showed a total increase of 23 inches in river height.

Occurrence of FYLF within Station 2B: No frogs were observed at Station 2B during the test flow.

Life stage and numbers of FYLF recorded at each station during the 500-cfs test flow is provided in Table 5.

TABLE 5. SUMMARY OF SURVEY RESULTS AT SITE 2 DURING THE 500-CFS TEST FLOW.

Station	Date of Survey	FYLF Observations	Location
2A	9/08/00	1 Juvenile	Immediately downstream of bridge – frog on cobble at water line
Total Juveniles: 1		Total Metamorphs: 0	Total Subadults/adults: 0
2B	9/08/00	0	No frogs found
Total Juveniles: 0		Total Metamorphs: 0	Total Subadults/adults: 0

4.1.2.3 Habitat Description and FYLF Occurrence Following the Test Flows

Following the test flows, instream flow releases were returned to pre-test flow conditions of approximately 110 cfs. Visual encounter surveys were repeated and changes in habitat were documented. The following station descriptions reflect changes in habitat conditions observed following the test flows.

- **Station 2A**

Habitat conditions were similar to those observed prior to the test flows.

Occurrence of FYLF within Station 2A: Juvenile FYLF were found along the water on wet sand, gravel, and rocks.

- **Station 2B**

Habitat conditions were similar to those observed prior to the test flows. Several bass were again observed in the backwater pool. The pool tail-out and the boulder/sedge habitat downstream of the tail-out were similar to pre-test flow conditions. Some vegetation was flattened, but the majority was still erect. The staff gauge was missing and assumed washed-out during the test flow.

Occurrence of FYLF within Station 2B: One juvenile FYLF was observed along the margin of the backwater pool. No other frogs were observed.

Life stage and numbers of FYLF recorded at each station following the test flows are provided in Table 6.

TABLE 6. SUMMARY OF SURVEY RESULTS AT SITE 2 FOLLOWING THE TEST FLOWS.

Station	Date of Survey	FYLF Observations	Location
2A	9/12/00	8 Juveniles	On wet sand, gravel and rocks along shoreline
Total Juveniles: 8		Total Subadults: 0	Total Adults: 0
2B	9/12/00	1 Juvenile	Along sandy, vegetated shore around backwater pool
Total Juveniles: 1		Total Subadults: 1	Total Adults: 0

4.1.3 Site 3

Site 3 is located in the vicinity of the swimmer's beach, approximately ½ mile above Poe PH, and includes two monitoring stations. Station locations are shown in Figure 3.

4.1.3.1 Habitat Description and FYLF Occurrence Prior to the Test Flows

The following station descriptions reflect habitat conditions observed during minimum instream flows of 110 cfs, prior to the test flows.

- **Station 3A**. Located on the right bank of the NFFR beginning at the small backwater pool at the upstream end of the swimmer's beach to approximately 390 ft upstream along cobble bar.

Station 3A consists of a low-relief cobble bar ranging from 10 to 70 ft wide. This station included a small backwater pool at the top of the swimmer's beach. The shallow, narrow backwater pool had one exposed sand bank and one heavily vegetated sand bank. The vegetation along the shoreline was primarily willow and riparian herbaceous plants. Above the backwater pool, the cobble bar extended upstream approximately 370 ft to a bedrock wall. The cobble bar is sparsely vegetated, and had numerous small, shallow pools along the margin. Mainstream habitat adjacent to the cobble bar was primarily low gradient riffle.

Occurrence of FYLF within Station 3A: Juvenile frogs were observed at the small backwater pool at the bottom of the station along the exposed sand bank, and along the heavily vegetated sand bank. All frogs were observed along the shoreline. Juvenile frogs were also found along the shoreline of the cobble bar on wet rocks.

- **Station 3B**. Located on the right bank of the NFFR from the lower end of the swimmer's beach, across the tail-out of the pool and up the left bank approximately 200 ft, for a total length of 390 ft.

Station 3B is located at the bottom portion of a large, deep pool at the swimmer's beach. The station included about 30 ft of the lower portion of the right bank gravel/sand beach. A small

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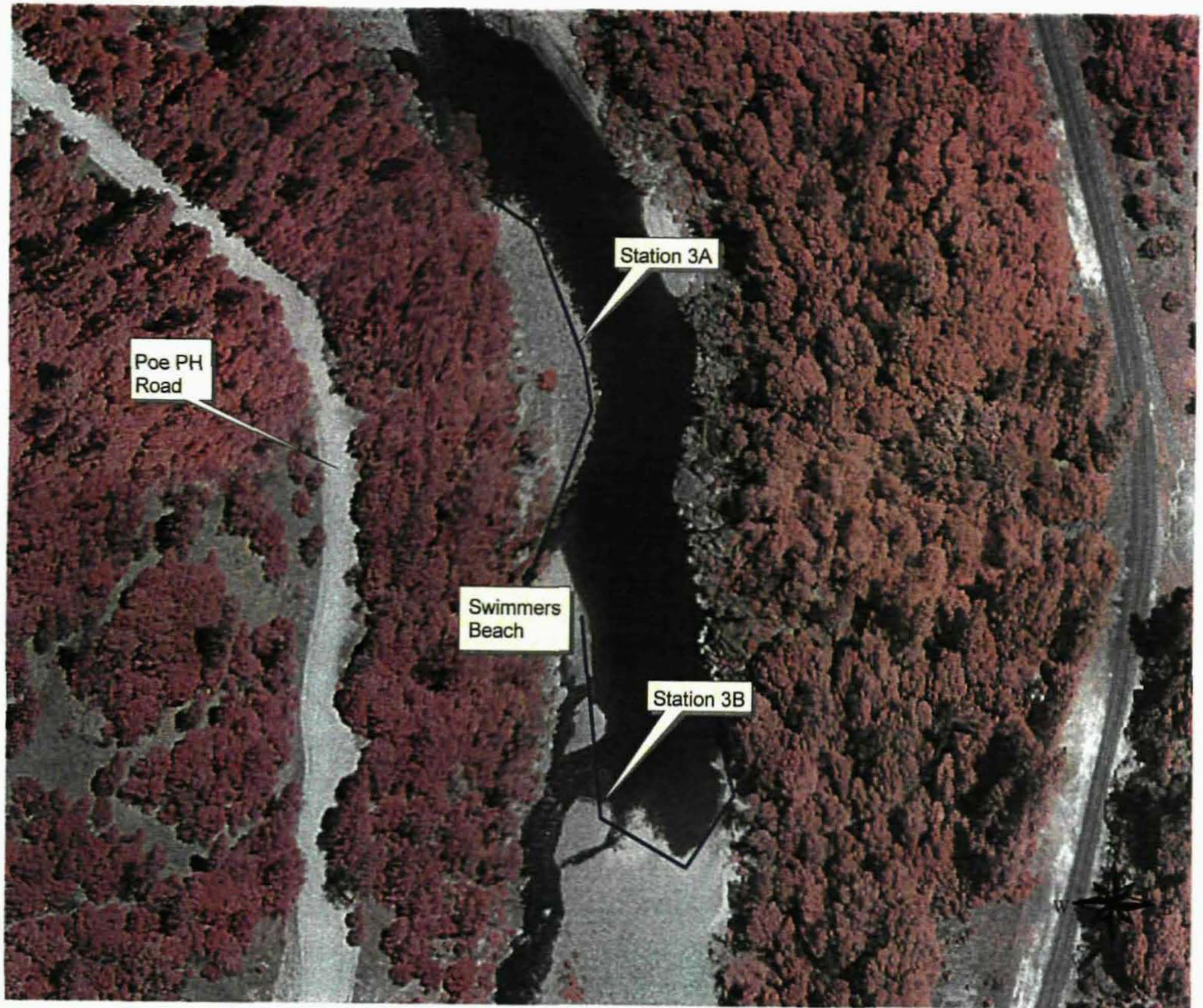

Figure 3. Site 3: Swimmer's Beach Area

backwater pool was located along a shallow low gradient riffle at the lower portion of the beach. At the tail-out of the large pool, there was one low-relief gravel/cobble island that created a split riffle. The right bank channel changed from a low gradient riffle into a narrow run adjacent to a bedrock wall. A staff gauge was placed in the run adjacent to the gravel island on the right side of the river. The water depth at the staff gauge was about 6 inches at 110 cfs. The gravel island was approximately 20 ft wide by 25 ft long, with a moderate herbaceous cover. Cobble habitat (with some sand) occurred along the lower left bank portion of the large pool. This area had minimal vegetation along the shore with some algae on the underwater cobble.

Occurrence of FYLF within Station 3B: The majority of juvenile FYLF were observed along the right bank gravel/sand shoreline at the bottom of the swimmer's beach, and on the gravel/cobble island. The frogs were concentrated in the wet gravel areas closest to the riffles and also seemed to prefer the vegetated portions of the island. Some frogs were observed up to 8 ft from water. When disturbed, frogs escaped into the riffle at the pool tail-out and took cover in crevices in the gravel substrate. Fewer frogs were observed along the left bank cobble and sand portion of the large pool where there was minimal vegetation and calm water.

Life stage and numbers of FYLF recorded at each station prior to the test flows is provided in Table 7.

TABLE 7. SUMMARY OF SURVEY RESULTS AT SITE 3 PRIOR TO THE TEST FLOWS.

Station	Date of Survey	FYLF Observations	Location
3A	9/01/00	9 Juveniles (23-25 mm SVL)	Frogs on sandy bank in backwater area and on cobble along shoreline
Total Juveniles: 9		Total Subadults: 0	Total Adults: 0
3B	9/01/00	34 Juveniles (23-28 mm SVL)	Frogs on wet gravel/cobble concentrated at tail-out of pool adjacent to fast water
Total Juveniles: 34		Total Subadults: 0	Total Adults: 0
3A	9/07/00	5 Juveniles (20-30 mm SVL)	Frogs on cobble and rocks along shoreline
Total Juveniles: 5		Total Metamorphs: 0	Total Adults: 0
3B	9/07/00	6 Juveniles	Frogs on wet rocks, gravel, and sand along shoreline, and small backwater area along left bank bedrock wall
Total Juveniles: 6		Total Subadults: 0	Total Adults: 0

4.1.3.2 Habitat Description and FYLF Occurrence During the Test Flows

During the test flow, visual encounter surveys were repeated and changes in habitat were documented. The following descriptions reflect changes in habitat conditions observed during the 500 cfs test flow.

- **Station 3A**

The water level at the small backwater pool at the top of the swimmer's beach increased by about 10 inches, inundating the vegetation that was previously along the shoreline. The cobble bar in the upper portion of the station maintained similar habitat conditions as those documented at 110 cfs. During the test flow, small, shallow pools were still present along the margin of the cobble bar, and the sparse vegetation along the shoreline was inundated.

Occurrence of FYLF within Station 3A: No frogs were observed at the small backwater pool at the top of the swimmer's beach, but two dogs had disturbed the area prior to the survey. Juvenile FYLF were observed along the margin of the cobble bar, and one metamorph was found in an isolated pool at the top of the cobble bar.

- **Station 3B**

The water level along the right bank at the bottom of the swimmer's beach increased inundating the vegetation along the shoreline. The majority of the gravel/cobble island was inundated and only a small amount of exposed substrate remained. The vegetation on the island was also inundated. The staff gauge showed an increase in depth of about 16 inches.

Occurrence of FYLF within Station 3B: Two FYLF juveniles were found on the right bank gravel shoreline at the bottom of the swimmer's beach. Two additional frogs were observed: one was located on the remaining substrate on the gravel/cobble island, and one was along the left bank cobble area at the bottom of the large pool.

Life stage and numbers of FYLF recorded at each station during the 500-cfs test flow are provided in Table 8.

TABLE 8. SUMMARY OF SURVEY RESULTS AT SITE 3 DURING THE 500 CFS TEST FLOW.

Station	Date of Survey	FYLF Observations	Location
3A	9/08/00	2 Juveniles	Frogs found at waterline
3A	9/08/00	1 Subadult (50 mm)	Frog found at waterline
3A	9/08/00	1 Metamorph	Isolated pool at upper end of the right bank cobble bar
Total Juveniles: 2		Total Metamorphs: 1	Total Subadults: 1
3B	9/08/00	6 Juveniles	Frogs along sand bank, on gravel island, and wet gravel at the tail-out of the large pool
Total Juveniles: 6		Total Metamorphs: 0	Total Adults: 0

4.1.3.3 Habitat Description and FYLF Occurrence Following Test Flows

Following the test flows, instream flow releases were returned to pre-test flow conditions of approximately 110 cfs. Visual encounter surveys were repeated and changes in habitat were documented. The following station descriptions reflect changes in habitat conditions observed following the test flows.

- **Station 3A**

Habitat conditions were similar to those observed prior to the test flow.

Occurrence of FYLF within Station 3A: Eight FYLF juveniles were observed at this station along the right bank cobble bar upstream of the swimmer's beach.

- **Station 3B**

Habitat conditions were similar to those observed prior to the test flow. The vegetation on the gravel/cobble island remained flattened as the result of inundation during the test flow.

Occurrence of FYLF within Station 3B: All juvenile FYLF observed at Station 3B were associated with the riffle area at the tail-out of the large pool, and on the gravel/cobble island. One subadult was found in the small backwater pool at the lower right bank portion of the swimmer's beach.

Life stage and numbers of FYLF recorded at each station following the test flows are provided in Table 9 below:

TABLE 9. SUMMARY OF SURVEY RESULTS AT SITE 3 FOLLOWING THE TEST FLOWS.

Station	Date of Survey	FYLF Observations	Location
3A	9/12/00	8 Juveniles	Frogs along shoreline, many on dry rocks
Total Juveniles: 8		Total Subadults: 0	Total Adults: 0
3B	9/12/00	29 Juveniles	Frogs along shoreline
3B	9/12/00	1 Subadult (40 mm SVL)	At the lower right bank portion of the beach in a small backwater pool
Total Juveniles: 29		Total Subadults: 1	Total Adults: 0

4.1.4 Site 4

Site 4 is located adjacent to Poe PH, and includes two separate monitoring stations. Station locations are shown in Figure 4.

4.1.4.1 Habitat Description and FYLF Occurrence Prior to the Test Flows

The following descriptions reflect habitat conditions observed during minimum instream flows of 110 cfs, prior to the test flows.

- **Station 4A**. Located along the right bank of side the channel along the margin of the boulder/cobble island extending from the low gradient riffle at the bottom of the side channel approximately 640 ft upstream to low gradient riffle at the top of the side channel. Station 4A also includes a small side pool adjacent to the low gradient riffle at the top of the side channel.

Station 4A is associated with a left bank side channel created by a large boulder/cobble island in the NFFR adjacent to the Poe Powerhouse. The station is located along the cobble/boulder shoreline on the right bank of the side channel. The low gradient riffle habitats at both the upper and lower portions of the side channel have numerous exposed boulders/cobble with an average depth less than 1-foot. The low gradient riffle at the top of the side channel has sparse vegetation along the margins consisting of scattered clumps of sedges and small willow saplings. The right bank is moderately sloping with patchy vegetative cover along the shoreline. At the top of the station, there is a shallow side pool (located on the island) that had a trickle of water flowing in from the low gradient riffle. The pool was approximately 6 ft in diameter and 10 inches deep with relatively calm water. There was sparse herbaceous vegetation along the margin of the pool. At 110 cfs, the side channel had slow moving to standing water with an average depth of about 3 ft. Large patches of green algae and a small amount of silt covered the bottom substrate throughout the side channel.

Occurrence of FYLF within Station 4A: All juvenile frogs observed at this station were in the side pool located at the top of the side channel adjacent to the low gradient riffle.

- **Station 4B**. Located along the left bank of the side channel from the low gradient riffle at the bottom of the side channel about 640 ft upstream to the low gradient riffle at the top of the side channel.

Station 4B is located along the left bank of the side channel described above. The left bank is steeply sloping with boulder and cobble along the shore. Vegetation along the left bank is nearly continuous from the low gradient riffle at the bottom to the low gradient riffle at the top of the station. Because of the steeply sloping bank, the vegetation is restricted to a narrow band of sedges and willows along the shore. Two staff gauges were placed along the left bank of the side channel: one located in the side channel above the low gradient riffle at the bottom of the side channel, and one located in the low gradient riffle at the top of the side channel.

Occurrence of FYLF within Station 4B: The subadults observed at the bottom of the station were on rocks along the shore.

Life stage and numbers of FYLF recorded at each station prior to the test flows are provided in Table 10.

TABLE 10. SUMMARY OF SURVEY RESULTS AT SITE 4 PRIOR TO THE TEST FLOWS.

Station	Date of Survey	FYLF Observations	Location
4A	9/01/00	5 Juveniles (20-25 mm SVL)	All found in side pool adjacent to low gradient riffle at top
Total Juveniles: 5		Total Subadults: 0	Total Adults: 0
4B	9/01/00	6 Juveniles (20-25 mm SVL)	On gravel, rocks, and wet soil associated with sedge clumps
4B	9/01/00	2 Subadults (~ 50 mm SVL)	On rocks along shore – dove into water and took cover in algae
Total Juveniles: 6		Total Subadults: 2	Total Adults: 0

4.1.4.2 Habitat Description and FYLF Occurrence During the Test Flows

During the highest test flow, visual encounter surveys were repeated and changes in habitat were documented. The following station descriptions reflect changes in habitat conditions observed during the 500-cfs test flow.

- **Station 4A**

During the highest test flow, conditions in the side channel remained fairly consistent with pre-test flow observations. There was now visible movement of water through the channel, and some vegetation along the shoreline was inundated. The water velocity through the channel was not high enough to remove the algae and silt observed prior to the test flow. The most noticeable change in habitat was associated with low gradient riffle habitats at both the upper and lower portions of side channel. These areas had more whitewater and nearly all previously exposed rocks were under water. In addition, the small pool at the top of the station was slightly larger and had a steady inflow that moved through the pool.

Figure 4. Site 4: Poe Powerhouse Area

100 0 100 200 Feet

Occurrence of FYLF within Station 4A: Juvenile FYLF were found along the cobble shoreline, and one subadult was observed below the pool at the top of the station.

- **Station 4B**

Habitat conditions for Station 4B were similar to those described for 4A. The staff gauge at the bottom of the station showed an increase in depth of about 11 inches. The staff gauge at the top of the station (at the head of the low gradient riffle) only read about 4 inches above the pre-test flow mark.

Occurrence of FYLF within Station 4B: All juvenile FYLF were observed at the top of the side channel at the low gradient riffle. Two were on wet rocks along the shore, and one was on a rock in the low gradient riffle.

Life stage and numbers of FYLF recorded at each station during the 500-cfs test flow are provided in Table 11.

TABLE 11. SUMMARY OF SURVEY RESULTS AT SITE 4 DURING THE 500-CFS TEST FLOW.

Station	Date of Survey	FYLF Observations	Location
4A	9/08/00	3 Juveniles	Frogs on wet cobble along shoreline
4A	9/08/00	1 Subadult	Frog along shore below side pool adjacent to low gradient riffle at top of channel
Total Juveniles: 3		Total Subadults: 1	Total Adults: 0
4B	9/08/00	3 Juveniles	All associated with low gradient riffle at top of channel
Total Juveniles: 3		Total: Subadults: 0	Total Adults: 0

4.1.4.3 Habitat Description and FYLF Occurrence Following the Test Flows

Following the test flow, instream flow releases were returned to pre- test flow conditions of approximately 110 cfs. Visual encounter surveys were repeated and changes in habitat were documented. The following station descriptions reflect changes in habitat conditions observed following the test flow.

- **Station 4A.**

Habitat conditions were similar to those observed prior to the test flows.

Occurrence of FYLF within Station 4A: One juvenile FYLF was observed along the cobble/boulder shoreline, and two subadults were at the pool at the top of the side channel adjacent to the low gradient riffle. All frogs were on wet rocks or sand along the shoreline.

- **Station 4B**

Habitat conditions were similar to those observed prior to the test flows.

Occurrence of FYLF within Station 4B: Three juvenile and two subadult FYLF were observed along the boulder/cobble shoreline, and one juvenile and one subadult FYLF were observed at the low gradient riffle at the top of the side channel. All frogs were found along the shoreline in the water or on wet rocks.

Life stage and numbers of FYLF recorded at each station following the test flows are provided in Table 12.

TABLE 12. SUMMARY OF SURVEY RESULTS AT SITE 4 FOLLOWING THE TEST FLOWS.

Station	Date of Survey	FYLF Observations	Location
4A	9/12/00	1 Juvenile	Frog along shoreline
4A	9/12/00	2 Subadults	Frogs in side pool adjacent to low gradient riffle at top of channel
Total Juveniles: 1		Total Subadults: 2	Total Adults: 0
4B	9/12/00	4 Juveniles	Frogs along shore and adjacent to low gradient riffle at top of channel
4B	9/12/00	3 Subadults	Frogs along shore and adjacent to low gradient riffle at top of channel
Total Juveniles: 4		Total: Subadults: 3	Total Adults: 0

4.2 Tributary Habitat Descriptions and Results of Visual Encounter Surveys

Tributary surveys were conducted primarily to determine occurrence of FYLF and to obtain information on microhabitat preferences in tributary streams.

4.2.1 Site TR1: Mill Creek

Mill Creek is a left bank tributary to the NFFR located approximately ½ mile downstream of Poe Dam (Figure 5). This tributary was surveyed from the mouth upstream approximately 2,000 ft. The lower portion of Mill Creek from the mouth of the creek up to a pool below the Highway (Hwy) 70 culvert was split into two main channels that flow into the NFFR. These channels were characterized by small boulder and cobble substrate associated with cascade/pool habitat. Just downstream of the mouth of Mill Creek (along the NFFR) was a perennial spring characterized by trickling water over cobble and gravel substrate. The area along the bank of the NFFR influenced by the spring was approximately 40 ft long and had abundant herbaceous cover including blackberry and tall grasses. Trout were observed in the pool below the Hwy 70 culvert.

Boulder, bedrock, and cobble substrates, associated with cascade/pool habitat characterize much of Mill Creek above the Hwy 70 culvert. Total channel width above the culvert was about 15 to 20 ft. The riparian canopy above the culvert included alder, bay, maple, and dogwood. Canopy cover ranged from 5 to 30 percent. Several small, shallow, slow-moving side channels with gravel substrate occurred in this reach. Abundant caddis larvae and trout were observed in deeper (> 5 ft deep) pools.

Approximately 400 ft upstream of the NFFR, the gradient increased and the habitat changed to predominantly boulder substrate with cascades and pocket water. This type of habitat extended about 100-150 ft. There was abundant large woody debris through this section of the creek. Three additional changes in creek gradient were observed above this reach: a lower gradient section approximately 350 ft long, a higher gradient section characterized by waterfalls and cascades, followed by a lower gradient channel dominated by bedrock with cascade/pool habitat.

FYLF observations recorded during the visual encounter survey conducted on Mill Creek, including location and microhabitat, are presented in Table 13.

TABLE 13. LOCATION AND MICROHABITAT OBSERVATIONS OF FYLF AT SITE TR1: MILL CREEK.

Stream Reach	FYLF Observations	Location and Microhabitat
From confluence with NFFR to Highway 70 culvert (approximately 200 ft)	3 Juveniles (23, 25, 25 mm SVL) 1 Adult (65 mm SVL)	One juvenile observed on bank of NFFR associated with a trickle of water from spring, and two juveniles were observed adjacent to main flow of creek near a small pool. Adult on cobble bank about 1ft from the water, at the base of a boulder/cobble cascade/pool.
From the Highway 70 culvert upstream approximately 2,000 ft	1 Adult (no SVL) 1 Adult (68 mm SVL) 1 Subadult (40-50 mm SVL)	Adult on dry boulder along riffle/cascade. Adult on boulder next to cascade in cascade/pool area. Subadult on dry boulder next to deep pool (4 ft).
Total Juveniles: 3	Total Subadults: 1	Total Adults: 3

4.2.2 Site TR2: Flea Valley Creek

FVC is a right bank NFFR tributary located approximately 1 mile downstream of Poe Dam (Figure 5). FVC was surveyed from the mouth upstream over ½ mile. A cobble deposit with little vegetative cover was located at the mouth of FVC. At the time of the survey, flow in the lower portion of FVC was dispersed over the cobble substrate. The habitat from the mouth of FVC approximately 250 ft upstream to the railroad bridge was primarily low gradient pocket water with cobble, boulder, and gravel substrate.. Riparian cover in this section consisted of willow, blackberry, and alder overhanging the creek. Vegetative cover ranged from fairly open to dense.

Through the town of Pulga, human disturbance and channel modification consisting of riprap banks considerably reduced riparian canopy. In this section, overhanging blackberry vines provided most of the vegetative cover. In the upper portion of the Pulga housing area, the habitat changed to step-pools with boulder/cobble substrate. Additional habitat changes above Pulga included a section of pocket water and shallow riffle that transitioned back to step-pool. Trout up to 8 inches long were observed in deeper pools throughout FVC.

Habitat upstream of the town of Pulga alternated between moderate gradient boulder, cobble, and gravel pocket water with dense riparian cover, to low gradient cascade/pool or riffle habitat with riparian and overhanging cover from 30 to 85 percent. Approximately ½ mile upstream of the NFFR, the creek levels-out into long, shallow riffles.

FYLF observations recorded during the visual encounter survey conducted on Flea Valley Creek, including location and microhabitat, are presented in Table 14.

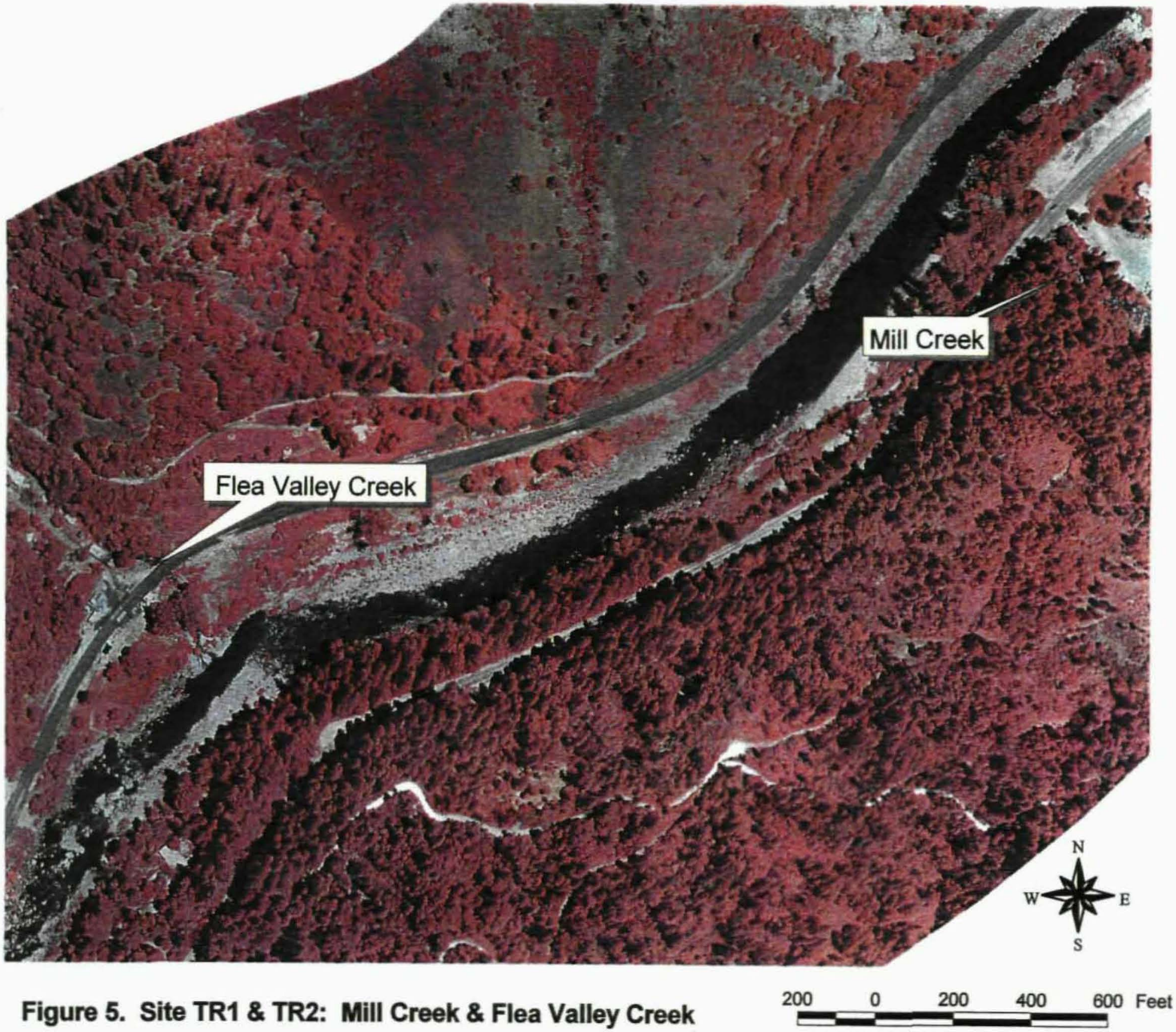

Figure 5. Site TR1 & TR2: Mill Creek & Flea Valley Creek

TABLE 14. LOCATION AND MICROHABITAT OBSERVATIONS OF FYLF AT SITE TR2: FVC.

Stream Reach	FYLF Observations	Location and Microhabitat
Along Flea Valley Creek within 50 ft of NFFR	6 Juveniles (23 to 25 mm SVL)	All frogs observed on wet rocks (cobble and boulder) in area with open banks with little riparian cover.
Approx. 30 ft downstream of railroad crossing	Adult (60 mm SVL)	Frog on wet gravel bank with willow cover.
Immediately upstream of railroad culvert.	Subadult (~50 mm SVL)	Frog observed on wet boulder in middle of channel.
Approx. 60 ft upstream of railroad culvert	Juvenile	Juvenile along stream bank.
Upper portion of Pulga housing area	Adult (~50 mm SVL) Juvenile	Adult on dry boulder adjacent to pool about 30 inches deep. Juvenile observed on wet gravel on stream bank.
About 30 ft upstream of PVC water pipe crossing	Adult (60 mm SVL)	Adult observed on rock in middle of channel.
Immediately upstream of power line crossing	Subadult (?) (~50 mm SVL)	Frog seen along small riffle.
About 80 ft downstream of uppermost house in Pulga (on left bank)	Juvenile (~25 mm SVL)	Frog observed in shallow riffle area along side of channel.
Adjacent to uppermost house in Pulga (right bank)	Adult (~60 mm SVL)	Frog found on wet, shady rock next to pool.
About 15 ft downstream of foot bridge	Juvenile (~23 mm SVL)	Juvenile on wet gravel basking in sun.
Long stream reach (roughly 500 ft) surveyed with no observations of frogs.		
Adjacent to last right bank house in Pulga; just upstream of footbridge	3 Adults (58, 60, & 60 mm SVL)	Adult on dry boulder in sun adjacent to small pool, and a second adult on dry boulder in middle of channel in riffle area just downstream of small pool. The other adult was observed on dry rock along the bank.
About 925 ft upstream of footbridge	Adult (~ 60 mm SVL)	Adult frog observed diving into pool.
Total Juveniles: 10	Total Subadults: 2	Total Adults: 8

4.2.3 Site TR3: Unnamed Tributary

This left bank unnamed tributary is located just over ½ mile downstream of Bardee's Bar (Figure 6). The stream was surveyed from the upper end of the railroad culvert upstream approximately 1,000 ft. A steep gradient, cascade/pool channel with pools 12 to 18 inches deep characterized the habitat in the drainage. The substrate consisted primarily of cobble and boulder with evidence (cobble piles) of historical mining. At approximately 300 ft upstream of the culvert, the creek became intermittent in short sections with water flowing under boulder and cobble piles in the creek channel. This was likely due to the modification of the stream bottom by past mining activities. The upper canopy in the drainage ranged from 0 to 100 percent, with an average of between 40 and 50 percent. The canopy consisted primarily of tall bay, oak, maple, and sycamore trees. The average overhanging cover was between 70 and 90 percent and consisted of bay, maple, and herbaceous plants.

FYLF observations recorded during the visual encounter survey conducted on the unnamed tributary, including location and microhabitat, are presented in Table 15.

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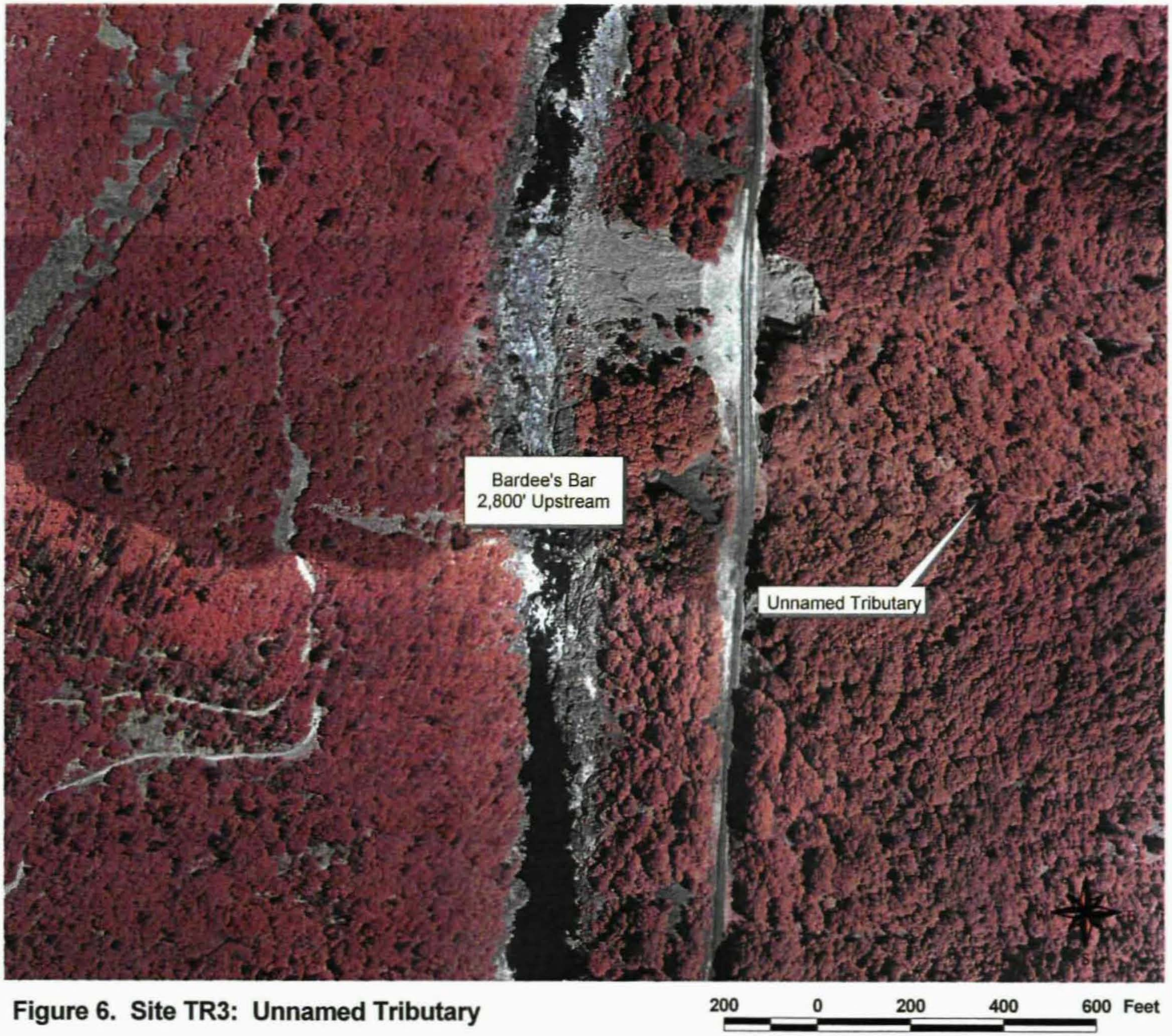

Figure 6. Site TR3: Unnamed Tributary

TABLE 15. LOCATION AND MICROHABITAT OBSERVATIONS OF FYLF AT SITE TR3: UNNAMED TRIBUTARY.

Stream Reach	FYLF Observations	Location and Microhabitat
At upstream base of railroad culvert	2 Subadults/adults (~40 – 50 mm SVL)	Both frogs on wet rocks within 15 feet of each other.
Approximately 250 to 300 ft upstream of railroad culvert	1 Subadult/adult (~50 mm SVL)	Frog seen on wet rock adjacent to cascade/pool.
Total Juveniles: 0	Total Subadults/adults: 3	

5.0 DISCUSSION

5.1 Evaluation of Effects of the Test Flow on FYLF and Associated Habitat at Four Sites Along the NFFR

The following discussion provides a preliminary assessment of the effects of the test flows (an increase from 110 cfs to 500 cfs) on FYLF and its habitat, at four sites along the NFFR. The potential effects of the intermediate 250-cfs release on amphibians and amphibian habitat were not evaluated, because the effects of the preceding 500 cfs flow would have masked any flow-specific effects at 250 cfs.

5.1.1 Evaluation of Effects on FYLF

As demonstrated by the results presented in Section 4.1, there was a noticeable change in the numbers of frogs observed at most of the stations prior to, during, and following the test flow. Except for Station 4A, the numbers of FYLF observed at each station decreased during the 500-cfs test flow, but returned to approximately the same pre-test flow numbers following the test flows. At Station 4A, the numbers of FYLF observed decreased during the test flow, and decreased again following the test flow. However, because only a small number of juveniles were observed at this site, this reverse trend is likely an anomaly.

At those stations where FYLF habitat was characterized as low-relief cobble/boulder bars, moderately to steeply sloping cobble/gravel bars, or boulder/cobble shorelines, increased water depth and water velocities created by the 500-cfs test flow did not appreciably change the nature or extent of the habitat. The frogs appeared to migrate up the shoreline to similar microhabitat as flows increased. At those stations where FYLF habitat was comprised of cobble bar side channels or boulder/sedge habitat, there was a substantial increase in water depth and velocity during the 500-cfs test flow that either reduced or eliminated available habitat.

Based on the limited data obtained during this monitoring effort, the three days of test flows (500 cfs for two days, and 250 cfs for one day) did not appear to have a noticeable negative effect on FYLF metamorphs, juveniles, or subadults at the stations monitored. In general, the numbers of FYLF juveniles and/or metamorphs observed at each station following the test flow were similar to numbers obtained prior to the test flow. Observations made during this monitoring study indicate that metamorphs are able to withstand higher flows by seeking cover in the cracks between boulders and cobble along the shoreline where velocities are lower. However, it is unclear where many of the juvenile and subadult frogs found cover during the 500-cfs test flow, since the number of frogs observed at most of the sites during the test flow was substantially lower than either before or after the test flow. Based on the observed response (noted above) of metamorphs to the test flows on the NFFR, it appears likely that many of the juvenile frogs also found shelter underwater in cracks between boulders and cobble.

During the 500-cfs test flow, stranding of juvenile frogs on isolated boulders up to 50 ft from shore was observed at stations 1A, 1C, 4A, and 4B. It is unknown whether these frogs survived, since they were not observed that far from shore at any of the sites prior to the test flow. Based on observations obtained at all of the sites prior to the test flow, juvenile frogs appear to remain close to shore in shallow water areas. These shallow water areas provide safe habitat from potential predation by fish, and other aquatic predators. Additionally, shallow water areas along the shoreline tend to have slower velocities and are more conducive to young frogs with limited swimming abilities. Juvenile frogs are preyed upon by many aquatic and terrestrial species, and being stranded in mid-river makes them more susceptible to predation.

Since the original site surveys were not conducted at exactly the same time of day, under the same weather and temperature conditions; the numbers of frogs observed at each station throughout the monitoring period may not have been representative of the total numbers of frogs present at each station. In the early evening, after the sun went down, most FYLF tended to seek cover and were often difficult to find. Surveys conducted in the late afternoon when air temperatures were lower than during mid-day, had lower frog counts than surveys conducted at the same location during the middle of the day. In addition, the presence of people and pets (which occurred at several of the stations) prior to and during surveys could have had an effect on the ability of surveyors to detect FYLF.

At Station 1A, the numbers of FYLF observed prior to the test flow was substantially less than the numbers of FYLF observed following the test flow. The lower numbers of FYLF observed at Station 1A prior to the test flow may have been due to the cooler air temperatures and lack of sunshine during the survey, which was conducted in the early evening (between 6:40 and 7:50 pm). In addition, Station 1A was the first survey conducted as part of the NFFR monitoring effort, and surveyors were likely not as proficient at detecting FYLF, as in subsequent surveys. Information obtained during the initial surveys on microhabitat use by FYLF along the NFFR, increased the ability of surveyors to detect their presence at all stations surveyed and monitored as part of this study.

5.1.2 Evaluation of Effects on FYLF Habitat

At stations 1A, 1C, 2B, and 3B, significant changes in FYLF habitat were documented during the test flow, in comparison to pre-test flow conditions. At these stations, FYLF habitat present prior to the test flow was either significantly reduced or eliminated during the highest test flow (500 cfs). Habitat conditions observed at each station following the test flows were similar to conditions documented prior to the test flows, except that vegetation (primarily sedges and other herbaceous plants) remained flattened for an extended period. Figure 7 shows the significant changes in habitat conditions documented at Station 1C prior to, during, and following the test flow.

At stations 1B, 2A, 3A, 4A, and 4B the only significant change in the habitat was associated with the depth and velocity of water within or adjacent to the habitat. At these stations, FYLF habitat was characterized as moderately to steeply sloping cobble/gravel bars or boulder/cobble shorelines, where increasing water depth and water velocities did not appreciably change the nature or extent of the habitat. Frogs appeared to migrate up the shoreline to similar microhabitat as flows increased. Figure 8 shows the minimal changes in habitat conditions documented at Site 3A prior to, during, and following the test flows.

Station 1C – Prior to Test Flows (110 cfs)

Station 1C – During 500-cfs Test Flow

Station 1C – Following Test Flows (110 cfs)

Figure 7. Station 1C, Test Flow Monitoring (Photographs of FYLF Habitat)

Station 3A – Prior to Test Flows (110 cfs)

Station 3A – During 500-cfs Test Flow

Station 3A – Following Test Flows (110 cfs)

(looking downstream)

Figure 8. Station 3A, Test Flow Monitoring (Photographs of FYLF Habitat)

A summary of the monitoring results for each site and station are provided below.

- **Site 1**. Numbers of FYLF subadults, juveniles, and metamorphs observed

Station	Prior to test flows	During 500-cfs test flow	Following test flows
1A	46 Juveniles 4 metamorphs	22 Juveniles 0 metamorphs	113 Juveniles 0 metamorphs
1B	17 Juveniles 8 metamorphs	8 Juveniles 0 metamorphs	12 Juveniles 8 metamorphs
1C	94 Juveniles 8 metamorphs	47 Juveniles 1 metamorph	98 Juveniles 9 metamorphs

- **Site 2**. Numbers of FYLF subadults, juveniles, and metamorphs observed

Station	Prior to test flows	During 500-cfs test flow	Following test flows
2A	8 Juveniles	1 Juvenile	8 Juveniles
2B	1 Juvenile 1 Subadult	0 Juveniles 0 Subadults	1 Juvenile 1 Subadult

- **Site 3**. Numbers of FYLF subadults, juveniles, and metamorphs observed

Station	Prior to test flows	During 500-cfs test flow	Following test flows
3A	9 Juveniles	2 Juveniles 1 Subadult 1 Metamorph	8 Juveniles
3B	34 Juveniles	6 Juveniles	29 Juveniles 1 Subadult

- **Site 4**. Numbers of FYLF subadults, juveniles, and metamorphs observed

Station	Prior to test flows	During 500-cfs test flow	Following test flows
4A	5 Juveniles 0 Subadults	3 Juveniles 1 Subadult	1 Juveniles 2 Subadults
4B	6 Juveniles 2 Subadults	3 Juveniles 0 Subadults	4 Juvenile Subadults

6.0 CONCLUSIONS

Amphibian surveys conducted in August and September 2000 at four sites along the NFFR, and in three selected tributaries to the NFFR, indicate that FYLF are present throughout much of the Poe Project area. FYLF were found at four separate locations along the NFFR and are likely present at additional sites with suitable habitat. FYLF were also observed in all three perennial tributaries.

Preliminary results of the FYLF monitoring studies conducted along the NFFR during the IFIM test flows, indicate that the high flow of 500 cfs did not appear to have a noticeable negative effect on FYLF metamorphs, juveniles, or subadults at the stations monitored in this study.

Based on the limited amount of data collected on amphibians along the NFFR below Poe Dam during the summer and fall of 2000, no definitive conclusions can be made about FYLF population numbers and approximate age structure, or species distribution within the Poe Project area. In addition, the monitoring results obtained on the NFFR during the IFIM test flows only apply to effects associated with an increase in flow from 110 cfs to 500 cfs during late summer. Similar increases in flow on the NFFR at another time of year (i.e., April – July) may have deleterious effects on FYLF eggs and tadpoles.

The following sections provide general statements that can be made regarding information collected in 2000 on FYLF along the NFFR, and in the three perennial tributaries surveyed.

6.1 FYLF Surveys

- Breeding activities appear to be focused along the NFFR. Tadpoles and metamorphs were observed at numerous locations along the river, and in some isolated side pools and spring-fed pools.

- Except for several juveniles observed in a side spring along FVC, only subadult and adult FYLF were observed in the three tributaries. Of the three tributaries surveyed, the largest numbers of adult and subadult FYLF were found in FVC.

- The largest number of juvenile FYLF observed in the Poe Project area in late August and early September 2000 occurred along the NFFR.

- The habitat types along the NFFR where the highest density of FYLF were observed included: cobble/gravel bars, boulder/sedge habitat, side-channels and isolated pools, and elevated spring-fed pools.

6.2 Effects of Test Flows on FYLF

- The numbers of metamorphs, juveniles, and subadults present at the four NFFR monitoring stations following the test flows were similar to the numbers recorded prior to the test flows.

- Based on the results, it appears that metamorphs (and likely older tadpoles), juveniles, and subadults are capable of tolerating short-term high flow events (500 cfs and possibly higher) without apparent negative effect.

- At 500 cfs, the amount of available FYLF habitat associated with most cobble/gravel bars, larger side-channels, and elevated pools did not change significantly from the 110-cfs minimum flow release. However, boulder/sedge habitat, and small side-channels and isolated pools along cobble/gravel bars present at 110 cfs were either substantially reduced or eliminated at 500 cfs.

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POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX E3-9

Results of 2000-2002 Surveys for Foothill Yellow-Legged Frogs (*Rana boylii*) within the Poe Powerhouse Project Area, North Fork Feather River.
Draft Report

Draft Report

RESULTS OF 2000-2002 SURVEYS FOR FOOTHILL YELLOW-LEGGED FROGS (*Rana boylii*) WITHIN THE POE POWERHOUSE PROJECT AREA, NORTH FORK FEATHER RIVER

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April 2003

JOB 306/2

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1.0 Introduction

Pacific Gas and Electric Company (PG&E) owns and operates the Poe Powerhouse Hydroelectric Project (Poe Project) in northeastern California. The Poe Project (FERC 2107) is in the process of being relicensed by the Federal Energy Regulatory Commission (FERC). As part of this relicensing process, PG&E contracted Garcia and Associates (GANDA) to complete a formal report based on the 2000/2001/2002 foothill yellow-legged frog (*Rana boylii*) surveys in the Poe Project area. The foothill yellow-legged frog (FYLF) is designated as a federal Species of Concern, a Forest Service Sensitive species, a California Species of Special Concern, and is fully protected by the state.

The study area includes the North Fork Feather River (NFFR), and up to 0.5 mile (0.8 km) of its tributaries, from Poe Reservoir to Big Bend Dam at the top of Lake Oroville. During 2000, FYLF surveys were conducted in three tributary sites. In 2001, FYLF Visual Encounter Surveys (VES) were conducted at four main stem river sites and associated subsites, along with eight tributary survey sites (Figure 1.1-1). In 2002, FYLF VESs were conducted in the same four main stem river sites and associated subsites. No tributary sites were surveyed in 2002. Detailed figures depicting each site on aerial photos are provided in Appendix A. Site habitat photographs appear in Appendix B in numerical order, by survey site.

2.0 FYLF Species Description, Distribution, Life History, and Habitat Preferences

This section was written by Pacific Gas and Electric Company biologists, Craig Seltenrich and Alicia Pool, and last updated in early 2003.

2.1 Species Description

Juveniles and Adults – The foothill yellow-legged frog is a moderate-sized frog, with juveniles ranging from 22 to 40 mm snout to vent length (SVL), and adults measuring from 40 to 65 mm SVL (Nussbaum et al. 1983). When they reach their maximum adult size, females are larger than males, and may measure up to 20 – 25 mm longer in SVL. The dorsal coloration of FYLFs is highly variable and in many situations blends closely with the predominant color of the surrounding substrate, making the frogs cryptic and difficult to spot. Dorsal color also appears to reflect the amount of sun exposure, with uniform dark gray or olive colored individuals typically observed in heavily shaded streams, and lighter gray, brown, tan, and yellow frogs with varying amounts of spotting found in areas that lack heavy shading (personal observations). Both juveniles and adults may have dark red coloration, often along the poorly developed dorsal lateral folds.

Many juvenile and adult FYLFs are spotted, and their skin may appear rough due to the presence of small tubercles. The tympanum is relatively small, about half the size of the

Figure 1. 1-1. FYLF survey locations in the Poe Powerhouse Project area

eye, and is colored and roughened like the surrounding skin, often making it difficult to see (Leonard et al. 1993; Nussbaum et al. 1983). The dorsal surfaces of the rear legs are often distinctly barred, and the ventral surfaces are pale to brilliant yellow; however, the yellow coloration may be faint or lacking in younger frogs. The posterior portion of the abdomen also may be yellow or light orange in color with the remainder of the abdomen white. Dark mottling on the chin and throat is common but not always present. The webbing of the hind toes is full, slightly concave, and extends to the tip of the longest toe (Leonard et al. 1993).

During the breeding period, males may be identified (without the need to capture them) by their enlarged forearms. In addition, they develop enlarged nuptial pads on the medial surfaces of the thumbs for gripping the female during amplexus, but this characteristic can only be observed if the frog is captured. Male frogs may be found in small groups in areas used for breeding, and young males may be observed in amplexus with each other. On the North Fork Feather River, male frogs have been observed on exposed substrates at mid-day calling from known oviposition sites (personal observations). The call consists of short coarse or guttural sounds with a slightly descending or ascending tone at the end of the call. These low volume calls are repeated in succession separated by silence of various lengths (personal observations). Because FYLFs are known to call primarily underwater (MacTeague and Northern 1993), this type of vocalization would presumably generate vibrations necessary to carry underwater, particularly in stream habitats.

Egg Masses – In coastal streams, Lind et al. (1996) found that egg masses are laid along stream margins in shallow water that is usually <1.0 m deep and in flows less than 21 cm/sec. In the Sierra Nevada Mountains, recent studies have indicated that FYLFs typically deposit egg masses in shallow edgewater habitat <40 cm deep with velocities <10 cm/sec (Pacific Gas and Electric Company 2001, 2002a, 2002b). FYLF egg masses are generally deposited in open, sunny areas and typically have a dark bluish tint for several days following oviposition (Ashton et al. 1998; personal observations). When first deposited, the egg mass is compact and expands as it absorbs water into a medium-to-large fist-sized cluster (Ashton et al. 1998), although smaller egg masses have been observed at some locations on the Middle Fork Stanislaus River (personal observations). Females normally deposit eggs in clusters of 200-300, but clusters may range from 100 to 1,000 eggs (Storer 1925; Nussbaum et al. 1983; Zeiner et al. 1988). After absorbing water, the egg mass loses its bluish color and resembles a bunch of small grapes. Individual eggs are distinctly black and are encased by clear gelatinous envelopes (Ashton et al. 1998), and as the ova develop, they can be seen elongating within the envelope (personal observations). Eggs on the outside of the mass that receive the most sunlight have been observed developing and hatching first, with the interior eggs hatching at a later date (personal observations). Depending on stream water quality and water velocity at the location of the egg mass, sediment and algae may accumulate on the mass making it very difficult to find. Within a week or two after eggs have hatched, the egg mass breaks down and the tadpoles begin to disperse (Ashton et al. 1998). This may be highly dependent on the location of the egg mass and stream conditions, such as water temperature, water depth, cover, and flows.

Tadpoles – When tadpoles emerge, they are totally black and measure less than 8 mm total length (Nussbaum et al. 1983). As tadpoles grow, they begin to turn light brown, tan, or olive, with gold flecks or dark spots scattered on the dorsal surface and tail musculature. At this stage, their cryptic coloration blends with the algae and flocculent material in shallow edgewater habitat, making them very difficult to find. Depending on the stage of development, their eyes may appear on the top of the head or slightly inset from the outline of the head when viewed from above (personal observations). Rear legs begin to develop first and become fully developed before front legs start to appear. Tadpoles retain their tail during metamorphosis, providing them with excellent propulsion and making them difficult to capture when combined with the cryptic coloration (personal observations). Tadpoles reach a maximum total length of around 55 mm, and once metamorphosed into young frogs, they measure between 22 and 27 mm total length (Nussbaum et al. 1983; Zeiner et al. 1988), with the majority of newly metamorphosed frogs measuring from 22 to 24 mm (Pacific Gas and Electric Company 2001, 2002a, 2002b).

2.2 Distribution

Historically, FYLFs were found in the Coast Ranges from the Santiam River drainage in Oregon (Mehama and Marion counties) to the San Gabriel River drainage in California (Los Angeles County), and along the west slopes of the Sierra Nevada/Cascade crest in most of central and northern California (Storer 1925; Fitch 1938; Zweifel 1955). The elevational range of the FYLF extends from near sea level to about 5,000 ft. However, specimens catalogued at the University of California Museum of Vertebrate Zoology (MVZ 35914-18) show that this species has been recorded at elevations as high as 6,000 ft in Plumas County (Zweifel 1955). Jennings and Hayes (1994) indicate that FYLFs have disappeared from about 45 percent of their historic range in California and 66 percent of their historic range in the Sierra Nevada Mountains. Based on the results of recent surveys conducted on the Pit, North Fork Feather, North Fork Mokelumne, and Middle Fork Stanislaus rivers, breeding populations of FYLFs documented on these regulated rivers have all been below 3,000 ft in elevation, with the majority of the frogs occurring at elevations below 2,500 ft (Pacific Gas and Electric Company 2001, 2002a, 2002b; Spring Rivers 2001; Ibis Environmental, Inc. 2002).

FYLF have been recorded in several locations within and adjacent to the Poe Powerhouse Project area along the lower reaches of the North Fork Feather River (NFFR) above Lake Oroville (ECORP 2000; this study). Other records from Plumas County include observations in Slate Creek, Onion Creek, and Slate Creek Reservoir, three miles southeast of Little Grass Valley Reservoir; South Fork Feather River near Forest Road 22N24; and Spanish Creek, 200 m north of Forest Road 24N30 (CDFG 2002). Koo and Vindum (1999) found FYLF in September 1998 on Spanish Creek near Greens Flat, approximately seven miles east of Three Lakes at an elevation of 4,000 ft (1311 m). Another recent (2002) survey along the Spanish Creek drainage northeast of the Project area found adult FYLF occurring less than one mile from adult mountain yellow-legged frogs (*Rana muscosa*; MYLF) on Bean Creek (GANDA 2002). MYLFs occurred at an elevation of 4,500 feet (1,475 m) and FYLFs were observed at 4,400 feet (1,440 m). The highest elevational record for FYLF from nearby Lassen National Forest also occurred at 4,400 ft. (1,440 m) along Round Valley Creek, approximately 22 km west of Lake Almanor in Tehama County (1999; M. McFarland, USFS Biologist, Jan. 2001, unpublished Lassen National Forest data).

2.3 Life History

FYLFs are a highly aquatic amphibian, spending most or all of their life in or near streams. In addition, frogs have been documented underground and beneath surface objects more than 50 m from water (Nussbaum et al. 1983). Adult FYLFs are primarily diurnal with strong site fidelity and typically occupy small home ranges. However, from April through June, adults and subadults may move several hundred meters or more, to congregate at breeding sites. FYLFs may be active all year in the warmest localities, but may become inactive or hibernate in colder areas.

Seasonal movements of adult and recently metamorphosed FYLFs indicate a preference for different habitat types depending on seasonal requirements. Adult frogs, primarily males, will congregate along main stem rivers during spring to breed. However, adults do not typically remain in these areas during summer, returning instead to basking and foraging sites on tributaries, or retreating to cooler microhabitats along shaded river sections. They also may decrease diurnal activity during the hottest part of the summer. Zweifel (1955) noted that younger individuals typically remained by the stream until late fall and appeared earlier in the spring than adults. Observations of juvenile FYLFs have shown a strong tendency to initiate upstream migrations in late summer and early fall (Ashton et al. 1998; Twitty et al. 1967) similar to the compensating mechanism displayed by stream insects subject to downstream drift (Jennings and Hayes 1994). These movements are often correlated with the presence of upstream tributaries containing suitable habitat for FYLFs, and it is speculated that this may be an evolutionarily mechanism this species has developed to repatriate larvae that may have been washed downstream (Ashton et al. 1998).

Egg laying normally follows the period of high-flow discharge associated with winter rainfall and snowmelt, usually between late March and early June (Storer 1925; Grinnell et al. 1930; Wright and Wright 1949). Prior to the onset of breeding, adult frogs begin to appear along stream margins, especially on warm sunny days. As flows diminish and water temperatures begin to increase, males are usually the first to begin moving back to breeding areas to establish calling stations. Females arrive later when average air temperatures increase, stream flows decrease, and water temperatures reach 12 to 15°C. Breeding tends to take place in the same general area each year, unless stream conditions change and the habitat is no longer suitable for breeding. FYLF oviposition has previously been thought to be completed within a two-week period (Storer 1925; Zweifel

1955; Nussbaum et al. 1983; Stebbins 1985; Jennings 1988); however, studies on coastal streams (Kupferberg 1996; Lind et al. 1996) and Sierra Nevada streams (Pacific Gas and Electric Company 2001, 2002a, 2002b) have revealed that breeding may extend over a longer period of time. Kupferberg (1996) suggests this might be the result of late season rains or drought conditions.

Females may deposit from 100 to 1,000 eggs (Storer 1925), but more typically deposit 200 to 300 eggs in clusters attached to the sides or undersides of cobbles and boulders, or less commonly to gravel, vegetation, or submerged logs or root wads. Egg masses (clusters) are most often deposited in shallow edgewater areas <40 cm deep with little or no water flow (<10 cm/sec), and eggs generally hatch in about 15 to 30 days depending on water temperature. Nussbaum et al. (1983) reported eggs hatching in about five days at a temperature of 20° C. FYLF tadpoles metamorphose into juvenile frogs in three to four months. During the early stages of development, tadpoles are herbivorous, feeding on diatoms and other algae (Kupferberg 1996), and as they mature will opportunistically feed on the necrotic tissue of dead tadpoles or macrofauna, if available (Ashton et al. 1998).

After metamorphosis, the diet of juvenile frogs is similar to that of adults and includes terrestrial and aquatic invertebrates such as spiders, moths, flies, beetles, water striders, snails, and grasshoppers, as well as crustaceans and molluscs. Two years are thought to be required to reach adult size (Storer 1925), with sexual maturity at 1-2 years for males and two years for females (Zweifel 1955; Nussbaum et al. 1983), although some individuals may reproduce as early as six months after metamorphosis (Jennings 1988). During studies on a tributary to the Yuba River, Van Wagner (1996) documented one-year-old males with enlarged forearms and nuptial pads that had a strong clasping reflex. He also noted that larger young-of-the-year males displayed these breeding characteristics during the fall, when both male and female adult frogs displayed breeding readiness. Of particular note, some of the larger females displayed distended abdomens and appeared gravid. Although little data are available regarding longevity of FYLFs in the wild, Van Wagner (1996) reported a female at least three years old, and based on studies of other ranids, the life span of FYLFs may be more than three years (Duellman and Trueb 1986).

Garter snakes (*Thamnophis* spp.) are the principal natural predator of tadpoles, juvenile and adult frogs. Other natural predators that FYLFs evolved with may include aquatic insects, various fish species, birds, and mammals (Ashton et al. 1998). Moyle (1973) implicated introduced bullfrogs (*Rana catesbeiana*) in the observed reduction of FYLF populations in the Central Valley and Sierra foothills. The introduction of non-native fishes, including centrarchids (bass, sunfish, etc.), known to readily eat Rana eggs (Werschkul and Chrsitensen 1977), and stocking of salmonids (trout) in streams where they historically did not exist, also may contribute to the disappearance or reduction of FYLF populations in Sierra streams. Additional human-caused impacts to FYLFs and their habitat include, but are not limited to, construction and maintenance of dams and reservoirs, controlled stream flows, recreation, mining, logging, and livestock grazing

(Jennings and Hayes 1994; Lind et al. 1996). In addition to these factors, there is increasing evidence reported by The Declining Amphibian Population Task Force (DAPTF) that the occurrence of disease, specifically the chytrid fungus, is increasing in the Sierra Nevada (Speare et al. 1998). With the increasing number of amphibian surveys in the Sierra Nevada mountains, there is a high risk of surveyors spreading diseases among and between amphibian populations. The DAPTF has compiled procedures to minimize the spread of disease agents and parasites between study sites, which can be found in the DAPTF Fieldwork Code of Practice website at (http://www.mpm.edu/collect/vertzo/herp/Daptf/fcode_e.html).

2.4 Habitat Preferences

FYLFs are characteristically found close to water in association with perennial streams and ephemeral creeks that retain perennial pools through the end of summer. In general, FYLFs appear to prefer low-to-moderate gradient (0 to 4%) streams, particularly for breeding; however, juvenile and adult frogs also may utilize moderate-to-steep gradient (4 to ≥10%) creeks during the summer and early fall (personal observations). FYLFs utilize or are associated with a variety of aquatic habitat types, including: pools, riffles, runs, cascade pools, and step-pools, depending on life stage and the time of year. In California, specific habitat preferences for each life stage have been documented for streams in the Coast Ranges (Kupferberg 1996; Lind et al. 1996), and in several large river systems in the Sierra Nevada (Pacific Gas and Electric Company 2001, 2002a, 2002b; Spring Rivers 2001; Ibis Environmental, Inc. 2002). Adults preferentially utilize shallow edgewater areas with low water velocities (<10 cm/sec) for breeding and egg laying, and juvenile and adult frogs may be found adjacent to riffles, cascades, main channel pools, and plunge-pools that provide escape cover.

FYLFs are found in or near streams associated with a variety of upland habitats including foothill hardwood, foothill hardwood-conifer, mixed conifer, chaparral, and coastal scrub. FYLFs have been documented on streams with both low and moderate amounts of riparian and overhanging canopy cover. Occurrence and distribution relative to stream canopy or shade may be somewhat tied to life stage (Ashton et al. 1998), but there is an observed preference for streams that offer a combination of exposed basking sites and shade (personal observations).

Little is known of the habits or habitat preferences of FYLFs during winter months at higher elevations (elevations where freezing conditions are common). FYLFs likely hibernate in nearby burrows or under cover objects such as woody debris and vegetation, or they may remain in the water where they have been found in streams with water temperatures as low as 7.5° C (personal observations).

Breeding and Egg-Laying Habitats – In rivers, breeding areas are often located within relatively close proximity to the confluences of tributary streams (Kupferberg 1996), and in both perennial and ephemeral streams with permanent pools (personal observations).

Macro- and microhabitats utilized by FYLFs for breeding and oviposition depend largely on the availability of suitable habitat. Breeding areas are typically located in shallow edgewater areas along low gradient cobble and small boulder dominated point or lateral bars, in side channels, pool tail-outs, and side pools along river margins. In many streams, FYLF breeding habitat is often associated with main channel pools, runs, glides, or very low-gradient riffles in areas with predominantly cobble, boulder, and gravel substrates.

FYLF egg masses are often attached to the sides or undersides of large cobble and boulders, although they also may be attached to small cobble, gravel/pebble substrates, vegetation, or underwater woody debris. In rivers, egg masses are typically located in relatively shallow, calm edgewater areas within 3 m of shore, and are more commonly found closer to the bottom than the water surface. Data obtained during studies conducted on the Pit, North Fork Feather, North Fork Mokelumne, and Middle Fork Stanislaus rivers (Pacific Gas and Electric Company 2001, 2002a, 2002b; Spring Rivers 2001; Ibis Environmental, Inc. 2002) indicate that these shallow breeding areas are typically <40 cm deep with velocities <10 cm/sec. However, depending on the habitat type and presence of aquatic predators, oviposition also may occur in deeper water and in slightly faster currents up to 20 cm/sec. Several studies have documented partial scouring of egg masses at velocities ≥ 20 cm/sec (Kupferberg 1996; Pacific Gas and Electric Company 2002a). Egg masses usually are located in open sunny areas with little shade from riparian vegetation. Field observations have documented that eggs exposed to the sun mature more quickly than those in shade or partial shade, regardless of water temperature. In addition, eggs on the perimeter of the mass have been found to develop and hatch first, with eggs located in the center hatching several days later (personal observations).

Tadpole Habitats – Tadpoles generally occur in the same locations and habitat as that used for breeding and egg deposition, and young tadpoles appear to have some fidelity to the original egg mass site (Ashton et al. 1998). In the absence of disturbance (e.g., substantial increase in water velocity, significant drop in water level, recreation, etc.), tadpoles usually remain in the vicinity of the egg mass for several days, slowly dispersing into adjacent areas as they grow. Young tadpoles forage on diatoms or other algae on the surface of the surrounding substrate (Kupferberg 1996; Ashton et al. 1998). However, as they develop, tadpoles lose the black coloration and become more camouflaged, blending with the background. From this stage of development (approximately four weeks after hatching) until they reach metamorphosis, tadpoles are cryptic and often match the color of bottom substrates and detritus. FYLF tadpoles appear to prefer edgewater habitat where water temperatures are generally warmer (usually by at least 2 - 4° C) than the mainstream temperature. Tadpoles appear to prefer calm shallow water and will utilize substrate interstices, detritus, and aquatic vegetation for cover.

Juvenile Habitats – Following metamorphosis, juvenile frogs may be observed in groups and, where numerous, may be conspicuous along rocky stream margins (personal observations). Juveniles typically remain in the vicinity of breeding locations for the remainder of the summer and fall. However, juvenile frogs have been observed on the Middle Fork Stanislaus River migrating upriver or up nearby tributaries in September (personal observations). When associated with river cobble bars, some juveniles may disperse to nearby isolated pools or side channels (personal observations). By November or December, and through the remainder of winter, juvenile frogs are typically absent from stream margins. However, depending on elevation and local weather conditions, juvenile and adult frogs occasionally may be observed on warmer winter days along streams, even when water temperatures are as low as 7.5° C (personal observations). In some streams, adult frogs may remain close to the water all winter, spending a portion of the time underwater (Van Wagner 1996).

As with adult FYLFs, juveniles are strongly associated with cobble bars and slow-moving portions of streams. On the South Yuba River, Yarnell (2000) found juvenile FYLFs in wider portions of stream channels with low-relief banks. These stream sections provided protected overflow areas during winter and spring months. Second-year juveniles begin to depend upon streamside shading (shading >20%) and the cover afforded by overhanging streamside vegetation (Ashton et al. 1998), much the same as adults.

Adult Habitats – During the summer and fall, adult FYLFs appear to prefer stream channels that provide exposed basking sites and cool shady areas immediately adjacent to the water's edge. When disturbed, they typically dive into the water and take refuge on the bottom in cobble, boulder, gravel, silt, or vegetation (Stebbins 1985). Recent observations (Kupferberg 1996; Lind et al. 1996; Pacific Gas and Electric Company 2001, 2002a, 2002b) have corroborated information from Moyle (1973) that adults tend to prefer channel margins that provide some vegetative shading, either from the riparian canopy or occasionally understory vegetation bordering the water's edge. In contrast, studies on the South Yuba River found that adults appear to prefer deep, channelized stream types and pool-type habitats on a year-round basis (Yarnell 2000). These differences are likely due to the availability of preferred habitat types on different river systems. FYLFs appear to be very adaptable to varying conditions and may utilize alternate habitat types when necessary. Recent studies conducted on several river drainages in the Sierra Nevada have documented significant differences in habitat types between drainages occupied by FYLFs (personal observations).

Recent investigations into the presence and distribution of FYLFs on the North Fork Feather, North Fork Mokelumne, Middle Fork Stanislaus (Pacific Gas and Electric Company 2001, 2002a, 2002b; Ibis Environmental, Inc. 2002), and Trinity (Lind et al. 1996) rivers have noted that, except during the breeding season, adults are seldom found in stream reaches that do not provide at least a moderate amount of riparian or margin vegetative shading. Though potentially abundant during the breeding season, adults typically are observed at a reduced frequency on main stem river areas during the remainder of the year. Ashton et al. (1998) speculated that adults either are dispersing into streamside vegetation or adjacent tributaries, or possibly reducing diurnal activity. During the summer, some adults may remain in the vicinity of breeding sites on main stem rivers if there are cool, partly shady areas with adequate cover (Pacific Gas and Electric Company 2002a, 2002b; personal observations). However, adults seem to prefer nearby tributary streams where overhead riparian canopy provides areas of partial sun and shade throughout the day, and air temperatures are cooler than on the main river. Perennial streams appear to be the preferred summer habitat of adults; however, ephemeral streams with perennial pools also provide suitable habitat (Pacific Gas and Electric Company 2002a, 2002b; Ibis Environmental, Inc. 2002). Adult frogs are not usually found in sections of creek that have moderately high to high amounts of low overhanging cover (shade).

As with juvenile FYLFs, adults are typically absent from stream margins by November or December through the remainder of winter. However, depending on elevation and local weather conditions, adult frogs occasionally may be observed on warmer winter days along streams (personal observations). In some streams, adult frogs may remain close to the water all winter, spending a portion of the time underwater (Van Wagner 1996).

3.0 Methodologies

3.1 Site Habitat Assessments

Detailed habitat assessments were conducted according to "A Standardized Approach for Habitat Assessments and Visual Encounter Surveys for the Foothill Yellow-Legged Frog (*Rana boylii*)" (Survey Protocol) (Seltenrich and Pool 2002) (Appendix C) by PG&E biologists Craig Seltenrich and Alicia Pool from May to September 2001. Habitat assessment standard operating procedures (SOPs) and data forms included in the Survey Protocol were used for all site habitat assessments. For all Habitat Assessment and Visual Encounter Survey forms, left bank and right bank notation refers to side of stream seen facing downstream. Habitat assessements were not repeated at subsites during 2002; however, significant habitat changes were noted onto field forms and this information is provided along with the 2001 results.

All survey sites contained two or more areas of distinct habitat (e.g., boulder/sedge margin, cobble bar, side pool) and the sites were divided into subsites based on these dissimilar habitat conditions. A separate habitat assessment form was completed for each subsite. Habitat assessments were conducted prior to Visual Encounter Surveys (Section 3.2) on the initial site visit. Additional habitat assessments were conducted during the season if habitat conditions changed significantly, and during a high flow period associated with the suspended operation of Poe Powerhouse during a wild fire adjacent to the Project area (12-13 September 2001).

Key habitat parameters recorded during habitat assessments included: water temperature; general habitat type; gradient; percent aquatic and terrestrial cover; percent riparian canopy; terrestrial and aquatic substrate; and water velocity. Stream measurements were determined using a 100 m tape and a rangefinder. Habitat photographs (Appendix B) were taken at all survey locations, usually during the habitat assessment procedure. An attempt was made to take photographs of upper (upstream), middle, and lower portions of all sites and subsites. Each photograph caption contains the date and time the picture was taken; site and location; subsite; and photograph number (initials of photographer/roll # - picture #).

3.2 Visual Encounter Surveys

Visual Encounter Surveys were conducted during the summer of 2000, spring and summer of 2001, and spring and summer of 2002 by PG&E biologists Craig Seltenrich and Alicia Pool. The timing and number of VES followed the schedule particular to habitat (i.e., mainstem river, tributary) as specified in the Survey Protocol. For the main river sites, one or two initial surveys were conducted in May and early June to search for egg masses and adults. A follow-up survey was conducted at all sites four to eight weeks later to search for larvae, metamorphs, and adults frogs. If tadpoles were found during earlier surveys, a final visit targeting juveniles and adults was conducted in late summer or early fall. As specified in the Survey Protocol, all tributary sites were searched once in late summer. VES were conducted on warm, sunny days with light or no winds, unless the site was protected from stronger prevailing winds, between 0900 and 1800 hours. Whenever possible, VES surveys were conducted from the downstream end to the upstream end of the site. Polarized sunglasses were used to reduce glare and increase visibility into aquatic habitats, and care was taken to minimize disturbance to herpetofauna and aquatic habitats.

The detailed VES Survey Protocol (Appendix C; Seltenrich and Pool 2002) was followed when conducting all VES. The two PG&E surveyors typically worked in tandem during surveys. One biologist searched the shoreline ahead for adult and juvenile frogs, using binoculars when feasible, while the second biologist searched appropriate microhabitats for egg masses and tadpoles using a dip net to sample areas of low visibility (e.g., undercut banks) and a Plexiglas frame to peer into areas with surface turbulence (e.g., pocket water behind boulders).

Data from VES were recorded onto Visual Encounter Survey Data Sheets in the survey protocol specific to either: (1) FYLF River Sites, or (2) FYLF Tributary Sites. Separate data sheets were provided for juveniles and adults, tadpoles, and egg masses (Appendix E). The data parameters collected for egg masses included: location; attachment substrate; percent silt on eggs; orientation and flow direction; stream velocity at egg mass; depth; distance to shore; aquatic habitat; and water temperature. The data parameters collected for tadpoles included: location; number of tadpoles; stage of development; aquatic habitat; substrate; distance to shore; stream velocity; depth; and water temperature. The data parameters collected for juvenile, subadult, and adult frogs included: number of frogs observed; frog location in site; sex; age; snout-vent length; habitat type; activity; and substrate. Search area lengths were measured with a 100 m tape and a rangefinder and included the lengths of all linear site and subsite transects, plus the lengths of additional transects searched (e.g., side pools).

For the analysis of Project-wide (pooled) data, egg mass flow velocities were entered onto data forms in the field in the following manner: (a) for a range (e.g. 5-7 cm/sec), values were entered as that mean (e.g., 6); (b) for less than a value (e.g. <2), values were entered as the maximum (i.e., 2 in example), or (c) for an estimate (~), values were entered as the estimated value. Also for this analysis, if tadpole distance to shore (cm) values were entered onto data forms in the field as: (a) a range (e.g. 15-20 cm), then values were entered as the maximum (e.g., 20); or (b) less than a value (e.g. <100 cm), then values were also entered as the maximum (i.e., 100 in example). This assumption was made to conservatively represent tadpole groups' exposure to predatory fish. However, if tadpole depth measurements were entered as a range (e.g., tadpoles were in 6-30 cm deep water), then values were entered as the mean (e.g., 18 cm). This assumption was made to give as much parity as possible to data representing tadpole depth requirements and habitat use tendencies.

4.0 Results

4.1 Site Habitat Assessments

In this section, a description is provided of pertinent habitat features at each of the four river survey sites (11 subsites) and eight tributary sites based on the information gathered during the 2001 site habitat assessments. Notes of significant changes to habitats observed in 2002 also are included. In general, many sites had more dense shoreline vegetation in 2002 compared to 2001 because of the absence of high, scouring flows during the winter/spring period between the two years. Completed Site Habitat Assessment Data Sheets for each site are located in Appendix D. Incidental sightings of non-target amphibians and other aquatic species are also included in site descriptions. Figure 1.1-1 above shows the location of all Poe Project FYLF survey locations.

4.1.1 Site 1 – Poe Powerhouse Area

Site 1 is located at the tail-out of a long riverine pool where a large cobble island forms a low-gradient side channel in a braided section of the NFFR flowing into Big Bend Reservoir adjacent to Poe Powerhouse. The powerhouse is located at the top of Big Bend Reservoir (functionally, Poe Powerhouse afterbay), impounded by the Big Bend Dam which is located about 1.3 km downstream from Poe Powerhouse. Built in 1911, this dam diverted water to the old Big Bend Powerhouse, now under Lake Oroville. At full pool (274 m, 899 ft elevation), Lake Oroville reservoir extends all the way up the NFFR channel to Big Bend Dam. Site 1 is 431 m in overall length and consists of two subsites. Stream flows were 3.7 cm/sec (Pulga gauge) on 12 May 2001, the date of the Site 1 habitat assessment. Two subsites were surveyed in both 2001 and 2002.

4.1.1.1 Subsite 1a

Subsite 1a is a low-gradient side channel along the left bank of the NFFR that drains the long pool upstream of Poe Powerhouse. The survey section includes both banks of a 160 m portion of the channel and the entire 8 m wetted channel width. Lotic habitat of the channel was mostly pool, with a high-gradient riffle at the head and a low-gradient riffle at the tail. Cobble bars formed both banks of this side channel with moderate- and high-gradients on the right and left banks, respectively, with no riparian cover. Vegetation (mostly sedge) was 30 percent for the right bank and 70 percent on the left, and terrestrial amphibian cover was estimated at 30 and 40 percent for the respective channel banks (mostly boulder on the right bank, and vegetation on the left bank). Aquatic cover was greatest along the right bank (50%) and consisted mostly of boulders. The aquatic substrate was mostly cobbles (50%) and boulders (20%). No algae was found on stream substrate on 29 September, 2001 (it had provided up to 30% aquatic cover prior), indicating that the channel was flushed out during peak flows when the powerhouse was off-line (11-13 September 2001; see Section 4.2). In 2002, heavy growth of herbaceous vegetation and willow carpeted most of the stream margin leaving very little exposed bank area. Three juvenile western terrestrial garter snakes (*Thamnophis elegans*), Pacific treefrog (*Hyla regilla*) tadpoles, and crayfish were observed at this subsite in 2001. Garter snakes (N = 5), treefrog tadpoles, and crayfish also were observed in 2002. Fish observed included centrarchids and cyprinids in both years.

4.1.1.2 Subsite 1b

Subsite 1b is a low-gradient cobble bar located at the tail-out of the long pool on the NFFR upstream of Poe Powerhouse and at the top of the large cobble island that forms two channels adjacent to the powerhouse. The subsite included 101 m along the base of the tail-out and was 4 m wide. The cobble bar gradient was low; the inundated cobble bar depth averaged 20 cm, with flows between 0 and 2 cm/sec. Lotic habitat was 90 percent pool and 10 percent low-gradient riffle. Aquatic substrate was mostly cobble (50%) and gravel (40%). While there was no riparian canopy cover, vegetation at the margin was 80 percent (mostly sedge) and contributed to most of the available terrestrial cover (60%). Emergent vegetation (10%), submerged vegetation (10%), and aquatic cover (30%) were all relatively sparse. In April 2002, habitat conditions were similar to those described in 2001; however, by August 2002, the shoreline vegetation growth was dense, up to three feet tall and offered very little open shoreline for frogs. One adult western aquatic garter snake (*Thamnophis couchii*), cyprinids, and crayfish were observed at Subsite 1b in 2001. Nine garter snakes, treefrog adults and egg masses, crayfish, and cyprinids were recorded during 2002 VES.

4.1.2 Site 2 – Swimmer's Beach Area

The Swimmer's Beach area (Site 2) is located about one river km upstream from Poe Powerhouse, and about 400 m upstream of the Poe Powerhouse Road bridge. From the top, the entire site extends for 435 m downstream along a run, through a low-gradient riffle, into a long riverine pool, and down to the pool tail-out at another low-gradient riffle. There were three subsites surveyed in 2001 and 2002 (see below); the initial site habitat assessments for all subsites were conducted on 11 May 2001, when stream flow at the Pulga gauge was measured at 3.7 cm/sec.

4.1.2.1 Subsite 2a

Subsite 2a is a low-gradient cobble bar and backwater pool area at the tail-out of the long pool at Swimmer's Beach. The subsite extends for 88 m through these habitats at the tail of the pool and was 4 m wide. The maximum depth of the backwater area was approximately 90 cm and averaged about 35 cm deep. The primary aquatic substrate was cobble (70%). No data were recorded for vegetative cover in 2001. By 17 May 2002, vegetation, mostly razor grass, covered almost 100 percent of the shoreline. Two garter snakes and cyprinids were observed at this subsite in 2002. Centrarchids, Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento suckers (*Catostomus occidentalis*), crayfish, treefrog adults and tadpoles, and three garter snakes were observed during 2002 VES at Subsite 2a.

4.1.2.2 Subsite 2b

Subsite 2b is a low-to-moderate gradient cobble/boulder bar along the right bank in the middle portion of the main channel pool at the Swimmer's Beach area. The subsite was 96 m long and 3 m wide. A backwater area at the top of the site was 30 cm deep at its maximum and averaged 15 cm deep overall. Forb and sedge vegetation covered only 40 percent of the margin, and both terrestrial and aquatic cover was estimated at 50 percent, primarily boulders. In July, the habitat along the edgewater appeared suitable for FYLF juveniles and tadpoles, i.e., shallows with flocculent material and abundant aquatic insects. The principal aquatic substrates were cobble (50%) and boulder (30%), and lotic habitat was mostly pool (80%) with some run (20%). There was no riparian canopy cover. The inundated portion of the cobble bar averaged 20 cm deep. One adult treefrog, cyprinids, and crayfish were seen at Subsite 2b in 2001. Juvenile centrarchids, cyprinids, an adult treefrog, and one garter snake were recorded in 2002.

4.1.2.3 Subsite 2c

Subsite 2c is a low-gradient cobble/boulder lateral bar on the left bank along the run and riffle portion at the top of Site 2 at Swimmer's Beach. The lower end of this subsite is at the head of a low-gradient riffle at the base of the run. The subsite is 122 m long and 3.5 m wide. A backwater area at the bottom of the site averaged 20 cm deep and was 35 cm deep at its maximum. Vegetation cover at the margin was only 40 percent (forb, sedge, and willow), and emergent and submergent vegetation cover was sparse (20% and 10%, respectively). Terrestrial and aquatic amphibian cover was moderate (50% and 60%, respectively), with mostly boulders and cobbles. The inundated portion of the cobble bar averaged 25 cm deep, with flow velocities between 1-3 cm/sec. Four garter snakes, including adult and juvenile western aquatic and western terrestrial species, and treefrog tadpoles were recorded at this subsite in 2001. Two garter snakes, treefrog tadpoles, cyprinids, centrarchids, and crayfish were recorded in 2002.

4.1.3 Site 3 - Bardees Bar Area

Site 3 is located in the NFFR Bardees Bar area, approximately 6 km upstream of Poe Powerhouse. The overall site is 181 m long and includes the lower portion of a large main channel pool and a side pool near its tail-out. There were two subsites surveyed in 2001 and 2002; initial habitat assessments for these subsites were conducted on 31 May 2001, when river flows at the Pulga gauge upstream measured 3 cm/sec.

4.1.3.1 Subsite 3a

Subsite 3a is a 103 m long and 4 m wide section of boulder/sedge margin along a right bank side pool and at the tail-out riffle on the main channel pool in Site 3. Lotic habitat was 80 percent pool and 20 percent riffle. Depths in backwater habitats averaged 100 cm with a maximum of 200 cm. Potential amphibian habitat conditions were similar for both side pool and river channel portions of this subsite, except that submerged vegetation (algae, aquatic plants) was denser in the side pool (50%) than out on the river (<10%). Sedge, forb, and willow vegetation coverage at the margin was 50 percent overall, and terrestrial cover (boulder, vegetation) was 50 and 40 percent for the river and side pool portions, respectively. Shoreline vegetation along the margin has increased since 2001; however, the difference was less that at some of the other subsites, due primarily to the abundance of rocky substrates. Boulders made up most of the aquatic substrate (60%), and there was less than 10 percent riparian cover, in the form of willows. In general, there was very little habitat for tadpoles in the side pool with predators occurring up to the shoreline and small crayfish occupying areas of potential habitat. Cyprinids, centrarchids (large bass), and large and small crayfish were observed in Subsite 3a waters in 2001. Centrarchid, crayfish, and six garter snakes were recorded during 2002 VES.

4.1.3.2 Subsite 3b

Subsite 3b is a 78 m length of 3 m wide moderate-to-steep gradient cobble/boulder lateral bar located along the right bank of the main channel pool at the Bardees Bar old bridge crossing. There were no backwater areas present and the main channel pool comprised 100 percent of the lotic habitat in the subsite. Mostly grass and sedge vegetation covered 50 percent of the shoreline margin, but emergent and submerged vegetation cover was low (20% and <10%, respectively). Aquatic and terrestrial amphibian cover, principally cobble and boulders, were estimated at 30 percent each. Aquatic substrate at the subsite was comprised of predominantly cobble (50%) and gravel (30%). In 2002, edgewater habitats were disturbed by recreational and mining activities, and substrates were highly compacted which mostly eliminated potential aquatic cover for tadpoles. In addition, very little algae or detritus was available for tadpoles where mining occurred. Bass

(*Micropterus* sp.), pikeminnow, and a juvenile western aquatic garter snake were observed at the subsite in 2001, whereas crayfish, centrarchids, and cyprinids were observed during the 2002 VES.

4.1.4 Site 4 – Flea Valley Creek Area

The Flea Valley Creek survey area (Site 4) is located on the NFFR at the confluence with Flea Valley Creek and adjacent to the Pulga railroad siding and town site, about 1 km downstream of Poe Dam. The overall site length is 419 m. The top half is low-gradient run and riffle, and the bottom half is low-gradient run. There were four subsites surveyed in 2001 and 2002 (see below); the initial site habitat assessments for all subsites were conducted on 10 May 2001, when stream flow at the Pulga gauge just downstream measured 3.6 cm/sec.

4.1.4.1 Subsite 4a

Subsite 4a is a 72 m long by 6 m wide section of boulder/sedge margin along the right bank of the NFFR approximately 10 m downstream from the confluence with Flea Valley Creek. The area contained backwater areas (30 cm average depth, 50 cm maximum), with two contiguous side pools, three isolated side pools, and a spring pool pothole at the top of the site. Sedge growth covered 60 percent along the margin and accounted for 30 percent emergent cover on the initial visit; however, by 30 May 2001, vegetation (predominately sedge) on the margin and emergent vegetation for both increased to 80 percent cover. Terrestrial cover estimates also increased from 60 percent to 90 percent between the two visits, due to increased sedge growth. Sedge growth density was even greater during visits in 2002. Boulders provided most of the estimated 20 percent aquatic amphibian cover. Willow leaf emergent growth increased riparian canopy from <2 percent on 10 May to about 15 percent on 30 May. Aquatic substrate was primarily boulders (50%) and cobble (40%). There was a high amount of detritus covering all substrate that was easily suspended. Lotic habitat was run. Fish species observed in 2001 included salmonids and cyprinids, along with one juvenile garter snake and treefrog tadpoles. Other species observed during VES in 2002 included sucker, cyprinids, salmonids, treefrog tadpoles and adults, crayfish, and six garter snakes.

4.1.4.2 Subsite 4b

Subsite 4b is a moderate-gradient cobble/boulder lateral bar (50 m x 3 m) along the right bank, formed by the alluvial outflow of Flea Valley Creek into the NFFR. Aquatic substrate was primarily cobble (70%), with 30 percent gravel. Margin, emergent, and submerged vegetation coverage were all <10 percent, as was the available aquatic and terrestrial amphibian cover. Lotic habitat was run, and there was no riparian canopy. Salmonids and cyprinids were observed in this subsite in 2001. Other species observed during VES in 2002 included cyprinids, salmonids, treefrog tadpoles and adults, crayfish, and six garter snakes.

4.1.4.3 Subsite 4c

Subsite 4c is a broad, low-gradient lateral cobble/boulder bar on the right bank NFFR along riffle/run habitat just upstream of the confluence of Flea Valley Creek. There were no backwater areas, although there was one isolated and three contiguous side pools in the subsite. Emergent and submerged vegetation were sparse (10%), as was the riparian canopy (<10%). Overall available terrestrial and aquatic amphibian cover values were only moderate (30% and 40%, respectively). In 2002, the amount of detritus was up to 6 cm thick in some places. Aquatic substrate was mostly cobble (50%) and boulder (40%). The inundated portion of the cobble bar averaged 15-20 cm deep with flow velocities between 3-4 cm/sec. Lotic habitat at this subsite was mostly run (80%) with some riffle (20%). Male FYLF were calling during the initial site habitat assessment on 10 May 2001, and fish observed included salmonids and cyprinids. Other species observed during VES in 2002 included centrarchids, cyprinids, treefrogs (egg masses, tadpoles, juveniles, and adults) and crayfish.

4.1.4.4 Subsite 4d

Subsite 4d is a low-to-moderate gradient lateral cobble/boulder bar located on the right bank NFFR opposite the confluence of Flea Valley Creek. There were no backwater areas, although there was one isolated and two contiguous side pools in the subsite. Vegetation at the margin was moderately dense (60%), with less emergent (30%) and submerged (<10%) vegetation. Terrestrial cover was also moderately dense (60%), and aquatic cover somewhat sparse (20%); however, by 26 July, edgewater habitat had 80 percent flocculent material. In August 2002, brown algae and diatoms covered almost 100 percent of the edgewater substrate. The inundated portion of the cobble bar averaged 15 cm deep with flow velocities between 1-5 cm/sec. Lotic habitat at this subsite was primarily run (75%) with some riffle (25%). Aquatic substrate was cobble (50%), gravel (30%), and boulder (20%). Cyprinids, salmonids, and an adult treefrog were recorded at the subsite in 2001. Other species observed during VES in 2002 included cyprinids, treefrog tadpoles and juveniles, crayfish, and two garter snakes.

4.1.5 Tributaries

4.1.5.1 Mill Creek – TR1

The confluence of Mill Creek (TR1) and the NFFR is approximately 800 m downstream of Poe Dam on the left bank. A habitat assessment was conducted on 30 August 2000 and the overall survey length along the creek was 500 m. The average wetted channel length was 5 m, and the discharge was approximately 0.01 cm/sec. There were numerous main channel pools (10+) and side pools (5+) along the survey reach. Vegetation at the margin was sparse (10-15%), but terrestrial and aquatic cover values were relatively good (60-

70%), with many logs and boulders. Riparian canopy cover ranged from 10 to 30 percent, bank gradient was low to moderate, and stream gradient moderate to high. The stream gradient became steeper about 270 m from the NFFR confluence; and aquatic habitat changed from cascade/pool/riffle to cascade/plunge pool/waterfall habitat. Lotic habitat was rated at 20 percent riffle, 20 percent pool, 30 percent cascade, and 30 percent plunge pool. Salmonids were observed in this tributary. Overall, the creek had suitable habitat for FYLF, but breeding sites during higher flows appeared to be limited.

4.1.5.2 Flea Valley Creek – TR2

The confluence of Flea Valley Creek (TR2) with the NFFR is approximately 1.5 km downstream of Poe Dam on the right bank. A habitat assessment was conducted on 31 August 2000 and the overall survey length along the creek was 750 m. The average wetted channel length was 3 m, and the discharge was approximately 0.03 cm/sec. There were numerous main channel pools (15-20) along the survey reach. Vegetation at the margin was relatively dense (70%), and terrestrial and aquatic cover values were also high (about 95% and 65%, respectively), with mostly vegetation, boulders, and undercut banks. Riparian canopy cover ranged from 40 to 90 percent, bank gradient was moderate, and stream gradient was low-to-moderate. The stream aquatic habitat changed several times, alternating between riffle/pocket water and pocket water/cascade habitats. Lotic habitat was rated at 30 percent riffle, 20 percent pool, 20 percent cascade, and 30 percent pocket water. Salmonids and one adult garter snake were observed in this tributary. Overall, Flea Valley Creek provides excellent habitat for FYLF, primarily because of habitat features present and a relatively constant, spring-fed flow through the summer.

4.1.5.3 Unnamed Tributary #1 to NFFR – TR3

The confluence of the unnamed tributary #1 (TR3) with the NFFR is approximately 700 m downstream of Bardees Bar on the left bank. A habitat assessment was conducted on 7 September 2000 and the overall survey length along the creek was 100 m. The average wetted channel length was approximately 2 m, and the discharge was approximately 0.01 cm/sec. Vegetation at the margin was dense (80%), terrestrial cover was 90 percent (mostly boulders and vegetation), and aquatic cover values were moderate (40%, mostly boulders). Riparian canopy cover was 50 percent, bank gradient was moderate, and stream gradient high. However, overhanging cover ranged from 0 to 100 percent, averaging 80 percent. The stream gradient did not change within the survey reach. Lotic habitat was rated at 20 percent riffle, 10 percent run, 20 percent pool, and 50 percent shallow (30-45 cm deep) plunge pool. No fish were observed in this tributary. The stream was intermittent in places, flowing beneath piles of boulder and cobble, and the area was historically mined.

4.1.5.4 Unnamed Tributary #2 to NFFR – TR4

The confluence of the intermittent unnamed tributary #2 (TR4) with the NFFR is located approximately mid-way between Bardees Bar and Swimmer's Beach on the right bank. A habitat assessment was conducted on 14 September 2001 and the overall survey length along the creek was 305 m (portions upstream and downstream of Bardees Bar Road combined). The average wetted channel length was 1 to 3 m wide and the creek was dry in places. Discharge was less than 0.01 cm/sec. Overhanging cover was 30 percent. Terrestrial cover was 100 percent and varied, including rootwad, vegetation, logs, boulders, burrows, woody debris, and leaf litter. Aquatic cover value was moderate (50%) in the pool, and mostly composed of boulders. Riparian canopy cover was 70 to 80 percent, bank gradient was high, and stream gradient was moderate to high. The stream gradient did not change within the survey reach. Lotic habitat was intermittent and 100 percent cascade/pool. No fish were observed in this tributary. Several FYLF were observed in the survey reach (see Section 4.3.3), occupying isolated, apparently perennial, shallow (average 15-35 cm deep, maximum 60 cm) pools.

4.1.5.5 Camp Creek – TR5

The confluence of Camp Creek (TR5) with Poe Reservoir is approximately 1.7 km upstream of Poe Dam on the right bank. Habitat assessment occurred on 6 August 2001 and the overall survey length along the creek was about 470 m. The average wetted channel length was 15 m. There were numerous main channel pools along the survey reach. Vegetation at the margin was relatively sparse (30%), and terrestrial and aquatic cover values were moderate (40%), mostly composed of vegetation and boulders. Riparian canopy cover was 25 percent, bank gradient was high, and stream gradient moderate. The stream gradient and aquatic habitat did not change within the survey reach. Lotic habitat was rated at 60 percent riffle, 20 percent run, and 20 percent pool. Large salmonids and a California newt (*Taricha torosa*) larvae were observed in this tributary. Overall, the creek had good habitat for FYLF.

4.1.5.6 Heinz Creek – TR6

The confluence of Heinz Creek (TR6) with Poe Reservoir is approximately 800 m upstream of Poe Dam on the left bank and the habitat assessment occurred on 17 August 2001. The overall survey length along the creek was 305 m. The average wetted channel length was 2-3 m, and the discharge was approximately 0.03 cm/sec. Vegetation at the margin was moderate (30-40%), as were terrestrial and aquatic cover values (about 35% and 25%, respectively), with logs and boulders being the most frequent components. Riparian canopy cover ranged from 0 to 40 percent, bank gradient was moderate to high, and stream gradient high. The lower, unsurveyed portion of the reach near the Highway 70 bridge has been altered for stream stabilization. Most of the banks along the drainage were actively eroding. Lotic habitat was rated at 20 percent riffle, 10 percent run, 20 percent pool (to 60 cm deep), and 50 percent cascade/plunge pool. No fish were observed in this tributary. This tributary contained suitable adult FYLF habitat with pools, edgewater, and flocculent material suitable for tadpoles.

4.1.5.7 Dogwood Creek – TR7

The confluence of Dogwood Creek (TR7) with Poe Reservoir is approximately 800 m upstream of Poe Dam on the right bank. Habitat assessment occurred on 17 August 2001 and the overall survey length along the creek was 200 m. The average wetted channel length was 4-5 m, and the discharge was approximately 0.06 cm/sec. Vegetation at the margin was sparse (10%), but terrestrial and aquatic cover values were relatively high (75% and 35%, respectively), with boulders, logs, and other woody debris as the primary components. Riparian canopy cover was 50 percent, bank gradient was moderate to high, and stream gradient was low at the top, moderate in the middle, and high in the bottom portion, which included most of the survey section. The stream gradient changed approximately 90 m from the railroad bridge, and aquatic habitat changed from riffle/run/pocket water to bedrock cascade/pool. Lotic habitat was rated at 20 percent riffle, 20 percent run, 20 percent pool, and 40 percent bedrock cascade/pool. Salmonids were observed in this tributary. Habitat was unsuitable for FYLF from about 90 m below the bridge downstream in cascade/pool habitat. From the bridge upstream, habitat improved. Water temperatures were cool for August; however, the creek appeared sterile with very few aquatic insects.

4.1.5.8 Unnamed Tributary # 3 to NFFR – TR8

The confluence of Unnamed Tributary #3 (TR8) with the NFFR is approximately 300 m upstream of Poe Dam on the left bank. Habitat assessment occurred on 16 August 2001 and the overall survey length along the creek was 230 m. The average wetted channel length was 2 m, and the discharge was <0.01 cm/sec. Vegetation at the margin was moderate (60%), as was the terrestrial cover value (60-70%), composed of boulders, logs, and organic debris. Aquatic cover was less than 20 percent. Riparian canopy cover ranged from 70 to 80 percent, and bank gradient and stream gradient were both moderate to high. The stream gradient and aquatic habitat did not change in the survey reach. Lotic habitat was rated at 60 percent riffle, 10 percent run, 10 percent pool, and 20 percent cascade/plunge pool. No fish were observed in this tributary. Both banks of the drainage were actively eroding; potential pools were filled with sediment (none >10-12 cm deep), and many trees had fallen into the channel.

4.2 Increased Flow Evaluation

On 12 and 13 September, 2001, an evaluation of the effects of increased flows on FYLF habitat was conducted in the Poe Reach. These increased flows, which fluctuated between 5 and 7.4 cm/sec, were the result of the Poe fire that damaged transmission lines and required the temporary shutdown of Poe Powerhouse. Habitat assessments were conducted at all four study sites along the NFFR during this two-day period. These data were collected to compare the distribution and extent of habitat, as well as specific habitat parameters (e.g., depth, velocity, habitat structure, etc.), at these elevated flows with previous data obtained at the existing flow condition (approximately 2.8 cm/sec).

The site-specific flow evaluation provided below is focused primarily on the effects of these higher flows on FYLF breeding, tadpole development, and juvenile habitat and, secondarily, on subadult and adult habitat. Habitat assessment forms from this evaluation are presented in Appendix D.

A separate, intensive study conducted in September 2002 evaluated the effects of five flow releases (baseline to 310 cfs) on FYLF suitable habitats in the Poe reach (see GANDA 2003). Areas of preferred and marginal habitat were calculated at 13 subsites and compared for each flow level in the Poe reach during this study.

4.2.1 Poe Powerhouse Area (Site 1)

At Subsite la (side channel), the higher flows resulted primarily in an increase in depth, with little or no increase in edgewater habitat, and only a slight increase in flow velocity. The increased depth (increase of 11- 12 cm), which allows predators to move closer to the banks, decreased the overall value of this habitat for juveniles and, possibly, subadults and adults.

At Subsite lb (tail-out of large pool/top of center channel island), edgewater habitat increased at the higher flows; however, habitat complexity decreased slightly, due to the loss of emergent cobble and boulders in the breeding area that were present at flows around 2.8 cm/sec. Due to a lack of information regarding the importance of edgewater habitat relative to habitat complexity, the overall effects of higher flows at this subsite are unknown.

4.2.2 Swimmer's Beach Area (Site 2)

At Subsite 2a (low-relief tail-out of large pool), the higher flows and increased depth (increase of 11-12 cm) resulted in an increase in edgewater habitat; however, habitat complexity decreased slightly, due to the loss of emergent cobble and boulders in the breeding area that were present at flows around 2.8 cm/sec. Similar to Subsite lb, the overall effects of higher flows at this subsite are unknown, due to the lack of information regarding the importance of edgewater habitat relative to habitat complexity.

At Subsite 2b (low-relief lateral bar), the higher flows and increased depth (increase of 11-12 cm) resulted in an increase in edgewater habitat and overall habitat. The average flow velocity increase was not noticeable (range = 0-0.08 cm/sec).

At Subsite 2c (low-relief lateral bar), edgewater habitat increased slightly at the higher flows. However, the increased depth (increase of 10-11 cm) both removed and added habitat, depending on location. Overall, the amount of habitat remained approximately the same.

4.2.3 Bardees Bar Area (Site 3)

At Subsite 3a (low-relief boulder/sedge habitat), the higher flows resulted primarily in an increase in depth, with little or no increase in edgewater habitat. The increased depth (increase of 14-19 cm), which allows predators to move closer to the banks, decreased the value of this habitat for juveniles and, possibly, subadults and adults.

At Subsite 3b (high-relief lateral bar), edgewater habitat was significantly reduced at the higher flows. The increased depth (increase of 12-15 cm), which allows predators to move closer to the banks, and the reduction in edgewater habitat, decreased the overall value of this habitat.

4.2.4 Flea Valley Creek Area (Site 4)

At Subsite 4a (boulder/sedge habitat), the higher flows and increased depth (increase of 10-12 cm) resulted in an increase in edgewater habitat in some locations and a loss in others. Overall, the amount of habitat remained approximately the same.

At Subsite 4b (moderate-relief lateral bar), the higher flows and increased depth (increase of 12-13 cm) resulted in a slight increase in edgewater habitat and overall habitat

At Subsite 4c (low-relief willow side channel/lateral bar), the higher flows and increased depth (increase of 12-13 cm) resulted in a small increase in edgewater habitat; however, habitat complexity decreased slightly and velocities generally increased. The increased depth (which allows predators to move closer to the banks), in addition to the increase in velocities decreased the overall value of this habitat.

At Subsite 4d (moderate-relief lateral bar), the higher flows and increased depth resulted primarily in an increase in depth (increase of 16-18 cm), with little or no increase in edgewater habitat. Additionally, habitat complexity decreased slightly and velocities increased slightly. The increased depth (which allows predators to move closer to the banks), and the increase in velocities, decreased the overall value of this habitat.

4.3 Visual Encounter Survey Results

A summary of pooled data showing overall trends in egg mass attachment site, tadpole group, and frog (adult, subadult, juvenile) distribution and habitat use found throughout Project area NFFR sites is presented in this section. In addition, site-specific results are presented for both the NFFR and tributary sites. Data forms completed for VES for 2001 and 2002 are included in Appendix E.

4.3.1 Project Area Comprehensive Analysis

4.3.1.1 Egg Masses

A total of 26 FYLF egg masses were found during VES at all four Poe Project area main stem survey sites (11 subsites) in May 2001. Of these, one detached egg mass was found floating at Subsite 4c and was not included in the habitat analysis. Data from a revisit to another egg mass at Subsite 4b, apparently covered by a drifting algal mat that delayed maturation, also was not included in this analysis. Flow velocity at the attachment site of this egg mass on 10 May was the highest recorded in the Project area in 2001 (i.e., 20 cm/sec, included in data analysis), and the algal mat apparently acted to retard flow substantially as recorded during the second visit (<2 cm/sec on 30 May). This egg was partially detached when found on 10 May, and observers estimated that the eggs on the outside of the mass probably would be torn off shortly. All egg masses were apparently laid by the end of May 2001; three found in Subsite 4d on 30 May were not present during the 10 May VES (see also Section 4.3.2).

During 2002, data were collected from a total of 28 egg masses found in the 11 subsites. No data were collected from two additional egg masses found at Subsites 3b, apparently dislodged by adjacent dredge mining activity. Eggs from another egg mass at Subsite 4b were being scoured from 14-20 cm/sec flow velocities; this egg mass was relocated into a more protected area after microhabitat data were collected from the original oviposition site. Most egg masses in 2002 were apparently deposited in May; however one fresh egg mass was found at Subsite 2a on 12 April 2002 (water temperature = 15° C), while another egg mass was deposited around 2 June at Subsite 4b (water temperature = 15° C). Egg masses appeared to break down rapidly after hatching.

Despite the two relatively high-flow velocity values mentioned above, the average flow velocity at egg mass attachment sites was 1.4 cm/sec in 2001 (N = 25) and 2.2 cm/sec in 2002 (N = 28), and these values were similar between years (Table 4.3-1).

Figures 4.3-1a and 4.3-1b graphically depict the distance to shore and corresponding depths of egg masses and depths of the associated stream bottom at the 25 and 28 attachment sites for 2001 and 2002, respectively. Most egg masses were laid within about 3 m of shore for both years, although two were found over 5 m from shore in the wide, shallow pool tail out Subsite 1b in 2002. In addition, all egg masses were deposited at depths <50 cm. There also were no significant differences between years for mean values of distance to shore, depth of egg masses, and depth to the bottom at egg mass sites (Table 4.3-1). Mean water temperatures at egg mass sites during surveys were significantly different between years (2001 = 18.5° C, 2002 = 15° C; Table 4.3-1); however, since these data were not recorded at the time of oviposition, little can be concluded from these differences.

Table 4.3-1. Summary of mean habitat parameters for FYLF egg masses found in the NFFR, Poe Powerhouse Project area, 2001-2002.

2001	**VELOCITY cm/sec**	**DIST. TO SHORE cm**	**DEPTH TO BOTTOM cm**	**DEPTH OF EGG MASS cm**	**WATER TEMP °C**
Average	1.4	166.4	24.5	18.0	18.5
Standard Dev.	3.9	83.7	8.8	9.4	1.8
Range	0-20	50-310	13-45	5 - 43	15-22
Number	25	25	25	25	25
2002	**VELOCITY cm/sec**	**DIST. TO SHORE cm**	**DEPTH TO BOTTOM cm**	**DEPTH OF EGG MASS cm**	**WATER TEMP °C**
Average	2.2	156.2	24.8	20.0	15.0
Standard Dev.	3.8	136.4	7.5	7.1	1.8
Range	0-17	30-520	13-42	9-37	12-19
Number	28	28	28	28	28
COMPARISONS BETWEEN 2001 AND 2002					
Difference?	no	no	no	no	yes
t	0.766	0.324	0.152	0.866	7.052
df	51	51	51	51	51
P	0.44	0.75	0.88	0.39	<0.01

Tables 4.3-2a and 4.3-2b compile data from other various habitat parameters recorded at the 53 total egg mass attachment sites found in the Project area during 2001 and 2002. Attachment substrate was either cobble, boulder, or bedrock, and cobble was the dominate aquatic substrate at the majority of sites. Egg masses were found predominately in main channel pool and run main stream habitats both years. Edgewater was the dominant microhabitat type in 2001 and 2002 (100% in 2002), with some use of backwater (20%) and channel (4%) pools in 2001. Other habitat parameters reflected the generally low-flow velocities found: over one-half of the egg masses were in areas of no flow considering both years combined, with 40 percent receiving shear (along the side of egg mass) flow in 2001; 50 percent were oriented into the flow in 2002. Also, about 90 percent of egg masses had silt deposits, although none were covered on greater than 50 percent of the exposed surface.

Figure 4.3-1a. Distance from shore and corresponding depths of egg mass and stream bottom for 25 FYLF egg masses observed in the NFFR, Poe Powerhouse Project area, 2001.

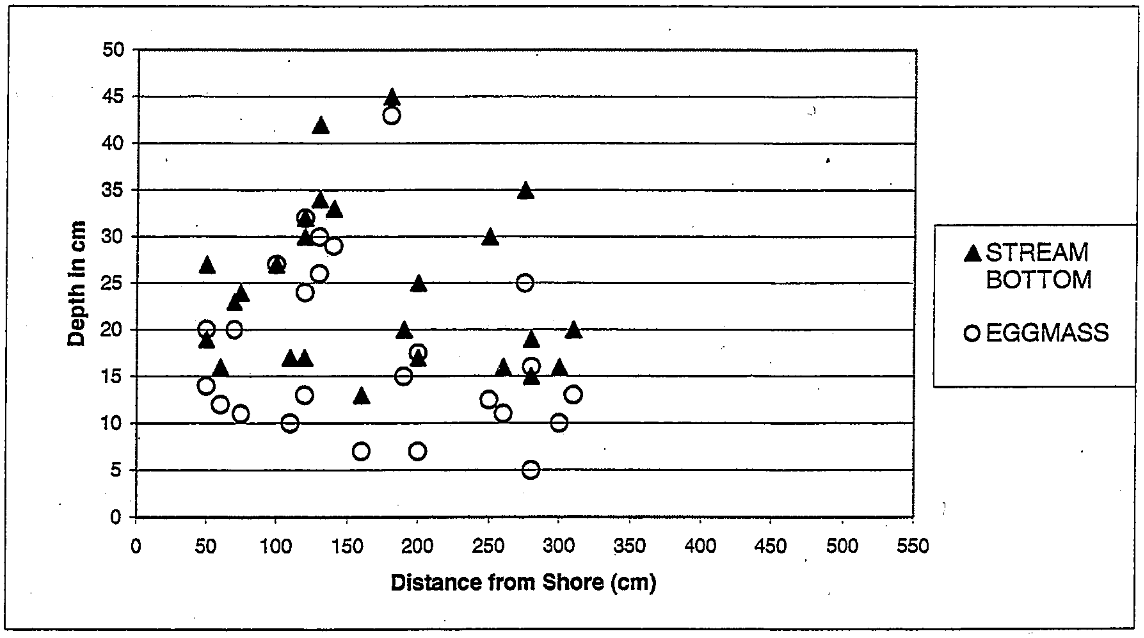

Figure 4.3-1b. Distance from shore and corresponding depths of egg mass and stream bottom for 28 FYLF egg masses observed in the NFFR, Poe Powerhouse Project area, 2002.

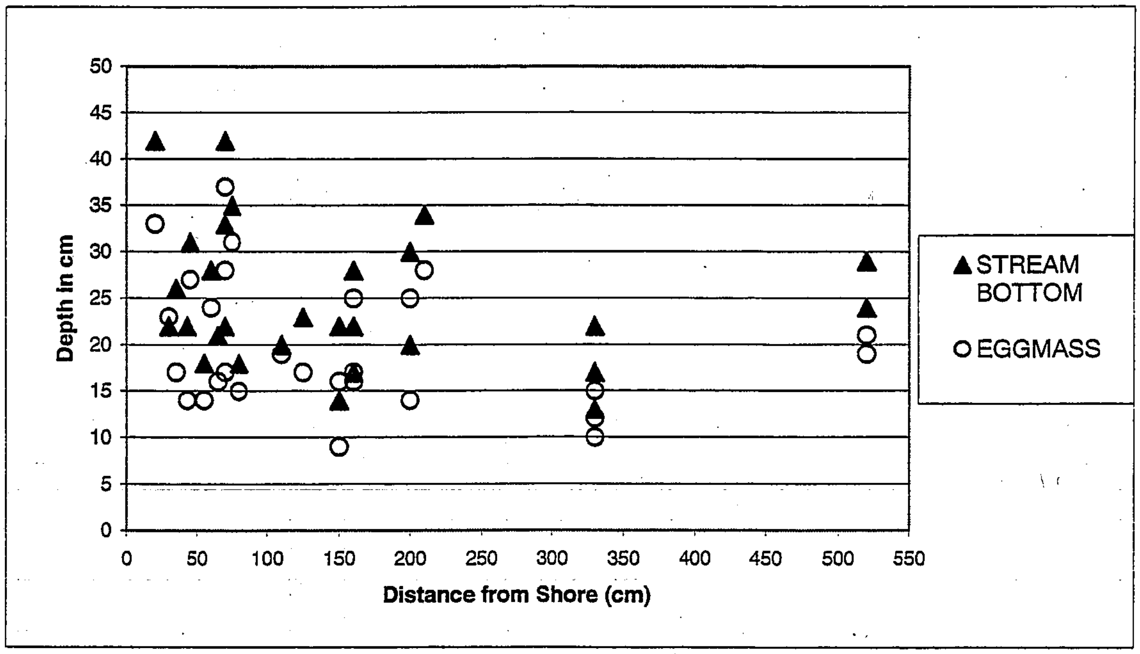

Table 4.3-2a. Aquatic habitat characteristics of 25 FYLF egg mass attachment sites in the NFFR, Poe Powerhouse Project area, 2001.

			ATTACHMENT SUBSTRATE		% SILT ON EGGMASS			ORIENTATION ON SUBSTRATE					FLOW DIRECTION			MICRO-HABITAT			SUBSTRATE					MAINSTREAM HABITAT		
Subsite No.	# of Egg Masses	Date	cobble	boulder	none	<25	25-50	upstream	downstream	shore side	stream side	underneath	into flow	shear flow	no flow	backwater pool	edgewater	channel pool	cobble/sand	cobble/gravel	cobble	cobble/boulder	boulder/cobble	low gradient riffle	run	main channel pool
1a	0	5/12/01																								
1b	2	5/12/01	1	1		1	1			2				1	1		1	1				2				2
2a	3	5/11/01	3				3			2	1			2	1	3					3					3
2b	0	5/11/01																								
2c	2	5/11/01	2		1	1					2			2			2				2				2	
3a	0	5/31/01																								
3b	8	5/31/01	6	2		6	2	1	2	1	3	1			8		8		2	5			1			8
4a	3	5/10/01		3		2	1			2		1	1		2	2	1					2	1		3	
4b	1	5/10/01	1		1						1			1			1				1				1	
4c	3	5/10/01	1	2		3		1			2			2	1		3					2	1	3		
4d	0	5/10/01																								
4d	3	5/30/01		3		1	2				2	1		2	1		3			3					3	
	25	**TOTALS**	**14**	**11**	**2**	**14**	**9**	**2**	**2**	**7**	**11**	**3**	**1**	**10**	**14**	**5**	**19**	**1**	**2**	**8**	**6**	**6**	**3**	**3**	**9**	**13**
		% of TOTAL	56	44	8	56	36	8	8	28	44	12	4	40	56	20	76	4	8	32	24	24	12	12	36	52

Table 4.3-2b. Aquatic habitat characteristics of 30 FYLF egg mass attachment sites in the NFFR, Poe Powerhouse Project area, 2002. Two egg masses at Subsite 3b had incomplete data.

			ATTACHMENT SUBSTRATE			% SILT ON EGGMASS			ORIENTATION ON SUBSTRATE					FLOW DIRECTION			MICRO-HABITAT			SUBSTRATE					MAINSTREAM HABITAT			
Subsite No.	# of Egg Masses	Date	cobble	boulder	bedrock	none	<25	25-50	upstream	downstream	shore side	stream side	underneath	into flow	shear flow	no flow	backwater pool	edgewater	channel pool	cobble/sand	cobble/gravel	cobble	cobble/boulder	boulder/cobble	low gradient riffle	run	glide	main channel pool
1b	6	5/9/02	3	3		1	4	1	4		2		1	5		1		6			5		1					6
2a	3	4/12-5/10/02	3			1		2			1	2				3		3			2	1						3
2c	2	5/17/02	2					2				2				2		2									2	
3b	6	5/16/02	5	1				6		1		3		2		2		6		1	5							6
4a	6	5/21/02	1	5			1	5		1	1	2	1	3		3		6					3	3		6		
4b	2	5/22/02		2			1	1		2				2				2			1		1			2		
4c	1	5/22/02			1			1	1							1		1						1		1		
4d	2	5/22/02			2	1		1	1			1		1		1		2			1		1			2		
4d	2	5/22/02		2			2					2		2				2					2			2		
	30	**TOTALS**	**14**	**13**	**3**	**3**	**8**	**19**	**6**	**4**	**4**	**12**	**2**	**15**	**0**	**13**	**0**	**30**	**0**	**1**	**14**	**1**	**8**	**4**	**0**	**13**	**2**	**15**
		% of TOTAL	47	43	10	10	27	63	21	14	14	43	7	54	0	46	0	100	0	4	50	4	28	14	0	43	7	50

4.3.1.2 Tadpoles

Habitat parameters from a total of 32 tadpole groups from all four Poe Project area survey sites (11 subsites) combined were assessed during VES in 2001; 35 tadpole groups from these sites were assessed in 2002. Tadpole hatching began in early May 2001 at the more downstream subsites (i.e., sites 1 and 2) where water temperatures were 19-22°C, but had not begun at the upstream-most Site 4 in early May when water temperatures at egg masses ranged from 15-17°C. Tadpoles were hatched or hatching at all sites by the end of May 2001. Hatching was observed in mid-May at Site 2 during 2002.

Table 4.3-3 provides microhabitat data collected at tadpole group sites during 2001 and 2002. Distance to shore mean values were significantly higher in 2002 compared to 2001 (158 cm vs. 94 cm) due, in part, to the relationship of certain tadpole groups to egg mass sites found at greater than 5 m from shore at Subsite 1b. Other habitat variables, namely depth to bottom, water temperatures, and flow velocities, were statistically similar between years. Figures 4.3-2a and 4.3-2b show the distance to shore and corresponding depths of tadpole groups at 31 and 35 locations in the Project area for 2001 and 2002, respectively. All tadpoles were found at depths ≤45 cm, and most were within 200 cm of shore. Average water temperature at tadpole groups was 22°C in 2001 and 21°C in 2002.

Table 4.3-3. Summary of mean habitat parameters for FYLF tadpole groups found in the NFFR, Poe Powerhouse Project area, 2001-2002.

2001	**VELOCITY cm/sec**	**DIST. TO SHORE cm**	**DEPTH TO BOTTOM cm**	**WATER TEMP °C**
Average	0.6	94.0	19.0	22.2
Standard Dev.	0.7	74.7	10.7	3.4
Range	32	31	32	32
Number	0-2	15-280	3-45	18-29
2002				
Average	0.6	157.5	21.3	21.4
Standard Dev.	0.7	100.1	9.7	3.2
Range	35	35	35	35
Number	0-2.5	44-450	5-42	12-28
COMPARISON BETWEEN 2001 AND 2002				
DIFFERENCE?	no	yes	no	no
t	0.128	2.941	0.940	1.013
df	65	62	65	65
P	0.90	0.005	0.35	0.31

For both years combined, flow velocities at tadpole group locations (mean = 0.6 cm/sec, N = 67, SD = 0.7, range = 0-2.5 cm/sec) averaged significantly less (t = 2.36, 55 df, P = 0.02) than at egg mass oviposition sites (mean = 1.8 cm/sec, N = 53, SD = 3.8, range = 0-20 cm/sec). Average depth of tadpole groups (20 cm, N = 67, SD = 10, range = 3-45) was also less than (t = 2.66, 118 df, P = 0.01) depths at egg mass attachment sites (24 cm, N = 53, SD = 8, range = 13-45); and, once hatched and mobile, tadpoles also moved closer to shore (N = 66, mean = 127 cm, SD = 94, range = 10-450) than egg mass oviposition sites (N = 53, mean = 161 cm, SD = 114, range = 20-520), though not significantly (t = 1.71, 101 df, P = 0.09).

Tables 4.3-4a and 4.3-4b compile data from other various habitat variables recorded at the 67 tadpole group locations found in the Project area during 2001 and 2002. Substrate varied more at tadpole group sites than at egg mass attachment sites and included some sand- and gravel-dominated substrates; however, most tadpoles (82%, both years) were found in cobble-dominated substrates. Tadpole microhabitat was either edgewater or pool (including backwater, edgewater, and side channel pool) habitat. In both years, percent algal cover on adjacent rocks varied widely, and 60 percent of tadpole groups were in habitats with <50 percent algal cover; however, 24 percent were found in areas with >80 percent algae. Detritus mixed with algae at many locations.

Figure 4.3-2a. Distance from shore and corresponding depth of 31 FYLF tadpole groups observed in the NFFR, Poe Powerhouse Project Area, 2001.

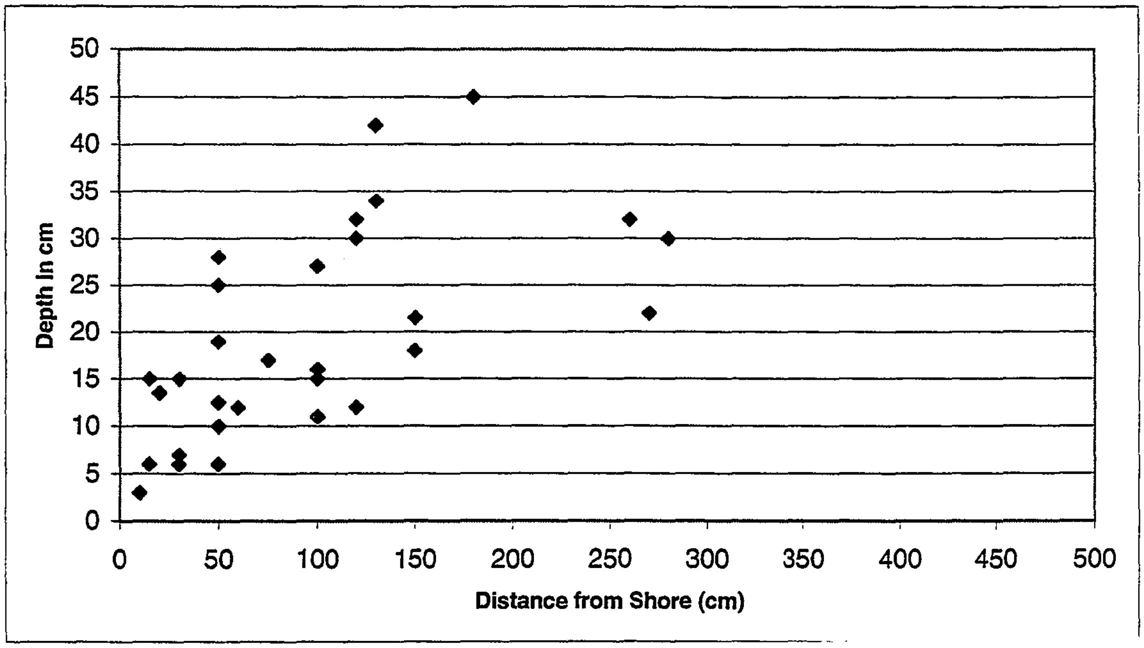

Figure 4.3-2b. Distance from shore and corresponding depth of 35 FYLF tadpole groups observed in the NFFR, Poe Powerhouse Project Area, 2002.

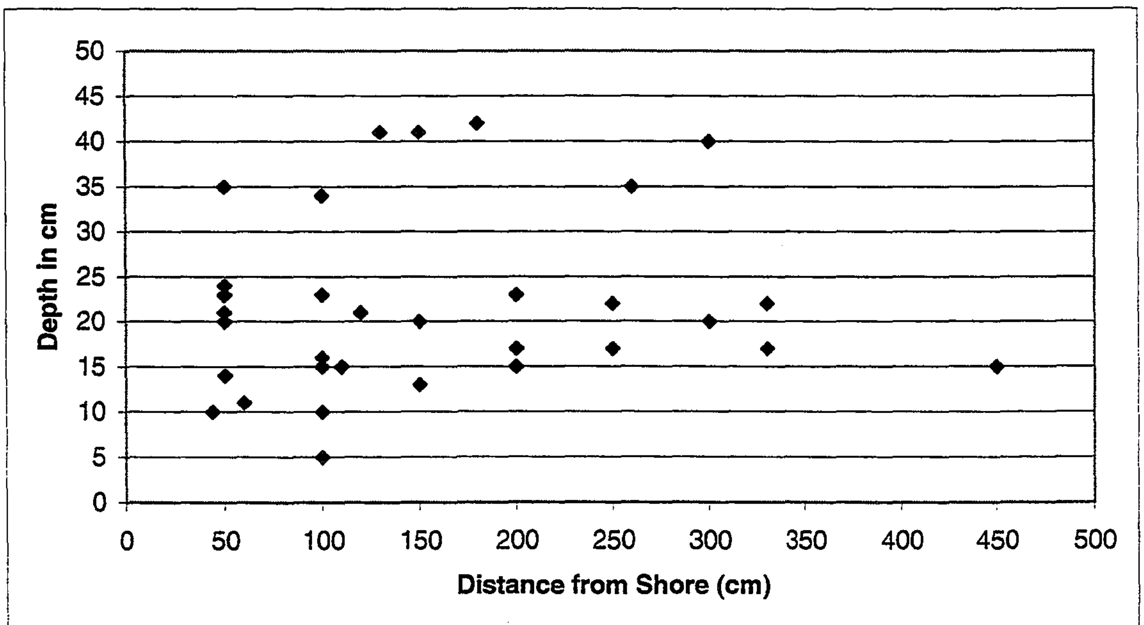

Table 4.3-4a. Aquatic habitat characteristics of 32 FYLF tadpole groups observed in the NFFR, Poe Powerhouse Project area, 2001.

			TADPOLE STAGE			MAINSTREAM HABITAT			MICROHABITAT					SUBSTRATE							% ALGAL COVER								
Subsite	# of Tadpole Groups	Date	no legs	rear legs	4 legs with tail	low gradient riffle	run	main channel pool	isolated side pool	backwater pool	side channel pool	edgewater	edgewater pool	sand/gravel	gravel/cobble	cobble/sand	cobble/gravel	cobble	cobble/boulder	boulder/cobble	10	20	30	40	50	60	70	80	90
1a	1	5/12/01	1					1				1				1					1								
2a	1	7/27/01			1	1				1				1											1				
2c	3	7/27/01	3				3					3					3						3						
3b	7	5/31/01	7					7				7				1	5			1	5	2							
4a	3	5/30/01	3				3			2		1			1				2										3
4b	1	5/30/01	1				1					1						1											1
4c	3	5/30/01	3			2	1					3							3										3
4a	2	7/26/01	1	1			2			1		1							2					2					
4b	3	7/26/01	1	1	1		3		1			2					3								2		1		
4c	2	7/27/01	1	1			2						2				2					2							
4d	6	7/26/01	2	3	1	4	2				4	1	1				3		2	1		2	1	2		1			
	32	TOTALS	22	6	4	7	17	8	1	4	4	20	3	1	1	2	16	1	9	2	6	6	4	4	3	1	1		7
		% OF TOTAL	69	19	13	22	53	25	3	13	13	63	9	3	3	6	50	3	28	6	19	19	13	13	9	3	3	0	22

Table 4.3-4b. Aquatic habitat characteristics of 35 FYLF tadpole groups observed in the NFFR, Poe Powerhouse Project area, 2002.

Subsite	# of Tadpole Groups	Date	TADPOLE STAGE			MAINSTREAM HABITAT				MICROHABITAT					SUBSTRATE							% ALGAL COVER								
			no legs	rear legs	4 legs with tail	low gradient riffle	glide	run	main channel pool	isolated side pool	backwater pool	side channel pool	edgewater	edgewater pool	sand/gravel	gravel/cobble	cobble/sand	cobble/gravel	cobble	cobble/boulder	boulder/cobble	10	20	30	40	50	60	70	80	90
1b	5	6/6/02	2						5					5				5						2	1				1	1
2a	2	5/10/02	2						2					2				2					2							
2a	6	6/6/02	6	2					6					6	1			6							2	4				
2c	2	5/17/02	2				2						2							2		1	1							
2c	1	8/14/02		1			1						1					1												1
4a	1	5/22/02	1					1					1							1			1							
4b	1	6/6/02	1					1						1						1		1								
4c	4	6/7/02	3	3		2		4		1			3							1	3							1	1	2
4a	4	6/6/02	4					4				2		2				2		1	1			1	1			1	1	
4a	3	8/16/02		3				3						3						3		1	1	1						
4b	3	8/16/02		3				3					3						1	1	1	2		1						
4c	1	8/16/02				1				1								1											1	
4d	2	6/7/02	2			2								2							2								1	
	35	**TOTALS**	**23**	**12**	**0**	**5**	**3**	**16**	**13**	**2**	**0**	**2**	**7**	**21**	**1**	**0**	**0**	**16**	**1**	**10**	**7**	**5**	**5**	**5**	**5**	**4**	**0**	**2**	**5**	**4**
		% OF TOTAL	66	34	0	14	8	43	35	6	0	6	22	66	3	0	0	46	3	29	20	14	14	14	14	12	0	6	14	12

4.3.1.3 Juveniles and Adults

A total of 90 and 93 FYLF of all age classes were found during VES in and adjacent to the eleven subsites in the Poe Project area in 2001 and 2002, respectively. Tables 4.3-5a and 4.3-5b provide the age classes, activities, and habitat use characteristics of FYLF sightings in the Project area. About one-quarter of the FYLF recorded were adults, two-thirds were juveniles, and the remainder were subadults. Most adult and subadult frogs were located on the NFFR subsites early in the season during the May/June surveys. Later in the summer and early fall, most adults and subadults apparently had left the river survey locations, a period when primarily juvenile FYLF were found at the sites.

Overall, most FYLF were observed while either sitting (52%) or basking (34%). While frogs occurred in more diverse substrates than either tadpoles or egg masses, most were found in cobble-dominated substrates (70%), followed by boulder substrates (18%), and sand- or gravel-dominated substrates (8%). The list of microhabitats utilized both years by adults, subadults, and juveniles (Tables 4.3-5a and 4.3-5b) is also more diverse than for the less-developed life stages. However, edgewater habitats were still dominant. Main stem aquatic habitats for frog locations were classified as mostly run (60%), main channel pool (22%), and low-gradient riffle (9%).

Table 4.3-5a. Age class, activity, and aquatic habitat use of 90 FYLF found during VES in the NFFR, Poe Powerhouse Project area, 2001.

			AGE			ACTIVITY				SUBSTRATE											MICROHABITAT							MAINSTREAM HABITAT				
Subsite No.	# of Frogs	Date	juvenile	subadult	adult	sitting	basking	hiding	floating	sand	sand/silt	sand/gravel	gravel/sand	gravel/cobble	cobble/gravel	cobble	cobble/boulder	boulder/gravel	boulder/cobble	boulder	isolated side pool[a]	backwater pool	side channel	edgewater	pool tail-out	edgewater pool	low gradient riffle	low gradient riffle	run	main channel pool	run/pool	step-pool
1a	2	5/12/01			2	2										2							2							2		
1b	1	5/12/01	1					1							1							1								1		
1b	1	7/27/01	1			1									1										1					1		
1a	2	9/27/01	2				2									1				1				1		1		2				
1b	2	9/27/01	2				2								2									2						2		
2a	2	5/11/01		1	1											2						2								2		
2c	1	5/11/01			1											1								1					1			
2a	2	7/27/01			2		2					1	1												1		1	1		1		
2b	2	7/27/01	1		1																											
2c	5	7/27/01	5			5				1															1	4			1	4		
2a	3	9/28/01	2		1	1	2						2							1		1			2				2	1		
2b	1	9/28/01	1				1										1				(1)										1	
2c	2	9/28/01	2				2								2									2				1	1			
3a	3	5/31/01			3		3											1	2					3						1	1	1
3b	4	5/31/01			4	1	3								3		1							4						4		
3b	1	7/27/01	1			1					1													1						1		
3b	1	9/28/01	1				1													1						1				1		
4b	7	5/9/01		3	4		7							7										7					7			
4c	4	5/9/01		1	3	1	3										4						4					4				
4c	1	5/30/01			1	1											1						1					1				
4c	4	7/27/01	3		1	4											4				3		1					1	3			
4d	5	7/26/01	5			5									5								1	4				1	4			
4a	6	9/26/01	5	1		6													3	3	2			4				1	5			
4b	10	9/26/01	10			10											10				6			4					10			
4c	7	9/27/01	7			7										1	4			2	(1)			6					7			
4d	11	9/27/01	11			4	3		4						4		6		1				7	4					11			
	90	**TOTALS**	**60**	**6**	**24**	**49**	**31**	**1**	**4**	**1**	**1**	**1**	**3**	**7**	**18**	**7**	**31**	**1**	**6**	**8**	**13**	**4**	**16**	**43**	**5**	**6**	**1**	**12**	**52**	**21**	**2**	**1**
		% OF TOTAL	67	7	27	58	36	1	5	1	1	1	4	8	21	8	37	1	7	10	15	5	18	49	6	7	1	14	59	24	2	1

[a]Entries in parenthesis were side pools not isolated from main channel

Table 4.3-5b. Age class, activity, and aquatic habitat use of 93 FYLF found during VES in the NFFR, Poe Powerhouse Project area, 2002.

			AGE			ACTIVITY					SUBSTRATE											MICROHABITAT							MAINSTREAM HABITAT				
Subsite No.	# of Frogs	Date	juvenile	subadult	adult	sitting	basking	hiding	floating	under water	sand	sand/silt	sand/gravel	gravel/sand	gravel/cobble	cobble/gravel	cobble	cobble/boulder	boulder/gravel	boulder/cobble	boulder	isolated side pool[a]	backwater pool	side channel	edgewater	pool tail-out	edgewater pool	low gradient riffle	low gradient riffle	run	main channel pool	run/pool	step-pool
1a	1	4/12/02			1		1										1							1							1		
1a	1	5/9/02			1					1						1								1					1				
1b	1	4/12/02		1			1							1											1						1		
1b	1	5/9/02			1	1										1									1	1					1		
2a	1	4/12/02			1					1							1							1							1		
2a	2	5/10/02		1	1	2										2											2				2		
2a	1	6/6/02			1	1										1											1				1		
2a	15	8/14/02	15			13		2									15								15			12			3		
2a	18	9/9/02	18			9	8			1						1	7	10							18					17	1		
2b	2	8/14/02	2							2										2					2						2		
2b	5	9/9/02	4		1	1		1		3										5					5					3	2		
2c	2	4/12/02			2	1				1							2								2					2			
3b	4	5/16/02			4	4											4								4						4		
4a	4	5/22/02			4		3			1								3		1					4					4			
4b	2	5/22/02			2		2									2									2					2			
4c	1	5/22/02			1		1													1					1					1			
4d	2	5/22/02	1		1		2									2									2					2			
4a	1	6/6/02			1	1												1									1			1			
4b	5	6/6/02			5	5												4		1					5					5			
4d	2	6/9/02	1		1		2													2		(2)							2				
4d	1	8/16/02	1			1														1					1					1			
4a	5	9/27/02	5			5											4	1				4			1					5			
4b	10	9/16-9/27/02	10				9			1								8		2		(2)								10			
4c	3	9/27/02	3			3														3					3					3			
4d	3	9/27/02	3				3								1			2				(1)			1				2	1			
	93	**TOTALS**	**63**	**2**	**28**	**47**	**32**	**3**	**0**	**11**	**0**	**0**	**0**	**1**	**1**	**10**	**34**	**29**	**0**	**18**	**0**	**9**	**0**	**3**	**64**	**1**	**4**	**12**	**5**	**57**	**19**	**0**	**0**
		% OF TOTAL	68	2	30	51	34	3	0	12	0	0	0	1	1	11	37	31	0	19	0	10	0	3	69	1	4	13	6	70	23	0	0

[a]Entries in parenthesis were side pools not isolated from main channel

4.3.2 Site-specific Results

4.3.2.1 Poe Powerhouse Area (Site 1)

Data from FYLF surveys in the Poe Powerhouse area (Site 1) are summarized in tables 4.3-6a and 4.3-6b for 2001 and 2002 survey years, respectively. No egg masses were found in the side channel (Subsite 1a), although two adult frogs were located there in the spring of both years. Two egg masses hatched successfully from the low-gradient cobble bar at the top of the island (Subsite 1b) in 2001, and a small number of juveniles (1-2) were also found throughout the season. Although six egg masses were located in 2002, there was apparently no recruitment of juveniles that year.

Table 4.3-6a. Number of FYLF egg masses, tadpoles, juveniles, subadults and adults observed during the 2001 Visual Encounter Surveys at the Poe Powerhouse area, Site 1, NFFR Poe Powerhouse Project area.

Site/ Subsite	Date	Search Area (m^2)	Average Discharge (cfs)	Egg Masses	Tadpole Groups[a]	Juveniles Observed	Adults/ Subadults Observed
1a	5-12-01	495	132	0	1s	none	2 A
1a	7-27-01	1,005	122	0	none	none	none
1a	9-27-01	495	116	0	none	2	none
1b	5-12-01	404	132	2	hatching	1	none
1b	7-27-01	404	122	hatched	none	1	none
1b	9-27-01	404	116	hatched	none	2	none
[a]Tadpole group numbers: L = >100 tadpoles/ m^2, M = 11-100, S = 5-10, s = <5							

Table 4.3-6b. Number of FYLF egg masses, tadpoles, juveniles, subadults and adults observed during the 2002 Visual Encounter Surveys at the Poe Powerhouse area, Site 1, NFFR Poe Powerhouse Project area.

Site/ Subsite	Date	Search Area (m^2)	Average Discharge (cfs)	Egg Masses	Tadpole Groups[a]	Juveniles Observed	Adults/ Subadults Observed
1a	4/12/02	495	115	0	none	none	2 A
1b	4/12/02	455	115	0	none	none	1 A
1b	5/9/02	404	115	6	none	none	1 A
1b	6/6/02	404	115	0	M	none	none
1b	8/15/02	404	115	0	none	none	none
1b	9/9/02	404	115	0	none	none	none
[a]Tadpole group numbers: L = >100 tadpoles/ m^2, M = 11-100, S = 5-10, s = <5							

4.3.2.2 Swimmer's Beach Area (Site 2)

Data from FYLF surveys in the Swimmer's Beach area (Site 2) are summarized in tables 4.3-7a and 4.3-7b. In 2001, three egg masses were found in the low-gradient cobble bar, pool tail-out Subsite 2a; no egg masses occurred in Subsite 2b, a low-to-moderate gradient cobble/boulder bar; and, two egg masses were located along the low-gradient cobble/boulder bar at Subsite 2c. Three, none, and two egg masses were also found in these subsites, respectively, in 2002. Relatively small numbers of tadpoles were observed during Visit #2 (27 July 2001) at subsites 2a and 2c, and juvenile frogs were found at all three subsites by late season 2001. Numerous small tadpoles were present at subsites 2a and 2c following hatching, and abundant numbers of juveniles were present at Subsite 2a late summer. Adult frogs occurred at all subsites in both years, some occurring in late summer and fall.

Table 4.3-7a. Number of FYLF egg masses, tadpoles, juveniles, subadults and adults observed during the 2001 Visual Encounter Surveys at the Swimmer's Beach area, Site 2, NFFR Poe Powerhouse Project area.

Site/ Subsite	Date	Search Area (m^2)	Average Discharge (cfs)	Egg Masses	Tadpole Groups[a]	Juveniles Observed	Adults/ Subadults Observed[b]
2a	5-11-01	352	132	3	hatching	none	1 SA, 1 A
2a	7-27-01	352	122	hatched	1M	none	2 A
2a	9-28-01	352	113	hatched	none	2	1 A
2b	5-11-01	288	132	0	none	none	none
2b	7-27-01	288	122	0	none	1	1 A
2b	9-28-01	288	113	0	none	1	(2 SA)
2c	5-11-01	488	132	2	hatching	none	1 A
2c	7-27-01	488	122	hatched	3s	5	none
2c	9-28-01	488	113	hatched	none	2	none

[a]Tadpole group numbers: L = >100 tadpoles/ m^2, M = 11-100, S = 5-10, s = <5

[b]Frog numbers in parenthesis were found adjacent to subsite

Table 4.3-7b. Number of FYLF egg masses, tadpoles, juveniles, subadults and adults observed during the 2002 Visual Encounter Surveys at the Swimmer's Beach area, Site 2, NFFR Poe Powerhouse Project area.

Site/ Subsite	Date	Search Area (m^2)	Average Discharge (cfs)	Egg Masses	Tadpole Groups[a]	Juveniles Observed	Adults/ Subadults Observed[b]
2a	4/12/02	308	115	1			1A
2a	5/10/02	308	115	2	2L		1A, 1SA
2a	6/6/02	308	115		6L		1A
2a	8/14/02	440	115			15	
2a	9/9/02	352	115			18	
2b	8/14/02	336	115			2	
2b	9/9/02	288	115			4	1A
2c	4/12/02	732	115				1A, 1SA
2c	5/17/02	549	115	2	2L		1A
2c	8/14/02	732	115		1s		

[a]Tadpole group numbers: L = >100 tadpoles/ m^2, M = 11-100, S = 5-10, s = <5

[b] Frog numbers in parenthesis were found adjacent to subsite

4.3.2.3 Bardees Bar Area (Site 3)

Data from FYLF surveys in the Bardees Bar area (Site 3) for 2001 and 2002 are summarized in tables 4.3-8a and 4.3-8b. No egg masses were found at the Subsite 3a side pool, and the subsite was not searched for egg masses in May or June, 2002. However, eight egg masses were located along Subsite 3b, a moderate-to-steep gradient cobble/boulder bar in 2001, and six were located there in 2002. At least one of the egg masses in 2001 appeared to have been partially eaten, while development in others was retarded and portions possibly unfertilized. Tadpoles were hatching around egg masses in late May 2001; however, none were seen on subsequent visits. Many fish, including bass, were present near egg masses in late May 2001, and tadpoles were dispersed and hidden in cracks. At least two of the egg masses at Subsite 3b had been disturbed by adjacent dredge mining activity in 2002.

Adult frogs occurred at both subsites in May 2001 (N = 3 and 4 at subsites 3a and 3b, respectively), and four adults were found in Subsite 3b in May 2002. One adult frog was in very close proximity to a garter snake, flushed by observers. Only one juvenile FYLF was seen at Subsite 3b during visits #2 and #3 for 2001, which occurred later in the summer and early fall. No juveniles were found during late summer in 2002.

Table 4.3-8a. Number of FYLF egg masses, tadpoles, juveniles, subadults and adults observed during the 2001 Visual Encounter Surveys at the Bardees Bar area, Site 3, NFFR Poe Powerhouse Project area.

Site/ Subsite	Date	Search Area m^2	Average Discharge cfs	Egg Masses	Tadpole Groups[a]	Juveniles Observed	Adults/ Subadults Observed
3a	5-31-01	412	116	0	none	none	3 A
3a	7-27-01	412	122	0	none	none	none
3a	9-28-01	412	113	0	none	none	none
3b	5-31-01	234	116	8	4S, 3M	none	4 A
3b	7-27-01	234	122	hatched	none	1	none
3b	9-28-01	304	113	hatched	none	1	none

[a]Tadpole group numbers: L = >100 tadpoles/ m^2, M = 11-100, S = 5-10, s = <5

Table 4.3-8b. Number of FYLF egg masses, tadpoles, juveniles, subadults and adults observed during the 2002 Visual Encounter Surveys at the Bardees Bar area, Site 3, NFFR Poe Powerhouse Project area.

Site/ Subsite	Date	Search Area m^2	Average Discharge cfs	Egg Masses	Tadpole Groups[a]	Juveniles Observed	Adults/ Subadults Observed
3a	8/17/02	412	115	0	none	none	none
3a	9/11/02	206	115	0	none	none	none
3b	5/16/02	195	115	6	none	none	4A
3b	8/17/02	117	115	0	none	none	none
3b	9/11/02	117	115	0	none	none	none

[a]Tadpole group numbers: L = >100 tadpoles/ m^2, M = 11-100, S = 5-10, s = <5

4.3.2.4 Flea Valley Creek Area (Site 4)

Data from 2001 and 2002 FYLF surveys in the Flea Valley Creek area (Site 4) are summarized in tables 4.3-9a and 4.3-9b. Egg masses were found at each of the four subsites in 2001, including three at Subsite 4a (low-gradient boulder sedge habitat), two at Subsite 4b (moderate-gradient cobble/boulder bar), four at Subsite 4c (low-gradient cobble/boulder bar), and three at Subsite 4d (low-to-moderate gradient cobble/boulder bar). A portion of one egg mass appeared to have been infected with fungus under attached algae, and affected eggs did not hatch. Numerous egg masses also were found in 2002, six at Subsite 4a, four at Subsite 4b, one at Subsite 4c, and two at Subsite 4d.

Tadpole groups were found at all subsites during VES for both 2001 and 2002, and relatively high numbers of juveniles (N = 5-11 in 2001, and N = 3-10 in 2002) were also recorded at each subsite during the early fall visit. Post-hatch, all tadpoles at Subsite 4c in 2001 were found on the bottom in thick layers of algae and detritus. Some tadpoles were located in deeper areas in Subsite 4a; these tended to be under cobble, probably to avoid predation, since algae and flocculent material were sparse in deeper areas. Adult FYLF were only seen at subsites 4b and 4c, primarily early in the season in 2001; however, adults were present in the early breeding season at all subsites in 2002.

Table 4.3-9a. Number of FYLF egg masses, tadpoles, juveniles, subadults and adults observed during the 2001 Visual Encounter Surveys at the Flea Valley Creek area, Site 4, NFFR Poe Powerhouse Project area.

Site/ Subsite	Date	Search Area m²	Average Discharge cfs	Egg Masses	Tadpole Groups[a,b]	Juveniles Observed[b]	Adults/ Subadults Observed[b]
4a	5-10-01	432	130	3	none	none	none
4a	5-30-01	432	115	hatched	3L	none	none
4a	7-26-01	432	123	hatched	2S	none	none
4a	9-26-01	432	111	hatched	none	5	1 SA
4b	5-10-01	150	130	1	none	none	4 SA, 3 A
4b	5-30-01	150	115	1	1M	none	none
4b	7-26-01	18	123	hatched	3s	none	none
4b	9-26-01	96	111	hatched	none	10	none
4c	5-10-01	882	130	4	none	none	1 SA, 3 A
4c	5-30-01	378	115	hatched	2L, 1M	none	1 A
4c	7-27-01	504	122	hatched	(2s)	(3)	(1 SA)
4c	9-27-01	504	116	hatched	none	7	none
4d	5-10-01	685	130	0	none	none	none
4d	5-30-01	685	115	3	hatching	none	none
4d	7-26-01	685	123	hatched	6s	5	none
4d	9-27-01	685	116	hatched	none	11	none

[a]Tadpole group numbers: L = >100 tadpoles/ m², M = 11-100, S = 5-10, s = <5

[b]Frog/tadpole numbers in parenthesis were found adjacent to subsite

Table 4.3-9b. Number of FYLF egg masses, tadpoles, juveniles, subadults and adults observed during the 2002 Visual Encounter Surveys at the Flea Valley Creek area, Site 4, NFFR Poe Powerhouse Project area.

Site/ Subsite	Date	Search Area m²	Average Discharge cfs	Egg Masses	Tadpole Groups[a,b]	Juveniles Observed[b]	Adults/ Subadults Observed[b]
4a	5/22/02	288	115	6	1M		4A
4a	6/06/02	216	115		4L		1A
4a	8/16/02	216	115		3S		
4a	9/27/02	315	115			5	
4b	5/22/02	100	115	2			2A
4b	6/06/02	125	115	2	1M		5A
4b	8/16/02	120	115		3S		
4b	9/27/02	90	115			10	
4c	5/22/02	567	115	1			1A
4c	6/06/02	480	115		4L	1	
4c	8/16/02	508	115		1s		
4c	9/27/02	635	115			3	
4d	5/22/02	411	115	2		1	1A
4d	6/06/02	548	115		2L		1A
4d	8/16/02	532	115			1	
4d	9/27/02	399	115			3	

[a]Tadpole group numbers: L = >100 tadpoles/ m², M = 11-100, S = 5-10, s = <5

[b]Frog/tadpole numbers in parenthesis were found adjacent to subsite

4.3.3 Tributary VES Results

FYLF were found in five of the eight tributary reaches surveyed in either 2000 and 2001. Four adults and three juvenile FYLF were recorded in a 500 m section of Mill Creek (TR1) on 30 August 2000. The adults were generally large, but were not as numerous as on Flea Valley Creek (Table 4.3-10). The three juveniles were found within 3-6 m (hipchain distance) of the confluence with the NFFR, and no sign of breeding was observed in the upstream portion of TR1. The frogs were found in a variety of stream habitats, including high-gradient riffle, pool, step pool, and cascade.

Flea Valley Creek (TR2) was surveyed three times during 2000 and 2001. On 31 August 2000, observers found 10 adults and 10 juveniles in the 750 m surveyed reach (Table 4.3-10). Six juveniles were sighted within 15 m of the confluence with the NFFR and the remaining 14 frogs were found as far as 46 m upstream from the railroad crossing. Their size (~23-25 mm) indicated they may have hatched from egg masses laid in Flea Valley Creek, although no other evidence of breeding was discovered. On 26 July 2001, three FYLF (2 subadults, 1 juvenile) were found in a 1,000 m survey of the tributary. On 26 September 2001, surveyors found 16 FYLF within the same 1,000 m portion of TR2: one adult, two subadults, and 13 juveniles. All juveniles were located within approximately 150 m of the confluence with the NFFR. Most of the frogs were found in cascade/pool and pocket water stream habitats, though there was some use of low-gradient riffle and main channel pool habitats as well.

In 2001, two unnamed tributaries (TR3, TR4) apparently provided late season refugia for adult FYLF. Three adults were recorded (in step pools) along the 100 m survey portion of TR3 on 7 September 2001, a creek that received at least partial sunlight during the middle of the day. Surveyors found 10 adult FYLF in a 305 m survey section of TR4 on 14 September 2001. All were located in step-pool or cascade/pool habitats.

One adult FYLF was found in the 470 m survey portion of Camp Creek (TR5) on 6 August 2001. This frog was located near the bottom of the tributary in low-gradient riffle habitat, just above the confluence with Poe Reservoir.

No FYLF were found during surveys at the remaining three tributary sites: 305 m of Heinz Creek (TR6) on 17 August 2001; 200 m of Dogwood Creek on 17 August 2001; and 230 m of Hibbard Creek on 16 August 2001.

Table 4.3-10. Number of FYLF juveniles, subadults and adults observed during the 2000 and 2001 Visual Encounter Surveys in the tributaries of NFFR Poe Powerhouse Project area.

Tributary	Date	Location	Search Length (m)	Adults/ Subadults Observed	Juveniles Observed
2000					
TR1	8/30/2000	Mill Creek, NFFR	~500	4 Adults	3
TR2	8/31/2000	Flea Valley Creek, NFFR	~750	10 Adults	10
TR3	9/7/2000	Unnamed tributary #1, NFFR	~100	3 Adults	0
2001					
TR2	7/26/2001	Flea Valley Creek, NFFR	~1000	2 Subadults	1
TR2	9/26/2001	Flea Valley Creek, NFFR	~1000	1 Adult, 2 Subadults	13
TR4	9/14/2001	Unnamed tributary #2, Bardees Bar Rd.	305	10 Adults	0
TR5	8/6/2001	Camp Creek, NFFR	nd	1 Adult	0
TR6	8/17/2001	Heinz Creek, Poe Reservoir	305	None	0
TR7	8/17/2001	Dogwood Creek, Poe Reservoir	200	None	0
TR8	8/16/2001	[illegible] Poe Reservoir	230	None	0

5.0 Discussion

In general, FYLF reproduction in the Poe Project area in 2001 and 2002 appeared successful, with adequate hatching success and some juvenile recruitment evident in most of the subsites. Initiation of egg laying in the Project area occurred in the downstream sites first (probably late April/early May in 2001), and were likely influenced by greater thermal warming in the lower reaches of the broad, open NFFR. The most successful reproductive effort occurred in the Flea Valley Creek area (Site 4), where two large tributaries enter the NFFR, one just upstream of the survey area (Mill Creek), and the other in the middle of Site 4 (Flea Valley Creek).

Perhaps the most disappointing reproductive results occurred at Subsite 3b, where eight egg masses were found in 2001 and six in 2002, but predatory fish were common (i.e., bass) and there was evidence of egg predation, and ultimately very little evidence of later season tadpole survival or juvenile recruitment. Centrarchids have been identified as predators on ranids, and can substantially impact frog populations (Jennings and Hayes 1994). Many rivers in California, such as the NFFR, now support substantial populations of introduced aquatic predators, including smallmouth bass and crayfish, which are a significant obstacle to FYLF population maintenance in large riverine systems. The steep gradient banks at this subsite predispose early FYLF life stages for such piscivorous predation. Also, dredge mining appeared to impact FYLF breeding activity at Subsite 3b, a relatively popular recreation area, in 2002.

Most egg masses and tadpole groups found in the Project area were in relatively shallow water close to shore. This is likely a response to predation (i.e., to occupy habitats too shallow for large piscivorous predators), or a by-product of predation where only egg masses and tadpoles occupying these habitats survived (C. Seltenrich, PG&E biologist, pers. comm. 2002). These shallow edgewaters also contained abundant organic sediments, flocculent materials, and aquatic insects as food sources for tadpoles and juveniles.

Flow velocities at egg mass attachment sites and tadpole groups were, in most cases, very low. There was evidence that two egg masses laid in higher velocity flows were subject to egg detachment. It is unlikely that egg masses were deposited during periods of higher stream flow in 2001 (i.e., at greater depths, distance to shore, or flow velocities than those measured) since the indications were that most egg masses were deposited in late April to mid-May and stream flow readings from the Pulga gage averaged 3.8 cm/sec for the 30 days of April (SD = 3, range = 3.6-4 cm/sec), approximating those from May (N = 31, mean = 3.6 cm/sec, SD = 6, range = 3.3-3.9 cm/sec).

At least five of the eight tributaries surveyed in the Poe Project area provided suitable habitat for FYLF. Flea Valley Creek was most utilized by frogs, and also may provide off-river breeding habitat, although this was not confirmed.

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Appendix A: Aerial Photographs of Survey Sites and Transect Locations

Appendix B: Site, Microhabitat, and FYLF Photographs

Appendix C: A Standardized Approach For Habitat Assessments and Visual Encounter Surveys for the Foothill Yellow-Legged Frog (*Rana boylii*) (Seltenrich and Pool 2002).

Appendix D: Site Habitat Assessment Forms

Appendix E: Visual Encounter Survey Data Forms

POE HYDROELECTRIC PROJECT

FERC NO. 2107

APPENDIX E3-10

Results of 2002 Study for Evaluating the Availability, Extent and Quality of Foothill Yellow-Legged Frog (*Rana boylii*) Habitat within the Poe Reach at the Existing Flow Level and at Four Higher Flows. Draft Report

Draft Report

RESULTS OF 2002 STUDY FOR EVALUATING THE AVAILABILITY, EXTENT AND QUALITY OF FOOTHILL YELLOW-LEGGED FROG (*Rana boylii*) HABITAT WITHIN THE POE REACH AT THE EXISTING FLOW LEVEL AND AT FOUR HIGHER FLOWS

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July 2003

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1.0 Introduction

Pacific Gas and Electric Company (PG&E) owns and operates the Poe Hydroelectric Project (Poe Project) in northeastern California. The Poe Project is located on the Poe Reach of the North Fork Feather River (NFFR) above Lake Oroville and downstream of the Cresta Reach of the NFFR (Figure 1.1.1). In response to concerns over foothill yellow-legged frog (*Rana boylii*, FYLF) breeding habitat area, PG&E designed this study. The primary purpose of this study is to evaluate changes in the availability, quality, and extent of breeding, tadpole rearing, and juvenile frog habitats for FYLF from the current flow regime (110 cfs) to four higher flow levels within the Poe Reach of the NFFR. PG&E contracted Garcia and Associates (GANDA) to assist in data collection to complete a formal report. The foothill yellow-legged frog (FYLF) is designated as a Federal Species of Concern, a Forest Service Sensitive Species, and a California Species of Special Concern, and is fully protected by the state.

This study was designed to document key habitat parameters at FYLF breeding sites along the Poe Reach of the NFFR (Figure 1.1.1). In addition, potentially suitable habitat sites located within 300 m upstream or downstream of each site were also assessed (Appendix I). Data collection was based on a combination of quantitative and qualitative methods. Most surveys were conducted from September 16 to September 20, 2002; additional data were collected for base flow levels on September 26-27, 2002.

Figure 1.1.1. FYLF habitat monitoring locations in the Poe Reach Study area

1.1 Background and Previous Studies

Within the Poe Project area (Project area), FYLFs occur in several areas along the main stem of the NFFR in a variety of habitats, as well as in several perennial and ephemeral tributaries. The results of three years of survey data (Pacific Gas and Electric Company file data, 2000-2003) within the Project area indicate that the majority of FYLF breeding habitats occurs in the NFFR at locations within close proximity to tributaries. Breeding activities have not been observed in any of the tributaries surveyed; however, these tributaries provide high quality summer habitat for adult and subadult frogs.

During initial surveys conducted in 2000 (Pacific Gas and Electric Company file data), four primary FYLF breeding locations were documented on the NFFR between Mill Creek in the upper portion of the Project area and Poe Powerhouse at the bottom of the Project area. Monitoring surveys conducted in 2001 and 2002 (Pacific Gas and Electric Company file data) verified the importance of these areas as breeding habitat for this species. Subsites were established at each of the four primary breeding sites based on differences in habitat, resulting in a total of nine subsites or breeding locations. In 2001 and 2002, surveys were conducted along other stretches of the main stem in the Project area to identify any additional areas that may provide suitable FYLF breeding habitat. During these surveys, two additional breeding areas were identified. Site 5 is located about midway between Bardee's Bar and Swimmer's Beach, and Site 6 is located between Site 5 and the Swimmer's Beach area subsites. These locations (sites 5 and 6) are representative of the remaining potential moderate to high quality habitat within the Poe reach. The habitat types and approximate locations of these subsites are provided in Table 1.1.

Table 1.1. General location and habitat types at 13 monitoring subsites included in the flow evaluations.

Survey Site Nos.	Monitoring subsite Nos.	Habitat Type and General Location
1	1b	Pool tail-out of large main channel pool just upstream of Poe Powerhouse
2	2a	Pool tail-out of large main channel pool at Swimmer's Beach
	2b	Low-to-moderate gradient right bank boulder/cobble bar about 50 m upstream of Swimmer's Beach
	2c-RB	Low gradient right bank cobble/boulder bars about 150 m upstream of Swimmer's Beach

Survey Site Nos.	Monitoring subsite Nos.	Habitat Type and General Location
	2c-LB	Low-gradient left bank cobble/boulder bars about 160 m upstream of Swimmer's Beach
3	3b	Moderate-to-high gradient right bank cobble/boulder bar at Bardees Bar
4	4a	Low-gradient right bank boulder/sedge habitat about 25 m downstream of the mouth of Flea Valley Creek
	4b	Low-to-moderate right bank cobble/boulder bar at the mouth of Flea Valley Creek
	4c	Low-gradient right bank cobble/boulder bar and willow side channel habitat about 40 m upstream of the mouth of Flea Valley Creek
	4d	Low-to-moderate gradient left bank side channel area and cobble/boulder bar across the river from the mouth of Flea Valley Creek
5	5a	Low-gradient right bank boulder/cobble bar and braided channel area between Bardees Bar and Swimmer's Beach at unnamed right bank tributary
	5b-e	Low-gradient right bank boulder/cobble bar and wide channel area between Bardees Bar and Swimmer's Beach
6	6a	Low-gradient left bank boulder/cobble bar located between Site 5 and the Swimmer's Beach area.

Eight subsites within the Project area were monitored during Instream Flow Incremental Methodology (IFIM) flow tests conducted in September 2000 (Pacific Gas and Electric Company file data). The potential effects of elevated IFIM flows of 250 and 500 cfs on FYLFs and their habitat were evaluated as part of the study. The overall results of the data collected on changes in FYLF habitat during the elevated IFIM flows showed that the amount and quality of suitable breeding, tadpole rearing, and juvenile frog habitat at the eight subsites was either reduced or eliminated at both 250 and 500 cfs. In September 2001, an additional flow evaluation was conducted within the Project area as a result of the Poe fire and the corresponding emergency outage that occurred at Poe Powerhouse. Again, the results showed an overall reduction in the amount and quality of breeding, tadpole rearing, and juvenile frog habitat at most subsites (Pacific Gas and Electric Company file data).

2.0 Methodology

Habitat parameters (depth, velocity, and area) and characteristics suitable for FYLF oviposition and tadpole rearing (e.g., aquatic cover and substrate composition) were evaluated at 13 monitoring subsites at the base river flow of approximately 110 cubic feet per second (cfs) and at four higher flow levels (150, 200, 250, and 310 cfs). In addition, *suitable edgewater habitats* within 300 m (upstream and downstream) from each subsite location were evaluated. These are referred to as *additional habitats* 300(+) for upstream and 300(-) for downstream sites. The same habitat parameters and characteristics measured at the 13 subsites were also measured at these additional habitats, if suitable habitat was present.

Preferred and *marginal edgewater habitats* for FYLF egg laying and larval rearing generally encompass characteristics presented in available literature concerning FYLF and recent data collected by PG&E on the NFFR and several other Sierra rivers. These characteristics are outlined further in Appendix A in a summary of known information on FYLF distribution, habitat, and life history. Subsite length, habitat width (area), mean water depth, and mean water velocity measurements were collected separately for *preferred edgewater habitats* and for *marginal edgewater habitats* using the criteria provided in the study plan (PG&E 2002a, Appendix B). These measurements allowed for a more refined analysis of the changes in both quantity and quality of habitats at each of the flows.

The methods that were used for measuring and documenting many of these parameters are provided in "A Standardized Approach for Habitat Assessments and Visual Encounter Surveys for the Foothill Yellow-Legged Frog (*Rana boylii*)" (PG&E 2002b). All of the habitat parameters and characteristics measured during this study were recorded on aerial photographs (Appendix C) and field data forms (Appendix D).

2.1 Data Collection

During the base flow analysis and each of the four test flows, PG&E biologists, Craig Seltenrich and Alicia Pool, and GANDA biologists, Ron Jackman, Ian Chan, Kevin Wiseman and Karla Marlow, made up the three two-person crews that measured the selected habitat parameters and characteristics at, and adjacent to, each of the 13 monitoring locations (Table 2.1). To ensure continuity in data collection efforts, the same two-person crews conducted all five habitat/flow evaluations (i.e., existing flow and the four higher test flows) at a given site/subsite.

Table 2.1. Crew members/survey sites evaluated for Poe Reach FYLF Habitat Flow Study

Survey Sites	Two-person Crew
Site 1 – Poe Powerhouse subsites	Kevin Wiseman/Karla Marlow
Site 2 – Swimmer's Beach subsites	Kevin Wiseman/Karla Marlow
Site 3 – Bardees Bar subsite	Ron Jackman/Ian Chan
Site 4 – Flea Valley subsites	Alicia Pool/Craig Seltenrich
Site 5 – Bardees Bar to top of Site 6 subsites	Ron Jackman/Ian Chan
Site 6 – Bottom of Site 5 to top of Swimmer's Beach subsites	Ron Jackman/Ian Chan

The flow levels used for this study were selected to cover a range of flows under which habitat changes were observed in 2000 (IFIM study) and 2001 (outage at Poe Powerhouse) at FYLF breeding sites. The flow release schedule is shown in Table 2.2.

Table 2.2. Flow levels and dates of discharge for Poe Habitat Flow Study

Discharge Levels	Date
110 cfs (Base flow)	Monday, September 16, 2002
150 cfs	Tuesday, September 17, 2002
200 cfs	Wednesday, September 18, 2002
250 cfs	Thursday, September 19, 2002
310 cfs	Friday, September 20, 2002
110 cfs (Base flow)	Thursday, September 26, 2002

FYLF habitat was divided into two groups during field data collection. *Preferred* habitat was edgewater habitat <30 cm deep with flow velocity ≤5 cm/s. *Marginal* habitat was edgewater areas between 30 and 50 cm deep with flow velocity <20 and >5 cm/s. *Preferred* and *marginal* habitats combined are considered *total habitat.*

In addition, two depth measurements were recorded for *preferred* and *marginal* habitats: maximum depth and average depth. On the data forms (Appendix D), maximum depth refers to the depth at the outer edge of habitat (*preferred* or *marginal*) at a specific transect, determined by any one of the limiting factors: depth, velocity, or width. For clarification, the term "maximum depth" has been changed to "habitat edge depth" within this report.

Three velocity measurements were recorded for *preferred* and *marginal habitats.* These measurements were: bottom velocity, average velocity at 66% depth, and maximum velocity. As with the maximum depth measurement, maximum velocity refers to the velocity at the outer edge of the habitat (*preferred* or *marginal*) at a specific transect. For clarification, the term "maximum velocity" has been changed to "habitat edge velocity" within this report.

Stage height measurements were taken at each subsite during each flow level. Measurements were recorded in centimeters from the top of the water column to the top of the rebar stakes placed as markers at the bottom and top of each subsite.

Habitat complexity and substrate composition were recorded during each flow level. Habitat complexity was the amount of exposed (i.e. above the water line) boulder and cobble substrate within suitable habitat and was recorded as a percentage to the nearest 10%. Substrate estimations were also estimated to the nearest 10%. Water temperatures (°C) were measured at each subsite during each flow level. Photographs were recorded for each subsite at both base and 310 cfs flow levels (Appendix E).

2.2 Data Analysis

All quantitative data for each subsite were entered into an Excel spreadsheet using the parameters provided on the data forms. For depth and velocity parameters, the mean values for each subsite were computed at each flow level (110, 150, 200, 250, and 310 cfs). Total area of FYLF habitat was pooled from subsite transects for between flow comparisons within subsites and among sites. Formulas used for area calculations and to extrapolate data, where needed, to fill data gaps are outlined in Appendix H.

For statistical analysis, a two factor ANOVA was used to test the null hypothesis: there is no difference in FYLF habitat area among the five flow levels. Site (n = 6) and Flow Level (n = 5) were input as independent variables and Habitat Area was the dependent variable. We also used this same model to test stage height, water temperature, and habitat complexity, substituting these into the model as a dependent variable. For ANOVA results with significant effects of site, flow or both, Tukey's multiple comparison tests were computed. For additional habitat sites only descriptive statistical summaries, were conducted. Additional habitat sites were not included as sites for inferential statistical analyses because these sites were not known breeding sites for FYLF and are therefore considered a different population from the FYLF sites.

Prior to conducting statistical testing, the data were evaluated to determine if required assumptions were met. Normality and constant variance were violated for several significance tests using the raw data. To alleviate these violations, the data were transformed using a square root (SQRT) or logarithmic transformation. After transformation, the data satisfied all required assumptions. Throughout the analysis, a family significance level of 0.10 (10%) was used. This 10% error rate applies to the entire set of comparisons and not to each individual comparison. The statistical software adjusted the p-values such that each can be compared to the significance level 0.10. The 10% level is appropriate for this study because is provides a balance between Type 1 and Type 2 errors associated with inferential statistical analysis.

To compute the SQRT values, the SQRT of the area at each transect interval was taken for each subsite/flow level combination. There were a total of 805 area measurements for the entire study. The SQRT of all the area measurements (at each transect interval) were taken and used as the response in the statistical analysis (i.e., to compute the p-values).

All graphs and numerical summaries are the original area scale (not the SQRT values). For the overall flow level comparisons, the statistics program (Minitab) captured all measurements (from all subsites) at a particular flow level and computed the averages. This process was repeated for each flow level. For the flow level comparisons within each subsite, the statistics program used all measurements at a particular flow level at that one subsite and computed the average. This process was repeated for each flow level at the one subsite and repeated for all other subsites and flow levels. For all statistical tests, subsite data were considered subsamples of each site (1-6).

3.0 Results

3.1 Subsite Habitat Descriptions

A description of pertinent habitat features for each of 13 monitoring subsites based on the information gathered during the initial base flow habitat measurements is provided in this section. More detailed habitat descriptions and site habitat assessment data forms for most subsites in this study can be found in the Poe Powerhouse Project 2000/2001/2002 FYLF Survey Results report (GANDA 2003). Habitat descriptions of additional habitats are provided in Appendix I. Figure 1.1.1 shows the location of all Poe FYLF Flow Study survey subsites.

3.1.1 Site 1 – Poe Powerhouse Area

Site 1 is located at the tail-out of a long riverine pool where a large cobble island forms a low-gradient side channel in a braided section of the NFFR that flows into Big Bend Reservoir adjacent to Poe Powerhouse. The powerhouse is located at the top of Big Bend Reservoir (functionally, Poe Powerhouse afterbay), impounded by the Big Bend Dam which is located about 1.3 km downstream from Poe Powerhouse. Site 1 is 431 m in overall length and consists of two subsites, one of which was evaluated during this flow study (Subsite 1b). Areas within 300 m upstream or downstream of the Poe Powerhouse Site contained no suitable habitat for FYLF, according to parameters outlined in the study plan (PG&E 2002a; Appendix B).

3.1.1.1 Subsite 1b – Poe Powerhouse

Subsite 1b is a low-gradient cobble bar located at the tail-out of the long pool and at the top of the large cobble island that forms two channels adjacent to the powerhouse. The subsite length included 70 m along the base of the pool tail-out. Substrate composition for Subsite 1b was mostly cobble (40%) and boulder (20%). Aquatic cover consisted of 90 percent algae/detritus, 30 percent gaps in substrate, and approximately 10 percent vegetation (mostly sedge). Bankfull width measured 104 m. Wetted channel width remained constant at 92 m.

3.1.2 Site 2 – Swimmer's Beach Area

The Swimmer's Beach area (Site 2) is located about one river kilometer upstream from Poe Powerhouse, and about 400 m upstream of the Poe Powerhouse Road bridge crossing over the NFFR. From the top, the entire site extends for 435 m downstream along a run, through a low-gradient riffle, into a long main channel pool, and down to the pool tail-out at another low-gradient riffle. There are three subsites in this area and all three were included in this study. Three *additional habitat* areas adjacent to the Swimmer's Beach Site were included in the study and evaluated as outlined in the study plan (PG&E 2002a; Appendix B).

3.1.2.1 Subsite 2a

Subsite 2a is a low-gradient cobble bar and backwater pool area at the tail-out of the long pool at Swimmer's Beach. The subsite length included 67 m along the base of the tail-out. Substrate composition for Subsite 2a was mostly cobble (80%) with a few boulders (10%) and gravel/pebble (10%). Aquatic cover consisted of 90 percent algae/detritus, 60 percent gaps in substrate, and about 20 percent vegetation. Bankfull width measured 58 m. Wetted channel width remained constant at 52 m.

3.1.2.2 Subsite 2b

Subsite 2b is a low-to-moderate gradient cobble/boulder bar along the right bank in the middle portion of the main channel pool at the Swimmer's Beach area. Subsite 2b was 93 m in length and composed of 50 percent boulder, 40 percent cobble, and 10 percent gravel/pebble. Aquatic cover consisted of 80 percent algae/detritus, 70 percent gaps in substrate, and little or no aquatic vegetation. Bankfull width measured 44 m. Wetted channel width remained constant at 37 m.

3.1.2.3 Subsite 2c (Right Bank)

Subsite 2c RB (Right Bank) is a low-gradient cobble/boulder lateral bar on the right bank along the run and riffle portion at the top of Site 2 at Swimmer's Beach. The downstream end of this subsite is at the head of a low-gradient riffle at the base of the run. The subsite length was 37 m and was estimated at 30 percent boulder, 50 percent cobble, and 20 percent gravel/pebble. Aquatic cover consisted of 70 percent algae/detritus, 60 percent gaps in substrate, and 30 percent aquatic vegetation. Bankfull width measured 49 m. Wetted channel width remained constant at 28 m.

3.1.2.4 Subsite 2c (Left Bank)

Subsite 2c LB (Left Bank) is a low-gradient cobble/boulder lateral bar on the left bank along the run and riffle portion at the top of Site 2 at Swimmer's Beach. The lower end of this subsite is at the head of a low-gradient riffle at the base of the run/glide. Subsite length was 126 m long and was estimated at 50 percent boulder, 40 percent cobble, and 10 percent gravel/pebble. Aquatic cover consisted of 70 percent algae/detritus, 80 percent gaps in substrate, and 60 percent vegetation. Bankfull width measured 55 m. Wetted channel width measured 47 m at the bottom of the subsite.

3.1.3 Site 3 - Bardees Bar Area

Site 3 is located in the NFFR Bardees Bar area, approximately 6 km upstream of Poe Powerhouse. The overall site is 181 m long and includes the lower portion of a large main channel pool and a side pool near its tail-out. There are two subsites in Site 3, however, only Subsite 3b was selected for this study.

3.1.3.1 Subsite 3b

Subsite 3b is a moderate-to-steep gradient cobble/boulder lateral bar located along the right bank of the main channel pool at the Bardees Bar old bridge crossing. The length was 64 m and substrate composition was estimated as 50 percent cobble, 20 percent boulder, 20 percent gravel/pebble, and 10 percent sand. Aquatic cover consisted of 10 percent algae/detritus, 60 percent gaps in substrate, and 10 percent aquatic vegetation. Bankfull width measured 48 m. Wetted channel width measured 40 m at the bottom of the subsite.

3.1.4 Site 4 – Flea Valley Creek Area

The Flea Valley Creek survey area (Site 4) is located on the NFFR at its confluence with Flea Valley Creek and adjacent to the Pulga railroad siding and town site, about 1 km downstream of Poe Dam. The overall site length is 419 m. The top half is low-gradient run and riffle, and the bottom half is low-gradient run. Site 4 includes four subsites that were selected for this study. One *additional habitat* area along the Flea Valley Creek Site was included in the study and evaluated.

3.1.4.1 Subsite 4a

Subsite 4a is a 72 m long by 6 m wide section of low-gradient boulder/sedge margin along the right bank of the NFFR approximately 10 m downstream from the confluence with Flea Valley Creek. The length of habitat evaluated for this study was 48 m. Substrate composition for Subsite 4a was estimated as 40 percent cobble, 40 percent boulder, and 20 percent gravel/pebble. Aquatic cover consisted of 60 percent algae/detritus, 40 percent gaps in substrate, and 10 percent woody debris. Bankfull width measured 55 m. Wetted channel width measured 24 m to 32 m during the flow study.

3.1.4.2 Subsite 4b

Subsite 4b is a moderate-gradient cobble/boulder lateral bar along the right bank of a run/glide, formed by the alluvial outflow of Flea Valley Creek into the NFFR. The length of habitat was 48 m and substrate composition was estimated as 60 percent cobble, 20 percent boulder, and 20 percent gravel/pebble. Aquatic cover consisted of 70 percent algae/detritus, 70 percent gaps in substrate, 10 percent aquatic vegetation, and 30 percent woody debris. Bankfull width measured 53 m. Wetted channel width ranged from 21 m to 26 m over the course of the flow study.

3.1.4.3 Subsite 4c

Subsite 4c is a broad, low-gradient lateral cobble/boulder bar on the right bank NFFR along riffle/run habitat just upstream of the confluence with Flea Valley Creek. The subsite length was 86 m and substrate composition was estimated as 50 percent boulder, 30 percent cobble, 10 percent gravel/pebble, and 10 percent sand. Aquatic cover consisted of 80 percent algae/detritus, 70 percent gaps in substrate, and little vegetation. Bankfull width measured 59 m. Wetted channel width ranged from 32 m to 39 m over the course of the flow study.

3.1.4.4 Subsite 4d

Subsite 4d is a low-to-moderate gradient lateral cobble/boulder bar located on the right bank NFFR opposite the confluence of Flea Valley Creek. The length of habitat evaluated for this study was an 86.5 m subsite. Substrate composition for Subsite 4d was estimated as 30 percent cobble, 20 percent boulder, 30 percent gravel/pebble, and 20 percent sand. Aquatic cover consisted of 70 percent algae/detritus, 40 percent gaps in substrate, and <10 percent woody debris. Bankfull width measured 54 m. Wetted channel width ranged from 23 m to 26.5 m over the course of the flow study.

3.1.5 Site 5 - Bardees Bar to Top of Site 6 Area

Site 5 is located upstream of the Swimmer's Beach and Site 6 subsites. It is a low-gradient right bank boulder/cobble bar and braided channel area almost midway between Bardees Bar and the top of the Swimmer's Beach site near an unnamed right bank tributary. This area was identified during 2001 and 2002 FYLF breeding habitat surveys and consists of five subsites, only one of which (Subsite 5a) was evaluated for this study as outlined in the study plan (PG&E 2002a; Appendix B). It should be noted that Subsites b,c,d,e (Section 3.1.7) were atypical and evaluated as four transects spaced along a wide, extensive side channel area and treated in the data as one subsite. Only depths and velocities were monitored, and no width or area measurements were recorded for this composite subsite. Two *additional habitat* areas were evaluated adjacent to this site.

3.1.5.1 Subsite 5a

Subsite 5a is a low-gradient right bank boulder/cobble bar near a wide, braided channel area located below Bardees Bar. The subsite length was 88 m and substrate composition was estimated as 40 percent gravel/pebble, 40 percent cobble, 10 percent boulder, and 10 percent sand. Aquatic cover consisted of 90 percent algae/detritus, 30 percent gaps in substrate, 10 percent aquatic vegetation, and 10 percent woody debris. Bankfull width measured 79 m. Wetted channel width measured 62 m.

3.1.5.2 Subsite 5b, c, d, e

Subsites 5b-e were evaluated as four combined subsite transects within a wide side-channel area of Site 5. Subsite 5b measured 36 m; Subsite 5c measured 29 m; Subsite 5d measured 31m; and Subsite 5e measured 33 m in length. Overall substrate composition for this area was estimated as 60 percent boulder, 20 percent cobble, 10 percent gravel/pebble, and 10 percent silt/clay. Aquatic cover consisted of 60 percent algae/detritus, 60 percent gaps in substrate, 10 percent vegetation, and 20 percent woody debris. Bankfull width measured 96 m. Wetted channel width measured 62 m.

3.1.6 Site 6 – Bottom of Site 5 to Swimmer's Beach Area

Site 6 is located upstream of Swimmer's Beach and downstream of the Site 5 subsites. It is a low-gradient left bank boulder/cobble bar. This area was identified during 2001 and 2002 FYLF breeding habitat surveys and consists of only one subsite. One *additional habitat* area was considered suitable FYLF habitat and was evaluated.

3.1.6.1 Subsite 6a

Subsite 6a is a low-gradient, left bank boulder/cobble bar along a glide. The subsite length was 157 m and substrate composition was estimated as 60 percent boulder, 20 percent cobble, 10 percent gravel/pebble, and 10 percent sand. Aquatic cover consisted of 10 percent vegetation, 80 percent algae/detritus, and 50 percent gaps in substrate. Bankfull width measured 55 m. Wetted channel width measured 21 m.

Table 3.2. Subsite Descriptions at Base Flow

3.2 Site-Specific Results

3.2.1 Site 1 - Poe Powerhouse Area

3.2.1.1. Subsite 1b FYLF Habitat Area

Across the five discharge levels, *total habitat* area decreased (-9.1%) from 337 m^2 at base flow to 306 m^2 during the 310 cfs discharge (Figure 3.2.1, Table 3.2.1.) Specifically, *preferred* habitat, 285 m^2 at base flow, decreased by 11 m^2 (-4%) at the 310 cfs flow. *Marginal* habitat, 52 m^2 at base flow, decreased by 19 m^2 (-37%) at the 310-flow level.

Figure 3.2.1. FYLF habitat area at 5 discharge levels, Subsite 1b.

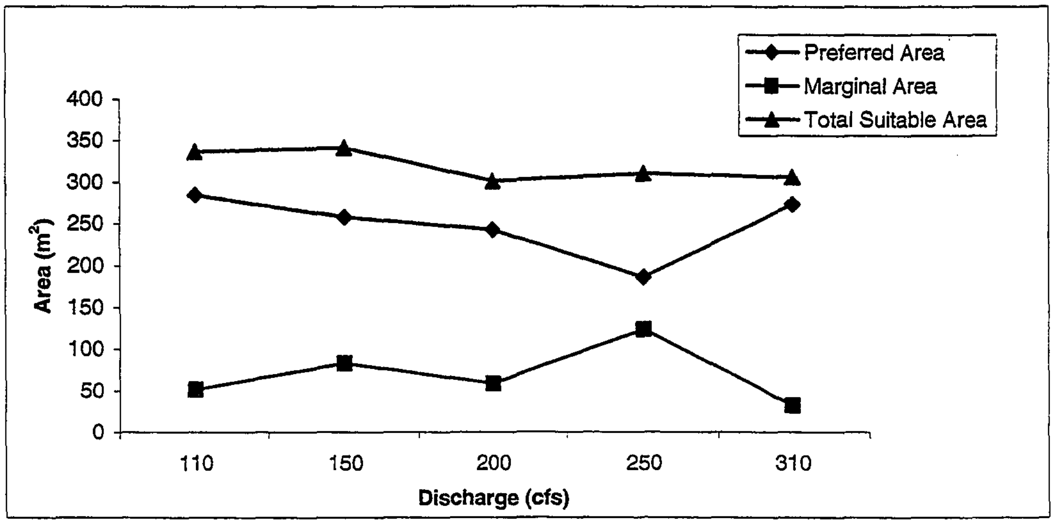


Table 3.2.1. FYLF habitat area and (%) change from base flow, Subsite 1b

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	150	200	250	310
Preferred Habitat Area	285	258 (-9.4)	243 (-14.9)	187 (-34.5)	274 (-4.0)
Marginal Habitat Area	52	83 (+60.4)	59 (+13.3)	124 (+139.0)	33 (-37.0)
Total Habitat Area	337	342 (+1.4)	302 (-10.5)	311 (-7.8)	306 (-9.1)

3.2.1.2 Subsite 1b Mean Habitat Depths

At base flow (110 cfs), the cobble bar bank gradient was low; the mean *preferred* habitat depth was 11 cm, and the mean *marginal* habitat depth was 19 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 16 cm and mean *marginal* habitat depth was 18 cm (Table 3.2.2). Stage height measurements at base flow were 57 cm and changed to 44 cm at the 310 cfs flow, a depth increase of 13 cm at the marker (Figure 3.3.10).

Table 3.2.2. Mean depths at 5 discharge levels, Subsite 1b

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Average Depth	10.97	12.95	15.06	13.58	16.48
Preferred Habitat Edge Depth	17.15	16.69	18.69	16.92	19.23
Marginal Average Depth	18.60	21.57	22.00	21.77	18.43
Marginal Habitat Edge Depth	23.20	23.71	23.33	24.69	22.00

3.2.1.3 Subsite 1b Mean Habitat Flow Velocities

At base flow (110 cfs), Subsite 1b showed mean *preferred* habitat flow velocities between 2 (bottom velocity) and 3 cm/s (habitat edge velocity). Mean *marginal* habitat flow velocities were between 10 (bottom velocity) and 15 cm/s (habitat edge velocity). At the highest flow (310 cfs), mean *preferred* habitat velocities were <1 (bottom velocity) and >2 cm/s (habitat edge velocity). Mean *marginal* habitat flow velocities ranged between 7 (bottom velocity) and 15 cm/s (habitat edge velocity) (Table 3.2.3).

Table 3.2.3. Mean velocities at 5 discharge levels, Subsite 1b

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	2.54	2.92	2.77	2.77	2.46
Preferred Average Velocity @ 66%	2.45	1.78	2.14	1.25	1.04
Preferred Bottom Velocity	1.62	1.58	2.09	1.17	0.50
Marginal Habitat Edge Velocity	14.60	12.43	15.17	9.08	15.00
Marginal Average Velocity @ 66%	14.60	10.14	11.67	7.31	8.71
Marginal Bottom Velocity	10.00	9.71	9.17	6.92	6.86

3.2.1.4 Subsite 1b – Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) was rated at 20 percent at base flows and increased slightly to 30 percent at the highest flow (310 cfs) where inundation onto the cobble bar created additional exposed boulder/cobble substrate. *Preferred* habitat within Subsite 1b was concentrated in the central pool tail-out region (found roughly between transects at 15 m and 52 m), with the amount of preferred habitat decreasing at the top and bottom of the subsite where the two channels are located. The maximum amount of inundation of the cobble bar extended approximately 5 m from the baseline flow edgewater line at 310 cfs, at the 47 m transect interval. The majority of the backwater inundation was concentrated within the first 52 m of the subsite, where water velocities were minimal or nonexistent in the pool tail-out river habitat. Inundation of the cobble bar into suitable edgewater habitats generally decreased in areas near the channel margins where water velocities increased steadily with increased flows. No suitable FYLF breeding habitat occurred within 300 m downstream of the subsite, which consisted mainly of high-velocity run habitat, similar to that found in the two adjacent channels. Habitat 300 m above Subsite 1b consisted of deep pool habitat, with steep bank gradients unsuitable for FYLF breeding or tadpole rearing. Crayfish (*Pacifastacus leniusculus*) were observed at Subsite 1b at all flow levels.

3.2.2 Site 2 - Swimmer's Beach Area

3.2.2.1 Subsite 2a FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area decreased (-25%) from 321 m^2 at base flow to 240 m^2 during the 310 cfs discharge. Specifically, *preferred* habitat decreased by 73 m^2 and *marginal* habitat decreased by 8 m^2 (Figure 3.2.2, Table 3.2.4).

Figure 3.2.2. FYLF habitat area at 5 discharge levels, Subsite 2a

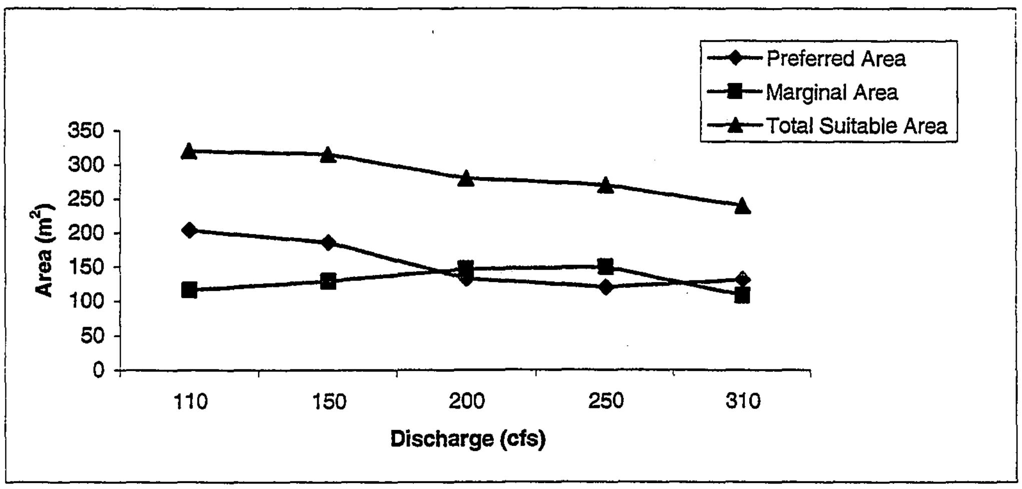


Table 3.2.4. FYLF habitat area and (%) change from base flow, Subsite 2a

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	150	200	250	310
Preferred Habitat Area	204	186 (-8.7)	133 (-34.8)	121 (-40.9)	131 (-35.6)
Marginal Habitat Area	117	130 (+11)	147 (+25.7)	150 (+28.2)	109 (-7)
Total Habitat Area	321	316 (-1.5)	280 (-12.8)	270 (-15.8)	240 (-25.2)

3.2.2.2 Subsite 2a Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 14 cm, and mean *marginal* habitat depth was 35 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 23 cm and mean *marginal* habitat depth was 38 cm (Table 3.2.5). Stage height measurements at base flow were 60 cm and decreased to 42 cm at the 310 cfs flow, a depth increase of 18 cm at the marker (Figure 3.3.10).

Table 3.2.5. Mean depths at 5 discharge levels, Subsite 2a

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Average Depth	14.15	17.62	22.29	20.18	23.38
Preferred Habitat Edge Depth	26.50	26.00	28.25	25.45	26.20
Marginal Average Depth	34.60	39.67	38.27	38.33	38.30
Marginal Habitat Edge Depth	41.70	42.22	45.45	44.50	44.60

3.2.2.3 Subsite 2a Mean Habitat Velocity

At base flow (110 cfs), the *preferred* habitat flow velocities were between <1 (bottom velocity) and >1 cm/s (habitat edge velocity). *Marginal* habitat flow velocities were between <1 (bottom velocity) and <2 cm/s (habitat edge velocity). At the highest flow- (310 cfs), mean *preferred* habitat velocities were recorded at <1 cm/s for both bottom and habitat edge velocities. *Marginal* flows were between <1 (bottom velocity) and 3 cm/s (habitat edge velocity) (Table 3.2.6).

Table 3.2.6. Mean velocities at 5 discharge levels, Subsite 2a

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	1.15	0.75	0.83	1.27	0.70
Preferred Average Velocity @ 66%	0.47	0.28	0.55	1.00	0.70
Preferred Bottom Velocity	0.48	0.10	0.18	0.36	0.10
Marginal Habitat Edge Velocity	1.70	2.00	3.55	4.25	3.10
Marginal Average Velocity @ 66%	1.50	1.11	2.73	2.75	0.90
Marginal Bottom Velocity	0.90	0.78	1.18	1.08	0.30

3.2.2.4 Subsite 2a Habitat Complexity and Qualitative Observations

Complexity of habitat (exposed boulder/cobble) was rated low at 10 percent at base flow. As water levels came up, complexity at this subsite diminished. However, at higher flows (250 and 310 cfs), water inundated the cobble bar and created more exposed boulder/cobble bringing the complexity rating back to 10 percent. *Preferred* FYLF habitat within Subsite 2a was concentrated in the shallow area near the top of the subsite, roughly between transects at 13 m and 43 m, linear distance. *Preferred* habitat decreased near the top of the subsite (at 0 m) due to the presence of a swift flowing channel that drained the pool tail-out. At approximately 43 m, the bank gradient gradually increased and the amount of *preferred* habitat decreased as water levels rose. As discharge levels increased, the cobble bar became increasingly inundated, particularly between 0 m and approximately 30 m linear distance along the subsite. At 310 cfs, a second channel was created through the cobble bar, connecting it to the main channel of the river just upstream of Subsite 2a (300-). Inundation of the cobble bar, which created backwater shallows, continued at moderate levels to approximately 43 m linear distance. Beyond this area, little or no inundation occurred due to the steep bank gradient, resulting in an overall increase in depth without an increase in water velocity. No additional FYLF breeding habitat occurred 300 m upstream of Subsite 2a. This was due to the presence of a sandy beach (Swimmer's Beach) as well as a low-gradient, but swift running channel that separates subsites 2a and 2b. *Additional* potential FYLF breeding habitat was identified 69 m downstream of Subsite 2a. One adult FYLF and several juveniles were observed during the first two flows, but not observed during or after the 200 cfs discharge. Several terrestrial and aquatic garter snakes and cyprinids were also present. Crayfish were observed at Subsite 2a at all flow levels.

3.2.2.5 Subsite 2b FYLF Habitat Area

Across the five discharge levels, *total habitat* decreased (-12%) from 347 m^2 at base flow to 306 m^2 during the 310 cfs discharge. *Preferred* habitat decreased by 64 m^2, but *marginal* habitat increased by 23 m^2 (Figure 3.2.3, Table 3.2.7).

Figure 3.2.3. FYLF habitat area at 5 discharge levels, Subsite 2b

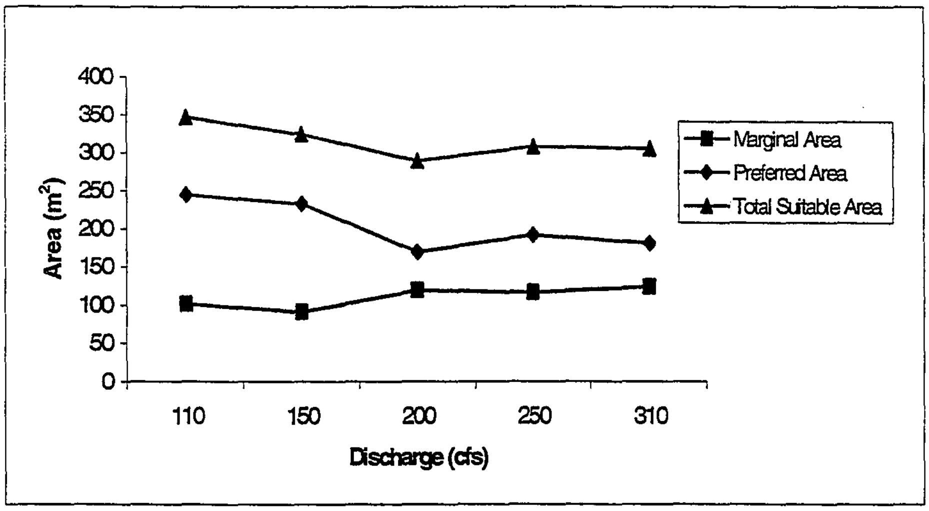


Table 3.2.7. FYLF habitat area and (%) change from base flow, Subsite 2b

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	150	200	250	310
Preferred Habitat Area	245	233 (-4.9)	169 (-30.9)	191 (-21.8)	181 (-26.1)
Marginal Habitat Area	102	91 (-10.3)	120 (+17.6)	117 (+14.5)	125 (+22.3)
Total Habitat Area	347	325 (-6.5)	289 (-16.7)	308 (-11.1)	306 (-11.9)

3.2.2.6 Subsite 2b Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 17 cm and mean *marginal* habitat depth was 39 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 23 cm, and mean *marginal* habitat depth was 40 cm (Table 3.2.8). Stage height measurements at base flow were 60 cm and decreased to 37 cm at the 310 cfs flow, a depth increase of 23 cm at the marker.

Table 3.2.8. Mean depths at 5 discharge levels, Subsite 2b

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Average Depth	17.44	21.18	22.94	23.00	23.19
Preferred Habitat Edge Depth	29.00	28.50	29.88	28.35	28.94
Marginal Average Depth	38.63	37.73	40.12	39.06	39.71
Marginal Habitat Edge Depth	47.81	47.27	49.00	47.53	47.71

3.2.2.7 Subsite 2b Mean Habitat Velocities

At base flow (110 cfs), the *preferred* habitat flow velocities were between 0 (bottom velocity) and 2 cm/s (habitat edge velocity). *Marginal* habitat flow velocities were between 0 (bottom velocity) and 1 cm/s (habitat edge velocity). At the highest flow (310 cfs), mean *preferred* habitat velocities were <1 cm/s for both bottom and habitat edge velocities. Mean *marginal* flows were <1 (bottom velocity) and <2 cm/s (habitat edge velocity) (Table 3.2.9).

Table 3.2.9. Mean velocities at 5 discharge levels, Subsite 2b

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	2.00	0.81	0.82	1.53	0.94
Preferred Average Velocity @ 66%	0.47	0.28	0.35	0.94	0.31
Preferred Bottom Velocity	0.00	0.40	0.06	0.53	0.31
Marginal Habitat Edge Velocity	0.56	1.27	3.76	4.47	1.53
Marginal Average Velocity @ 66%	0.56	0.80	2.41	3.06	0.82
Marginal Bottom Velocity	0.00	0.40	1.24	2.71	0.59

3.2.2.8 Subsite 2b Habitat Complexity and Qualitative Observations

Complexity of habitat (exposed boulder/cobble) was estimated at 50 percent at base flows and increased slightly to 60 percent at the highest flow, particularly at the upper portion of the subsite. *Preferred* FYLF breeding habitat within Subsite 2b was concentrated towards the top of the subsite, approximately between linear distances 33 m and 93 m. In this area, the cobble bar gradient decreased relative to the downstream portion of the subsite. The lower bank gradient allowed for an increase in backwater pools and shallows of the cobble bar as discharge levels increased. The bottom one-third of the subsite had a steeper bank gradient that resulted in less inundation of the bar and, as flows increased, depths tended to increase without a corresponding increase in water velocity. Two adult FYLF and several juveniles were observed during the base flow events, but were not observed after the 200 cfs discharge. Crayfish and cyprinids were observed at Subsite 2b at all flow levels. Additional potential FYLF breeding habitat was identified 16 m upstream of Subsite 2b.

3.2.2.9 Subsite 2c RB FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area decreased (-22%) from 135 m^2 at base flow to 106 m^2 during the 310 cfs discharge. Specifically, *preferred* habitat decreased by 4 m^2 and *marginal* habitat decreased by 25 m^2 (Figure 3.2.4, Table 3.2.10).

Figure 3.2.4. FYLF habitat area at 5 discharge levels, Subsite 2c RB

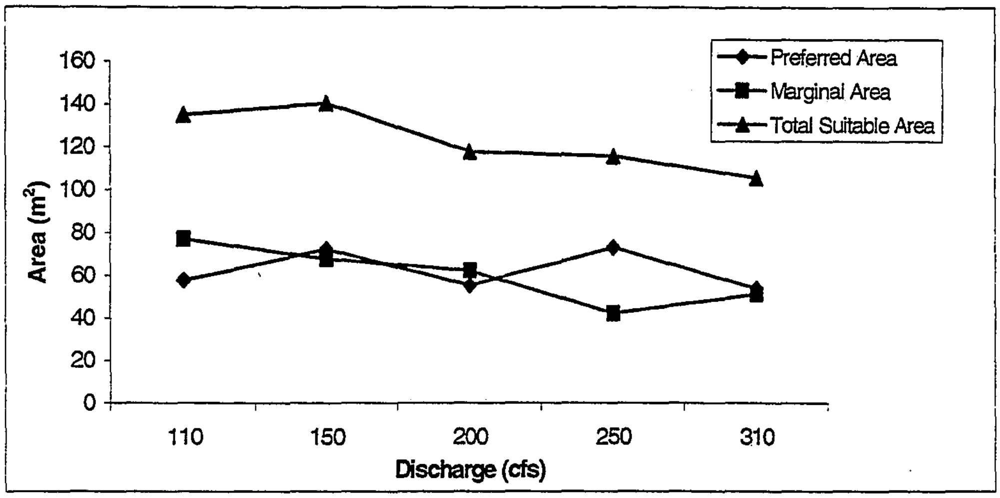


Table 3.2.10. FYLF habitat area and (%) change from base flow, Subsite 2c RB

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	**150**	**200**	**250**	**310**
Preferred Habitat Area	58	73 (+25.3)	55 (-4.2)	73 (+26.7)	54 (-6.5)
Marginal Habitat Area	77	68 (-11.9)	62 (-19.1)	42 (-45)	52 (-33.2)
Total Habitat Area	135	141 (+4.1)	118 (-12.7)	116 (-14.3)	106 (-21.7)

3.2.2.10 Subsite 2c RB Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 14 cm and mean *marginal* habitat depth was 25 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 17 cm and mean *marginal* habitat depth was 27 cm (Table 3.2.11). Stage height measurements at base flow were 74 cm and decreased to 63 cm at the 310 cfs flow, a depth increase of 11 cm at the marker.

Table 3.2.11. Mean depths at 5 discharge levels, Subsite 2c RB

Depth Measurements (cm)	Discharge Level (cfs)				
	110	**150**	**200**	**250**	**310**
Preferred Average Depth	13.63	14.80	13.29	14.25	16.67
Preferred Habitat Edge Depth	16.75	19.63	14.57	18.00	20.00
Marginal Average Depth	24.63	23.50	21.88	26.86	27.29
Marginal Habitat Edge Depth	26.25	28.00	24.63	29.86	27.71

3.2.2.11 Subsite 2c RB Mean Habitat Velocity

At base flow (110 cfs), the mean *preferred* habitat flow velocities were 1 (bottom velocity) and 4 cm/s (habitat edge velocity). *Marginal* habitat flow velocity means were between 10 (bottom velocity) and 18 cm/s (habitat edge velocity). At the highest flow (310 cfs), mean *preferred* habitat velocities were between 2 cm/s (bottom velocity) and 5 cm/s (habitat edge velocity). *Marginal* habitat flow velocities were between 14 (bottom velocity) and 17 cm/s (habitat edge velocity) (Table 3.2.12).

Table 3.2.12. Mean velocities at 5 discharge levels, Subsite 2c RB

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	3.88	4.25	4.71	5.00	5.00
Preferred Average Velocity @ 66%	2.38	1.60	4.00	2.00	3.17
Preferred Bottom Velocity	1.25	2.40	3.43	2.25	2.00
Marginal Habitat Edge Velocity	18.13	12.75	17.88	14.14	17.14
Marginal Average Velocity @ 66%	14.25	7.25	14.00	8.57	12.57
Marginal Bottom Velocity	10.13	5.38	8.63	9.43	14.43

3.2.2.12 Subsite 2c RB Habitat Complexity and Qualitative Observations

Subsite 2c RB is located just upstream of low-gradient riffle habitat on a lateral cobble bar. Habitat complexity was estimated at 60 percent at base flows, decreasing slightly to 50 percent at the highest flow. Backwater inundation of the cobble bar increased towards the top of the subsite, where bank gradient gradually decreased. As flow levels increased, numerous smaller currents formed around larger cobble and boulder substrate near the edgewater, particularly in the downstream portion of the subsite (at 0 m). Smaller currents caused fragmentation between preferred and marginal habitat and created patches with higher flow velocities. At flow levels greater than 200 cfs, both ends of the subsite lost suitable habitat. At the 5 m linear distance transect, increased water velocities (avg. 25 cm/s) at the edgewater accounted for loss of suitable habitat. At 37 m linear distance, increased depths contributed to the loss of suitable habitat. At higher discharge levels, a deepening side-channel pool was created at the top of the subsite near a large section of bedrock, also decreasing the width of suitable habitat. No potential FYLF breeding habitat was identified within 300 m upstream of Subsite 2c RB, mainly due steep bank gradients as well as close proximity to other established subsites. One adult FYLF and several juveniles were present and one southern alligator lizard (*Elgaria multicarinatus)* was observed. Crayfish were abundant throughout all flow levels.

3.2.2.13 Subsite 2c LB FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area remained approximately the same (<1% increase) at 547 m^2 at base flow (110 cfs) and 547 m^2 during the 310 cfs discharge. However, *preferred* habitat decreased by 169 m^2, while *marginal* habitat increased by 170 m^2 (Figure 3.2.5, Table 3.2.13).

Figure 3.2.5. FYLF habitat area at 5 discharge levels, Subsite 2c LB.

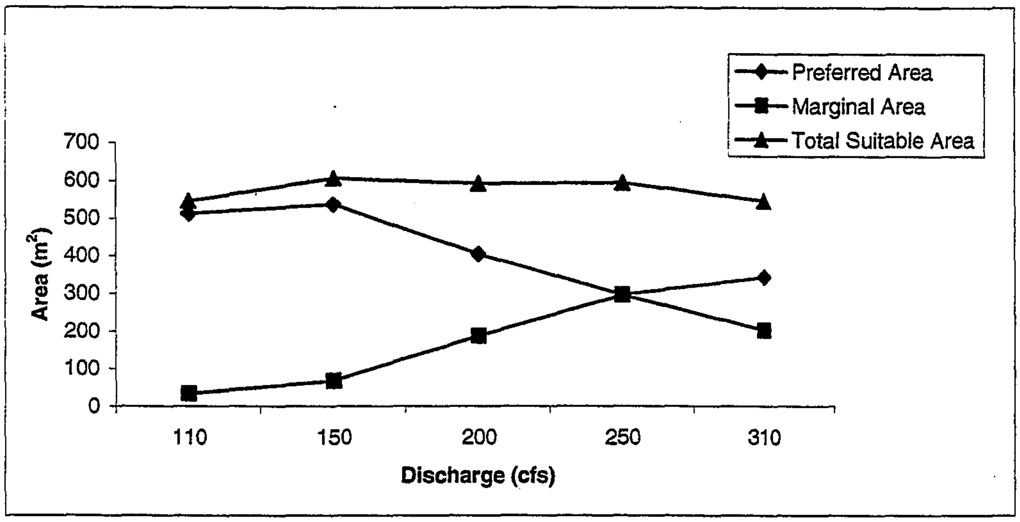


Table 3.2.13. FYLF habitat area and (%) change from base flow, Subsite 2c LB

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	**150**	**200**	**250**	**310**
Preferred Habitat Area	513	538 (+4.9)	405 (-21)	298 (-42)	344 (-33)
Marginal Habitat Area	34	68 (+100)	188 (+460)	297 (+783)	203 (+504)
Total Habitat Area	547	606 (+10.9)	593 (+8.5)	594 (+8.7)	547 (+0.1)

3.2.2.14 Subsite 2c LB Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 14 cm, and mean *marginal* habitat depth was 33 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 23 cm, and mean *marginal* habitat depth was 26 cm (Table 3.2.14). Stage height measurements at base flow were 60 cm and decreased to 42 cm at the 310 cfs flow, a depth increase of 18 cm at the marker.

Table 3.2.14. Mean depths at 5 discharge levels, Subsite 2c LB

Depth Measurements (cm)	Discharge Level (cfs)				
	110	**150**	**200**	**250**	**310**
Preferred Average Depth	13.62	15.73	19.22	21.23	22.64
Preferred Habitat Edge Depth	21.08	22.42	23.50	26.17	26.18
Marginal Average Depth	33.33	25.29	27.00	29.69	26.23
Marginal Habitat Edge Depth	42.33	32.00	30.30	31.92	34.70

3.2.2.15 Subsite 2c LB Mean Habitat Velocity

At base flow (110 cfs), the *preferred* habitat flow velocities were <1 (bottom velocity) and 1 cm/s at the habitat edge. *Marginal* habitat flow velocities were between 0 (bottom velocity) and <1 cm/s (habitat edge velocity). At the highest flow (310 cfs), mean *preferred* habitat velocities were <1 cm/s (bottom velocity) and >2 cm/s (habitat edge velocity). *Marginal* habitat flow velocities were between 2 (bottom velocity) and 8 cm/s (habitat edge velocity) (Table 3.2.15).

Table 3.2.15. Mean velocities at 5 discharge levels, Subsite 2c LB

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	1.00	2.25	2.58	3.08	2.18
Preferred Average Velocity @ 66%	0.78	0.91	1.34	1.90	1.2
Preferred Bottom Velocity	0.09	0.42	0.68	0.92	0.50
Marginal Habitat Edge Velocity	0.33	4.57	7.20	8.69	7.60
Marginal Average Velocity @ 66%	0.33	2.86	5.60	5.85	4.80
Marginal Bottom Velocity	0.00	2.86	3.10	4.85	2.31

3.2.2.16 Subsite 2c LB Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) at Subsite 2c LB was estimated at 80 percent during base flow and increased to 90 percent at the highest flow when the cobble bar became inundated creating additional exposed boulder/cobble. Inundation of the cobble bar at this subsite was fairly extensive due mainly to a low bank gradient located laterally along glide river habitat. Approximately 60 percent of the cobble bar became partially inundated at the 250 cfs release. No qualitative net loss or gain of suitable habitat was observed at Subsite 2c LB during the study. Near the wetted channel edge, at approximately the 20 m linear distance transect, was an isolated side pool, which became connected to the main channel of the river at the 250 and 310 cfs flows. At these higher flows, *preferred* habitat disappeared due to increased water velocities at the bottom of the subsite between linear distances 0 m and 20 m. Additional potential FYLF breeding habitat was located 32 m upstream of Subsite 2c LB. Juvenile frogs were observed during the first three flow events. Crayfish were abundant throughout all flow levels.

3.2.3 Site 3 - Bardees Bar Area

3.2.3.1 Subsite 3b FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area showed a decrease (-4%) with 101 m^2 at base flow to 97 m^2 during the 310 cfs discharge. Specifically, *preferred* habitat decreased slightly by 9 m^2, and *marginal* habitat increased slightly by 5.5 m^2 (Figure 3.2.6, Table 3.2.16).

Figure 3.2.6. FYLF habitat area at 5 discharge levels, Subsite 3b.

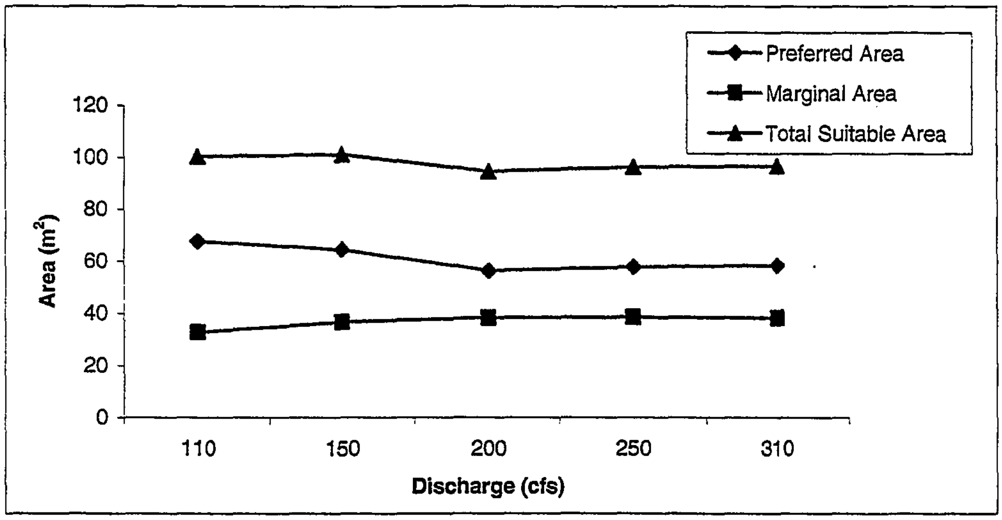


Table 3.2.16. FYLF habitat area and (%) change from base flow, Subsite 3b

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	**150**	**200**	**250**	**310**
Preferred Habitat Area	68	65 (-4.7)	56 (-16.6)	58 (-14.5)	59 (-13.5)
Marginal Habitat Area	33	37 (+11.7)	38 (+16.6)	39 (+17.4)	38 (+16.7)
Total Habitat Area	101	101 (+0.7)	95 (-5.8)	96 (-4.1)	97 (-3.6)

3.2.3.2 Subsite 3b Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 20 cm and mean *marginal* habitat depth was 42 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 20 cm, and mean *marginal* habitat depth was 42 cm (Table 3.2.17). Stage height measurements at base flow were 53.5 cm and decreased to 28 cm at the 310 cfs flow, a depth increase of 25.5 cm at the marker.

Table 3.2.17. Mean depths at 5 discharge levels, Subsite 3b

Depth Measurements (cm)	Discharge Level (cfs)				
	110	**150**	**200**	**250**	**310**
Preferred Average Depth	19.90	18.60	19.40	17.90	19.80
Preferred Habitat Edge Depth	30.00	30.00	30.00	30.00	30.00
Marginal Average Depth	42.40	41.20	41.30	40.90	41.50
Marginal Habitat Edge Depth	50.00	50.00	50.00	50.00	50.00

3.2.3.3 Subsite 3b Mean Habitat Velocities

At base flow (110 cfs), the mean *preferred* habitat velocities were 1 cm/s at both the bottom and the habitat edge velocities. Mean *marginal* habitat velocities were between 1 (bottom velocity) and 2 cm/s (habitat edge velocity). At the highest flow (310 cfs), mean *preferred* habitat velocities were >1 cm/s at both the bottom and the habitat edge. Mean *marginal* habitat velocities were between 1 (bottom velocity) and 4 cm/s (habitat edge velocity) (Table 3.2.18).

Table 3.2.18. Mean velocities at 5 discharge levels, Subsite 3b

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	1.00	1.46	1.00	1.43	1.29
Preferred Average Velocity @ 66%	1.00	1.00	1.00	1.00	1.00
Preferred Bottom Velocity	1.00	1.00	1.00	1.00	1.00
Marginal Habitat Edge Velocity	2.07	2.00	1.71	3.79	3.71
Marginal Average Velocity @ 66%	1.64	1.71	1.50	2.43	2.86
Marginal Bottom Velocity	1.00	1.00	1.00	1.00	1.29

3.2.3.4 Subsite 3b Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) at Subsite 3b was estimated at 10 percent during base flow and remained near 10 percent at the highest flow. At 250 cfs, the wetted edge of the moderate-to-steep gradient cobble/boulder bar had moved up noticeably from base flows, but suitable habitat did not appear to change much, although flow velocities appeared slightly higher. At 310 cfs, it appeared that the flow in the deep main channel pool adjacent to the subsite may have started to eddy, and flow velocities in the suitable habitat areas may have decreased somewhat.

3.2.4 Site 4 - Flea Valley Creek Area

3.2.4.1 Subsite 4a FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area increased by 99 m^2 (+45%). Specifically, *preferred* habitat increased approximately 69 m^2, and *marginal* habitat increased approximately 30 m^2 (Figure 3.2.7, Table 3.2.19).

Figure 3.2.7. FYLF habitat area at 5 discharge levels, Subsite 4a

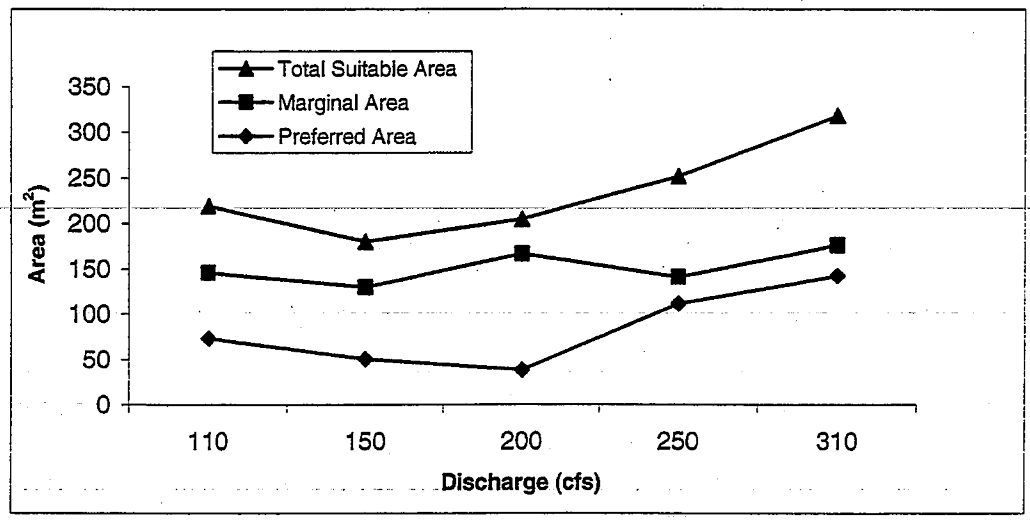


Table 3.2.19. FYLF habitat area and (%) change from base flow, Subsite 4a

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	150	200	250	310
Preferred Habitat Area	73	51 (-30.9)	38 (-48)	111 (+51.2)	142 (+93.5)
Marginal Habitat Area	146	130 (-11.1)	166 (+14)	141 (-3.6)	176 (+20.6)
Total Habitat Area	219	180 (-17.8)	205 (-6.8)	252 (+14.8)	318 (+45)

3.2.4.2 Subsite 4a Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 19 cm and mean *marginal* habitat depth was 38 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 19 cm, and mean *marginal* habitat depth was 42 cm (Table 3.2.20). Stage height measurements at base flow were 61.5 cm and decreased to 39 cm at the 310 cfs flow, a depth increase of 22.5 cm at the marker (Figure 3.3.10).

Table 3.2.20. Mean depths at 5 discharge levels, Subsite 4a

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Average Depth	19.09	19.56	19.67	15.71	18.88
Preferred Habitat Edge Depth	25.64	24.56	22.33	18.71	24.88
Marginal Average Depth	37.64	40	36.09	41.6	41.75
Marginal Habitat Edge Depth	41.91	42.15	44.91	45.8	43.13

3.2.4.3 Subsite 4a Mean Habitat Velocities

At base flow (110 cfs), the mean *preferred* habitat velocities were between 0 cm/s at bottom and 2 cm/s at the habitat edge. Mean *marginal* habitat velocities were between 2 (bottom velocity) and 6 cm/s (habitat edge velocity). At the highest flow (310 cfs), mean *preferred* habitat velocities were 2 cm/s at the bottom and 3 cm/s at the habitat edge. Mean *marginal* habitat velocities were near 3 for both the bottom and habitat edge (Table 3.2.21).

Table 3.2.21. Mean velocities at 5 discharge levels, Subsite 4a

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	1.91	2	2.67	1.14	2.63
Preferred Average Velocity @ 66%	1	0.78	2	0.86	2.25
Preferred Bottom Velocity	.45	4.44	4.4	0.86	1.88
Marginal Habitat Edge Velocity	6.09	6.46	5.73	2	2.88
Marginal Average Velocity @ 66%	3.36	3.62	5.27	2.6	2.5
Marginal Bottom Velocity	1.73	3.15	3.82	2.2	3.13

3.2.4.4 Subsite 4a Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) was estimated at 10 percent during base flow and increased slightly to 20 percent at the highest flow. During base and 150 cfs flow levels, conditions remained relatively similar. At the 200 cfs flow some new pools were formed further in from the margin, and bottom velocities increased. At the top of the subsite, a few isolated pools were formed, but were not suitable for FYLF habitat. At the 250 cfs flow, boulder exposure increased and complexity was reassessed at 20 percent. Between the 250 cfs and 310 cfs flows, there was deeper water (>50 cm) along the edge of the boulder/sedge habitat and extensive sedges lowered velocities within the preferred areas. Total habitat increased overall by nearly 100 m^2.

3.2.4.5 Subsite 4b FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area increased by 23 m^2 (+11.5%). Specifically, *preferred* habitat increased approximately 17 m^2, and *marginal* habitat increased approximately 6 m^2 (Figure 3.2.8, Table 3.2.22).

Figure 3.2.8. FYLF habitat area at 5 discharge levels, Subsite 4b

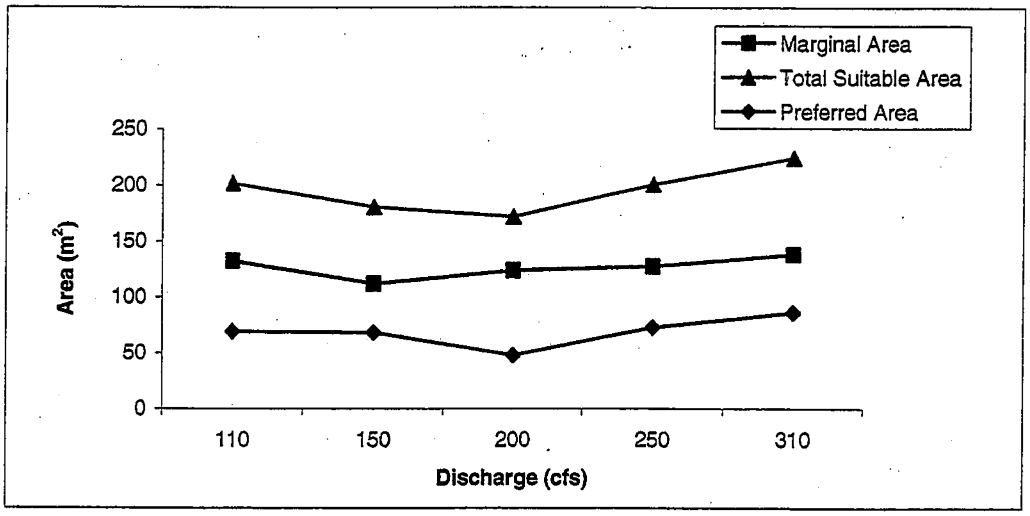


Table 3.2.22. FYLF habitat area and (%) change from base flow, Subsite 4b

Habitat Area Measurements (m^2)	Discharge Levels (cfs) 110	150	200	250	310
Preferred Habitat Area	69	69 (-1.2)	48 (-30.8)	73 (+5.3)	86 (+24.3)
Marginal Habitat Area	132	112 (-15.2)	124 (-6.2)	128 (-3.4)	138 (+4.7)
Total Habitat Area	202	181 (-10.4)	172 (-14.7)	201 (-0.4)	225 (+11.5)

3.2.4.6 Subsite 4b Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 15 cm, and mean *marginal* habitat depth was 35 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 19 cm, and mean *marginal* habitat depth was 39 cm (Table 3.2.23). Stage height measurements at base flow were 50.5 cm and decreased to 24 cm at the 310 cfs flow, a depth increase of 26.5 cm at the marker. Subsite 4b had a larger increase in depth at the marker than any other subsite.

Table 3.2.23. Mean depths at 5 discharge levels, Subsite 4b

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Depth	21.79	25.29	24.6	24.5	24
Preferred Average Depth	14.5	13.29	16	17.83	18.5
Marginal Habitat Edge Depth	43.43	38.25	41.43	47.75	46.4
Marginal Average Depth	34.57	31.38	34.14	32	39

3.2.4.7 Subsite 4b Mean Habitat Velocity

At base flow (110 cfs), the mean *preferred* habitat velocities were between 0 cm/s at bottom and 2 cm/s at the habitat edge. Mean *marginal* habitat velocities were between 4 (bottom velocity) and 11 cm/s (habitat edge velocity). At the highest flow (310 cfs), mean *preferred* habitat velocities were 3 cm/s at bottom and 3 cm/s at habitat edge velocities. Mean *marginal* habitat velocities were 3 cm/s for bottom and 7 cm/s for habitat edge velocity (Table 3.2.24).

Table 3.2.24. Mean velocities at 5 discharge levels, Subsite 4b

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	2	4.71	3.2	3.83	2.83
Preferred Average Velocity @ 66%	1	1.71	2.6	2.67	3.33
Preferred Bottom Velocity	0.21	1.29	2	2.83	3.33
Marginal Habitat Edge Velocity	10.57	11	10.43	9.25	7
Marginal Average Velocity @ 66%	9.86	7.38	9.71	5	3.2
Marginal Bottom Velocity	3.79	3.38	6.71	7	3

3.2.4.8 Subsite 4b Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) was estimated at 10 percent during base flow and decreased only slightly at the highest flow, mostly in the lower portion of the subsite. During base flow, a juvenile FYLF was observed. At 150 cfs, flow velocities and depths beyond the 32 m linear distance transect were unsuitable, reducing the total length of the subsite by nearly 16 m. At the 310 cfs flow level, 2 m was regained at the top of the subsite. *Total habitat* increased overall.

3.2.4.9 Subsite 4c FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area increased by 23 m^2 (+4%). Specifically, *preferred* habitat decreased approximately 6 m^2, and *marginal* habitat increased approximately 30 m^2 (Figure 3.2.9, Table 3.2.25).

Figure 3.2.9. FYLF habitat area at 5 discharge levels, Subsite 4c

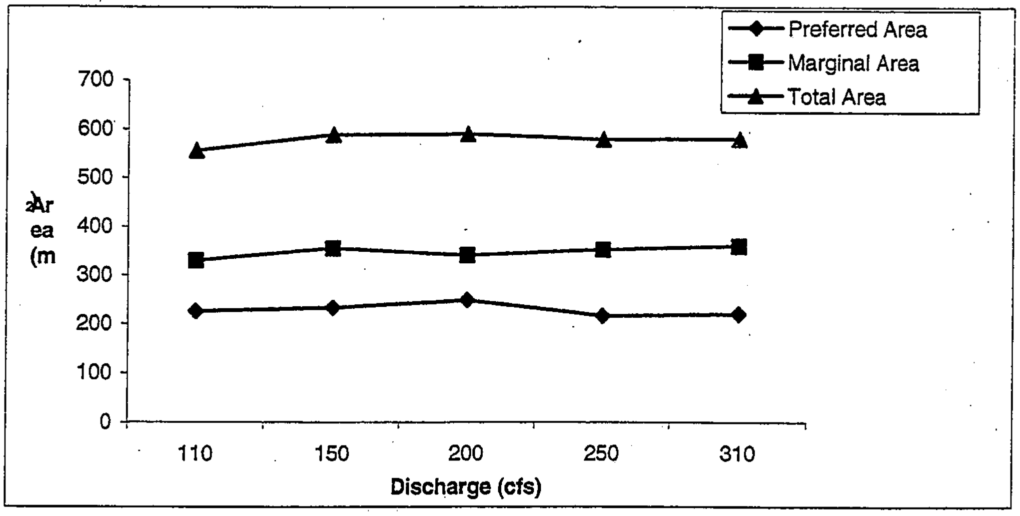


Table 3.2.25. FYLF habitat area and (%) change from base flow, Subsite 4c

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	150	200	250	310
Preferred Habitat Area	226	233 (+3.2)	248 (+9.9)	216 (-4.3)	220 (-2.7)
Marginal Habitat Area	331	356 (+7.6)	341 (+3.3)	352 (+6.7)	360 (+9)
Total Habitat Area	556	589 (+5.8)	590 (+6)	578 (+4)	580 (+4.3)

3.2.4.10 Subsite 4c Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 18 cm, and mean *marginal* habitat depth was 29 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 17 cm, and mean *marginal* habitat depth was 26 cm (Table 3.2.26). Stage height measurements at base flow were 56 cm and decreased to 39.7 cm at the 310 cfs flow, a depth increase of 16.3 cm.

Table 3.2.26. Mean depths at 5 discharge levels, Subsite 4c

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Depth	20.61	22.73	22.38	19.83	21.08
Preferred Average Depth	17.78	20.82	17.62	18.25	17.23
Marginal Habitat Edge Depth	30.53	29.22	26.89	29.9	25
Marginal Average Depth	28.53	26.56	28.56	29.8	26.25

3.2.4.11 Subsite 4c Mean Habitat Velocity

At base flow (110 cfs), the mean *preferred* habitat velocities were between 1 cm/s at the bottom and 3 cm/s at the habitat edge. Mean *marginal* habitat velocities were between 3 (bottom velocity) and 9 cm/s (habitat edge velocity). At the highest flow (310 cfs), mean *preferred* habitat velocities were 2 cm/s at the bottom and 3 cm/s at the habitat edge. Mean *marginal* habitat velocities were 6 cm/s for the bottom and 14 cm/s for the habitat edge (Table 3.2.27).

Table 3.2.27. Mean velocities at 5 discharge levels, Subsite 4c

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	3.06	2.45	3.08	3.33	3.08
Preferred Average Velocity @ 66%	2.22	2.09	1.92	2.17	2.23
Preferred Bottom Velocity	1.28	1.36	1.54	1.58	1.62
Marginal Habitat Edge Velocity	8.73	9.33	14.33	13.4	14.08
Marginal Average Velocity @ 66%	8.13	8.67	9.89	11.8	10.17
Marginal Bottom Velocity	3.13	3.89	3.67	6.4	5.67

3.2.4.12 Subsite 4c Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) was estimated at 40 percent during base flow, but increased to approximately 70 percent at the 150 cfs flow. Exposed boulder/cobble (i.e., complexity) declined over the remaining flow levels and returned to approximately 40 percent at the 310 cfs flow. Exposed boulder increased during the 200 cfs flow; changes were most noticeable during the 250 cfs flow level when waters began to inundate the cobble bar. As flows increased, several treefrogs (*Hyla regilla)* and FYLFs were observed in newer edgewater areas. Total habitat increased slightly over the course of the flow study.

3.2.4.13 Subsite 4d FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area decreased by approximately 123 m^2 (-28%). Specifically, *preferred* habitat decreased 55 m^2, and *marginal* habitat decreased approximately 69 m^2 (Figure 3.2.10, Table 3.2.28).

Figure 3.2.10. FYLF habitat area at 5 discharge levels, Subsite 4d

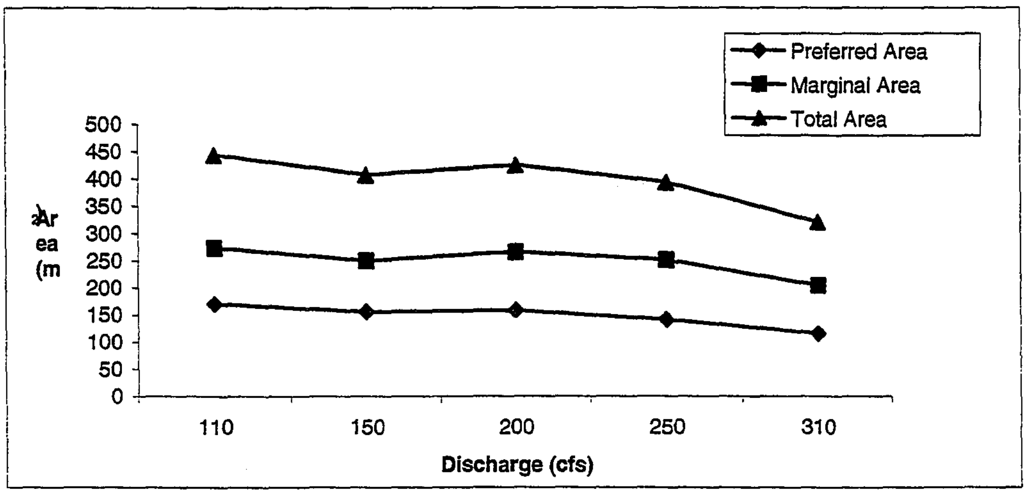


Table 3.2.28. FYLF habitat area and (%) change from base flow, Subsite 4d

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	150	200	250	310
Preferred Habitat Area	171	157 (-8.1)	159 (-6.6)	142 (-16.7)	116 (-32)
Marginal Habitat Area	274	251 (-8.4)	266 (-2.8)	252 (-7.9)	205 (-25.2)
Total Habitat Area	444	407 (-8.3)	425 (-4.3)	394 (-11.3)	321 (-27.8)

3.2.4.14 Subsite 4d Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 16 cm and mean *marginal* habitat depth was 32 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 16 cm and mean *marginal* habitat depth was 31 cm (Table 3.2.29). Stage height measurements at base flow were 58 cm and decreased to 35.4 cm at the 310 cfs flow, a depth increase of 22.6 cm at the marker.

Table 3.2.29. Mean depths at 5 discharge levels, Subsite 4d

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Depth	18.93	21.92	22	21.91	22.42
Preferred Average Depth	15.73	16.77	15.94	19.91	16.33
Marginal Habitat Edge Depth	36.73	37.82	33.86	31.92	34.38
Marginal Average Depth	32.09	32.82	26.79	29.33	30.77

3.2.4.15 Subsite 4d Mean Habitat Velocities

At base flow (110 cfs), the mean *preferred* habitat velocities were between 2 cm/s at the bottom and 4 cm/s at the habitat edge. *Marginal* habitat flow velocities were between 5 (bottom velocity) and 13 cm/s (habitat edge velocity). At the highest flow (310 cfs), velocities remained about the same as during the base flow. Mean *preferred* habitat velocities were 2 cm/s at the bottom and 4 cm/s at the habitat edge velocities. *Marginal* habitat flow velocities were between 5 cm/s for the bottom and 13 cm/s for the habitat edge (Table 3.2.30).

Table 3.2.30. Mean velocities at 5 discharge levels, Subsite 4d

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	3.6	3.46	3.31	3.55	3.5
Preferred Average Velocity @ 66%	2.33	2.38	2.19	2.09	2.08
Preferred Bottom Velocity	2	1.38	2.06	1.64	1.92
Marginal Habitat Edge Velocity	12.64	15.45	14.5	12.33	12.92
Marginal Average Velocity @ 66%	10.36	11.09	7.93	9	9.15
Marginal Bottom Velocity	4.73	4.45	5.07	5.42	5.31

3.2.4.16 Subsite 4d Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) was estimated at 20 percent during base flow, decreased to less than 10 percent during the 150 cfs flow, and did not change through the highest flow. At the 150 and 200 cfs flows, there was an increase in braided channels, reducing measurable transects when velocities were too high. Total habitat decreased over the course of the flow study.

3.2.5 Site 5 - Bardees Bar to Top of Site 6 Area

3.2.5.1 Subsite 5a FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area decreased (-38%) by approximately 142 m^2. Specifically, *preferred* habitat decreased 73 m^2, and *marginal* habitat decreased approximately 70 m^2 (Figure 3.2.11, Table 3.2.31).

Figure 3.2.11. FYLF habitat area at 5 discharge levels, Subsite 5a

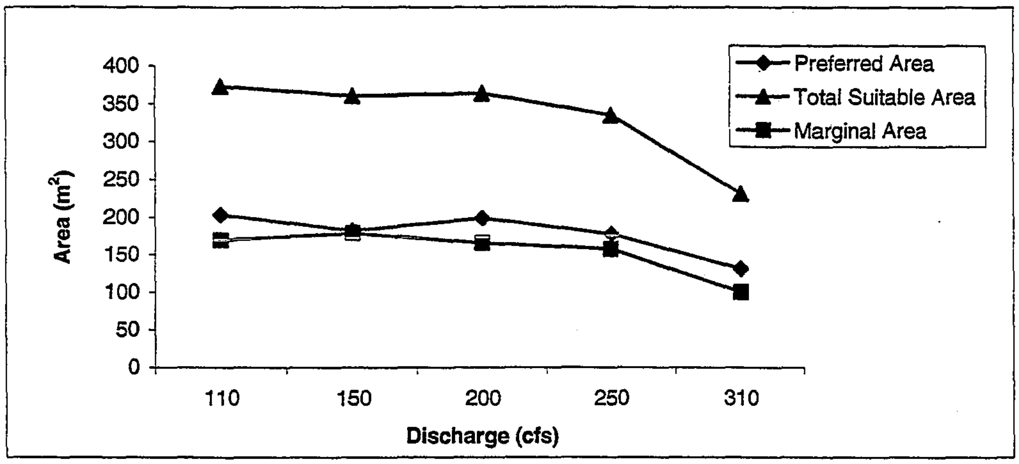


Table 3.2.31. FYLF habitat area and (%) change from base flow, Subsite 5a

	Discharge Levels (cfs)				
Habitat Area Measurements (m^2)	**110**	**150**	**200**	**250**	**310**
Preferred Habitat Area	203	182 (-10.4)	199 (-2.3)	177 (-12.8)	131 (-35.7)
Marginal Habitat Area	170	179 (+5.3)	165 (-2.7)	157 (-7.3)	100 (-41.1)
Total Habitat Area	373	361 (-3.3)	364 (-2.5)	335 (-10.3)	231 (-38.1)

3.2.5.2 Subsite 5a Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 12 cm and mean *marginal* habitat depth was 28 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 17 cm and mean *marginal* habitat depth was 37 cm (Table 3.2.32). Stage height measurements at base flow were 56 cm and decreased to 47 cm at the 310 cfs flow, a depth increase of 9 cm at the marker, the lowest increase in depth in the Poe Reach.

Table 3.2.32. Mean depths at 5 discharge levels, Subsite 5a

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Depth	20.5	21.1	24.3	25.5	28.3
Preferred Average Depth	12.4	15	14.8	16.9	17.3
Marginal Habitat Edge Depth	33.3	36	40.5	37.6	42.4
Marginal Average Depth	28	28.5	32.3	31.7	37.1

3.2.5.3 Subsite 5a Mean Habitat Velocities

At base flow (110 cfs), the *preferred* habitat flow velocities were between 1 cm/s at bottom and 4 cm/s at the habitat edge. *Marginal* habitat flow velocities were between 4 (bottom velocity) and 9 cm/s (habitat edge velocity). At the highest flow (310 cfs), mean *preferred* habitat velocities were 1 cm/s at the bottom and 2 cm/s at the habitat edge. *Marginal* habitat flow velocities were between 2 cm/s at the bottom and 6 cm/s at the habitat edge (Table 3.2.33).

Table 3.2.33. Mean velocities at 5 discharge levels, Subsite 5a

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	3.46	3.08	3.33	2.64	2.44
Preferred Average Velocity @ 66%	1.15	1.17	1	1.45	1.44
Preferred Bottom Velocity	1	1	1	1.18	1
Marginal Habitat Edge Velocity	9.46	9.23	9.83	8.36	5.56
Marginal Average Velocity @ 66%	6.85	7.54	6.67	5.09	3.56
Marginal Bottom Velocity	3.54	4.15	3.67	3.64	2.11

3.2.5.4 Subsite 5a Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) at Subsite 5a was estimated at 10 percent during base flow and remained at 10 percent during the highest flow. Since Subsite 5a was located along a lateral bar on an island sandwiched between the main channel of the NFFR and a wide side channel, there were small areas of flow-over at base flow from the side channel over low portions of the island and into the main channel. Three juvenile FYLFs were observed along the subsite at the 110 cfs base flow, and four were seen at 150 cfs. At base flow, this flow-through did not appear to impact FYLF habitat suitability. But beginning at the 200 cfs release, flow-through velocities were fast enough to begin degrading habitat conditions. This effect was more pronounced during the 250 cfs and 310 cfs flow releases, and the island was transformed into smaller islets with some higher ground. Shoreline vegetation at Subsite 5a was dense enough to inhibit flow velocities through newly inundated habitats, so suitable habitats would be more degraded (i.e., less area) at this subsite than data indicate.

3.2.5.5 Subsites 5b,c,d,e FYLF habitat area

Quantitative area measurements were not taken at this subsite. Descriptions and observations are outlined above at 3.1.5.2.

3.2.5.6 Subsites 5b,c,d,e Mean Habitat Depth

At base flow (110 cfs), the mean *total habitat* average depth for these combined subsites was 21 cm. At the highest flow (310 cfs), mean *total habitat* average depth was 37 cm. At base flow, the mean *total habitat* edge (noted here as "max") depth for these combined subsites was 34 cm. At the highest flow, mean *total habitat* edge depth was 45 cm (Table 3.2.34). Separate *preferred* and *marginal* habitat depths measurements were not taken at this subsite. Stage height measurements at base flow were 68 cm and decreased to 56 cm at the 310 cfs flow, a depth increase of 12 cm at the marker.

Table 3.2.34. Mean depths at 5 discharge levels, Subsite 5b,c,d,e

Discharge	Suitable Max Depth (b)	Suitable Max Depth (c)	Suitable Max Depth (d)	Suitable Max Depth (e)	Suitable Avg Depth (b)	Suitable Avg Depth (c)	Suitable Avg Depth (d)	Suitable Avg Depth (e)	Mean Max Depth Combined	Mean Average Depth Combined
110	28.71	42.83	27.33	35.29	17.71	27.1	17.67	22.43	33.54	21.23
150	29.71	47.5	31.17	39.57	21.57	31.67	20.5	23.71	36.99	24.36
200	31.86	48.83	33.5	43.14	25.14	36.17	24.83	26.71	39.33	28.21
250	33.71	51.83	35.17	45.71	27.14	38.67	28.67	32.14	41.61	31.65
310	38	55.67	37.83	49	31.43	42.67	38.67	35.29	45.13	37.01

3.2.5.7 Subsites 5b,c,d,e Mean Habitat Velocities

At base flow, mean velocity at the habitat edge ranged between 8 cm/s (Subsite 5c) and 13 cm/s (Subsite 5d). At the highest flow (310 cfs), maximum velocities ranged between 15 cm/s and 18 cm/s. Mean velocities at the habitat edge were 9 cm/s at base flow and 17 cm/s at the 310 cfs flow level (Table 3.2.35). Separate *preferred* and *marginal* habitat velocity measurements were not taken at this subsite.

Table 3.2.35. Mean depths at 5 discharge levels, Subsite 5b,c,d,e

Discharge	Suitable Max Velocity (b)	Suitable Max Velocity (c)	Suitable Max Velocity (d)	Suitable Max Velocity (e)	Mean Max Velocity All Subsites
110	9	7.6	12.8	7.86	9.32
150	11	6.8	14.5	7.3	9.9
200	13.4	9.2	15.8	11.4	12.46
250	16.8	11.8	20.5	14.7	15.9
310	18	15	18	18	17.29

3.2.5.8 Subsites 5b,c,d,e Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) at subsites 5b,c,d,e was estimated at 40 percent during base flow and decreased to 30 percent during the highest flow. One juvenile FYLF was seen within Subsite 5b and another within Subsite 5c during base flow data collection; there were also a number of crayfish in this wide side channel. By the 200 cfs release, flow velocities appeared slightly faster, though overall change seemed slight, and there was some shoreline flooding, especially around the island. At 250 cfs, island flooding increased, but flows appeared to be mostly absorbed by the wide side channel area. The edgewater along the downstream edge of Subsite 5b remained suitable throughout all flows, since most of the increased flow, even at 310 cfs, was carried in the side channel thalweg away from that shoreline. There was some noticeable increase in flow velocity and depth in other portions of the broad side channel area at 310 cfs.

3.2.6 Site 6 - Bottom of Site 5 to Swimmer's Beach Area

3.2.6.1 Subsite 6a FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area decreased (-20%) by approximately 130 m^2. Specifically, *preferred* habitat decreased 54 m^2, and *marginal* habitat decreased approximately 76 m^2 (Figure 3.2.12, Table 3.2.36).

Figure 3.2.12. FYLF habitat area at 5 discharge levels, Subsite 6a

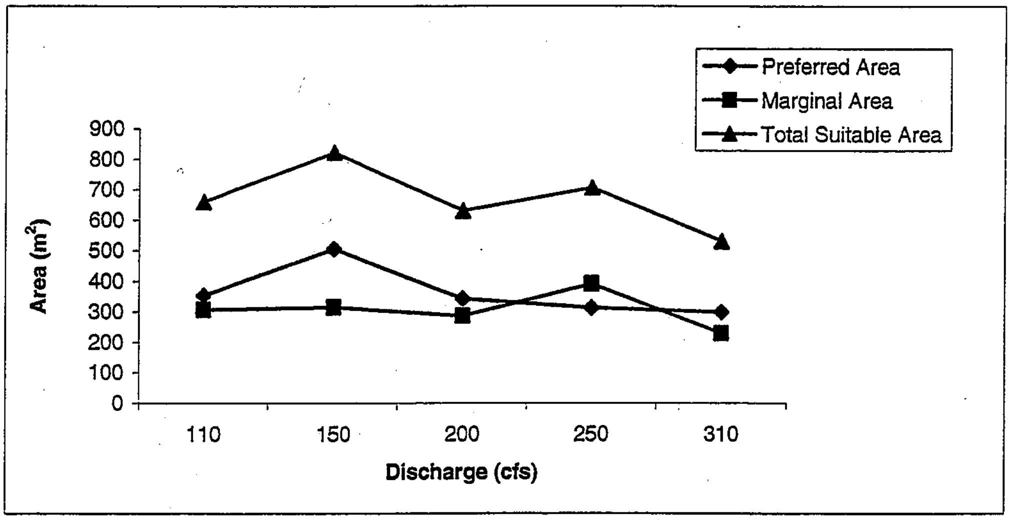


Table 3.2.36. FYLF habitat area and (%) change from base flow, Subsite 6a

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	150	200	250	310
Preferred Habitat Area	354	506 (+43)	344 (-2.9)	314 (-11.2)	301 (-15.1)
Marginal Habitat Area	307	316 (+2.9)	287 (-6.5)	392 (+27.6)	231 (-24.8)
Total Habitat Area	661	823 (+24.4)	631 (-4.6)	706 (+6.8)	532 (-19.6)

3.2.6.2 Subsite 6a Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 9 cm and mean *marginal* habitat depth was 22 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 15 cm and mean *marginal* habitat depth was 26 cm (Table 3.2.37). Stage height measurements at base flow were 66 cm and decreased to 50.5 cm at the 310 cfs flow, a depth increase of 15.5 cm at the marker.

Table 3.2.37. Mean depths at 5 discharge levels, Subsite 6a

	Discharge Level (cfs)

Depth Measurements (cm)	110	150	200	250	310
Preferred Habitat Edge Depth	18	26.9	20.9	24.5	21.9
Preferred Average Depth	9.3	15.2	15.8	14.8	15.4
Marginal Habitat Edge Depth	29.7	31.5	31.9	34.7	31.3
Marginal Average Depth	21.5	26	25.2	27.4	25.8

3.2.6.3 Subsite 6a Habitat Velocity

At base flow (110 cfs), the mean *preferred* habitat velocities were between 1 cm/s at bottom and 4 cm/s at the habitat edge velocities. *Mean marginal* habitat velocities were between 1 (bottom velocity) and 11 cm/s (habitat edge velocity). At the highest flow (310 cfs), mean *preferred* habitat velocities were 1 cm/s at the bottom and 4 cm/s at the habitat edge. Mean *marginal* habitat velocities were 5 cm/s for bottom and 15 cm/s for habitat edge (Table 3.3.38).

Table 3.2.38. Mean velocities at 5 discharge levels, Subsite 6a

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	4.14	4.9	4.62	4.27	3.88
Preferred Average Velocity @ 66%	1.33	1.5	2.05	1.86	2.06
Preferred Bottom Velocity	1	1	1	1	1
Marginal Habitat Edge Velocity	11.05	14	13.14	14.05	15.05
Marginal Average Velocity @ 66%	7.38	8.90	8.90	9.73	9.47
Marginal Bottom Velocity	1	3.65	3.43	3.64	5.37

3.2.6.4 Subsite 6a Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) at Subsite 6a was estimated at 50 percent during base flow and remained the same during the highest flow. Nine juvenile and two adult FYLFs were seen within Subsite 6a during the base flow evaluation, along with numerous crayfish. The bank gradient for most of the lower portion of the subsite was very low and new shallows were inundated immediately at the first flow increase of 150 cfs. A side effect of this flooding was the appearance of sections of edgewater where flow velocities were too fast for suitable frog habitat. These effects were enhanced and generally increased during the subsequent higher flow releases in the lower portion of the subsite. The bank gradient of the upper subsite was not quite so low, and it was mostly protected from higher flow velocities by a point of land at the upstream-most part of the subsite. At 250 cfs, extensive but shallow flooding occurred in the lower subsite, and much of this was suitable habitat for FYLFs (i.e., $\geq$10 cm average depth), and at 310 cfs a distinct edge to the bar was becoming re-established, though increased velocities were also evident.

3.3 Combined Results-All Sites

3.3.1 FYLF Habitat Area

Habitat area, depth and velocity parameters varied across flow levels. Total habitat area decreased by -10.3% (435 m^2 from a total of 4,243 m^2) from base flow to the 310 cfs flow release. Although habitat area changed across flow levels, only the change from base flow to the 310-flow level was significant ($P = 0.01$, $DFE = 775$).

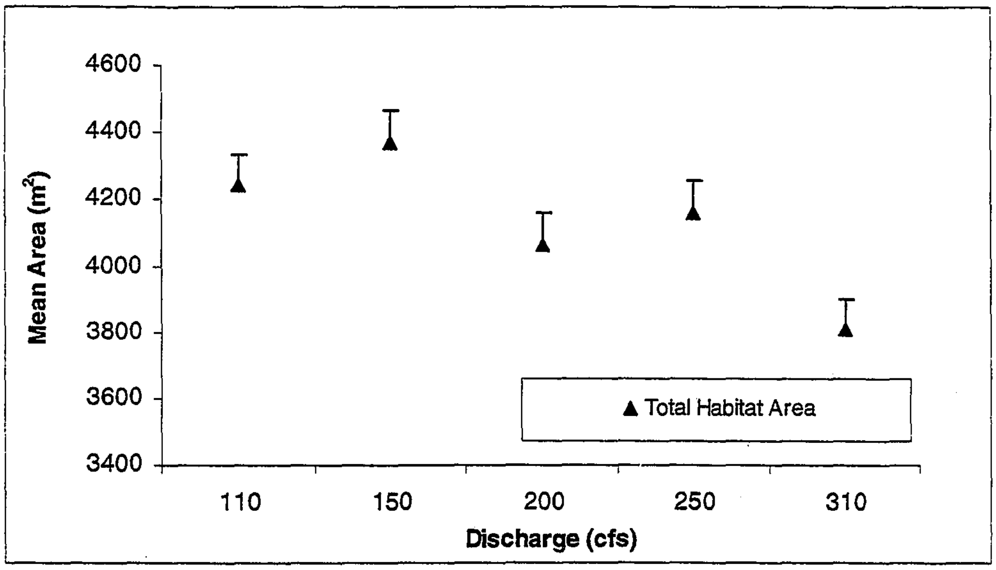
Most of the habitat lost was *preferred* habitat, which decreased by approximately 431 m^2 (18%) as flows increased from base flows to the 310-flow level. *Marginal* habitat decreased by only 4.2 m^2 (0.2%) from base flow to 310 cfs. Although the total habitat area decreased from the base flow to 310 cfs, the changes were not consistent with each flow level; that is, some flows yielded positive results (i.e., increased FYLF habitat), while others were negative (i.e., decreased FYLF habitat).

Overall *preferred* habitat area showed a slight increase (81 m^2; +3%) from base flows to 150 cfs, but began to decrease during the 200 to 250 cfs flows. The largest decrease (508 m^2, -15% from base flow) in *preferred* habitat occurred at the 250 cfs flow level. *Preferred* habitat increased slightly (76 m^2) as flows increased from 250 to 310 cfs, showing an overall decrease of 17.5 percent. *Marginal* habitat increased gradually (417 m^2; 24%) as flows went from base level to 250 cfs, but decreased sharply by 421 m^2 (-19%) from the 250 to the 310 cfs flow. Therefore, *marginal* habitat decreased by only -0.2 percent overall. Total habitat area increased slightly as flows increased from base flow to 150 cfs, but decreased from the 200 to 310 cfs flow levels, showing an overall decrease of –10 percent (Figure 3.3.1). Area measurements for each discharge level are shown in Table 3.3.1.

Table 3.3.1. FYLF habitat area and change (%) from base flow

Habitat Area Measurements	Discharge Levels (cfs)				
	110	150	200	250	310
Preferred Habitat Area (m^2)	2469.3	2550.5 (+3.3)	2098.2 (-15)	1961.8(-20.6)	2038.3 (-17.5)
Marginal Habitat Area (m^2)	1773.5	1820.2 (+2.6)	1964.6 (+11)	2190.5 (+23.5)	1769.3 (-0.24)
Total Habitat Area (m^2)	4242.7	4370.6 (+3.0)	4062.8 (-4.2)	4152.3 (-2.1)	3807.6 (-10.3)

Figure 3.3.1. FYLF habitat area at 5 discharge levels



3.3.2 Depth

Two depth measurements were recorded for *preferred* and *marginal* habitats: habitat edge depth and average depth. Each of these measurements increased slightly for both *preferred* and *marginal* habitats as flow levels increased (Table 3.3.2). Mean *marginal* habitat edge depth and mean *marginal* average depth each increased by 2-3 cm. Changes in *preferred* habitats depths were slightly more than that for marginal habitats, increasing by approximately 3-4 cm from base flows to 310 cfs (Figure 3.3.2). Actual depth measurements are shown in Table 3.3.2. Note that depth measurements were not taken in the same spot locations during each flow, and along with velocities, actually determined the location and extent of preferred and marginal habitat boundaries. Results of the ANOVA showed no significant changes in depth between flow levels.

Figure 3.3.2. Mean depth at 5 discharge levels

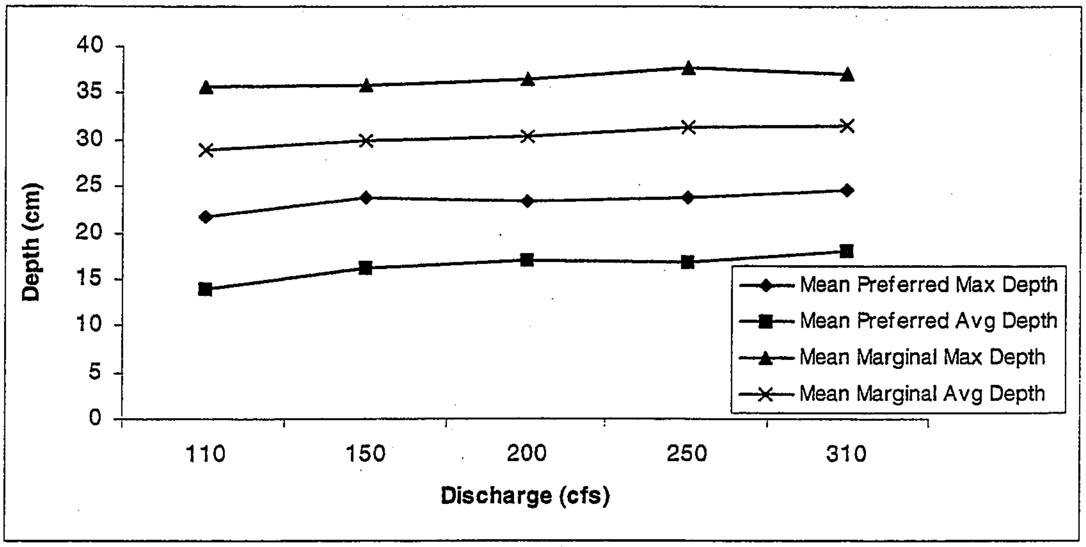


Table 3.3.2. Mean depths at 5 discharge levels

Depth Measurements (cm)	Discharge Level (cfs)				
	110	**150**	**200**	**250**	**310**
Preferred Habitat Edge Depth	21.78	23.74	23.45	23.77	24.65
Preferred Average Depth	14.01	16.12	16.97	16.79	18.04
Marginal Habitat Edge Depth	35.67	35.99	36.55	37.71	37.17
Marginal Average Depth	28.86	29.91	30.33	31.41	31.69

3.3.3 Velocity

Three velocity measurements were taken within both *preferred* and *marginal* habitats: bottom velocity, average velocity at 66% (nearest to the river bottom), and habitat edge velocity. In general, mean velocities remained relatively constant among discharge levels. Based on results of the ANOVA, velocities measured at 66% were significantly higher during the 150-flow compared to the 310-flow (P = 0.04, DFE = 837). Mean habitat edge velocities in *preferred* habitats decreased <1 cm/s from base flow to 310 cfs. Mean habitat edge velocities in *marginal* habitats increased from 8 cm/s at base flow to 10 cm/s at 310 cfs. Mean bottom velocity and mean average velocities changed <1 cm/s among the discharge levels (Figure 3.3.3; Table 3.3.3).

Figure 3.3.3. Mean velocities at 5 discharge levels

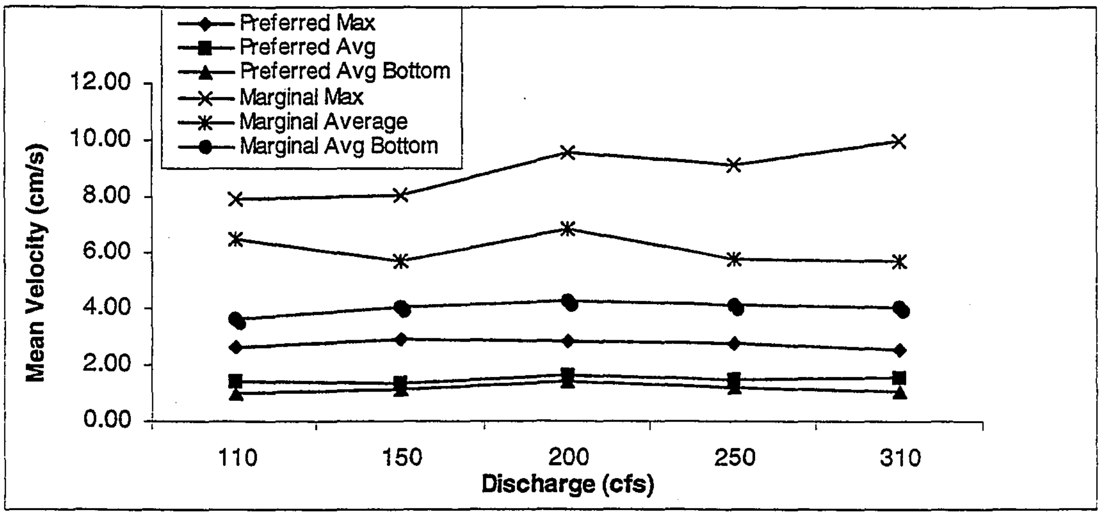


Table 3.3.3. Mean velocities at 5 discharge levels

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	2.63	2.92	2.84	2.80	2.55
Preferred Average Velocity @ 66%	1.43	1.33	1.66	1.50	1.56
Preferred Bottom Velocity	1.01	1.13	1.45	1.18	1.07
Marginal Habitat Edge Velocity	7.91	8.05	9.56	9.14	9.98
Marginal Average Velocity @ 66%	6.47	5.73	6.85	5.80	5.69
Marginal Bottom Velocity	3.61	4.10	4.27	4.16	4.05

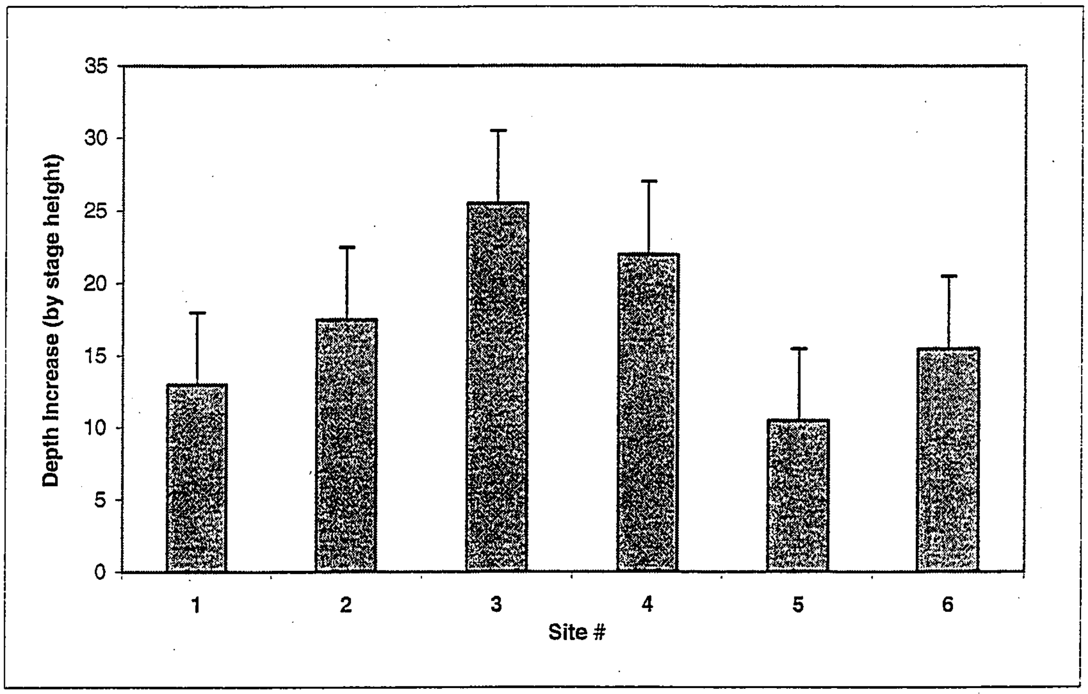
3.3.4 Stage Heights

Stage heights measurements were taken at all subsites. Measurements were taken from the top of the water to the top of the marker (rebar stake) and recorded on data forms at base flows and over the four subsequent higher flows. The increase in stage height between flow levels was strongly correlated (r = 0.99) to discharge level. The largest increase was at Subsite 4b (26.5 cm) and the smallest increase was at Subsite 5a (9 cm). Figure 3.3.10, below, shows the change in stage height for each of the six sites. Although the changes in stage height were relatively small two of the changes were statistically significant; the change from 150 cfs to 200 cfs (P = 0.09) and the change from 150 cfs to 310 cfs (P = 0.03, DFE 24). Table 3.3.10 provides the mean stage height changes for all sites combined at each discharge level.

Table 3.3.10. Mean Change in Stage Height

Discharge Level (cfs)	110	150	200	250	310
Mean Increase (cm) from Base Flow	0	+3.1	+8.7	+12.5	+17.9

Figure 3.3.10. Change in Stage Height (cm) from base flow to 310 cfs



3.3.5 Water Temperature

Water temperature measurements were taken at all sites at base flows and at the four higher flows. Temperature decreased slightly (<1° C) from base flow to the 310 flow-level; however neither this change or any other temperature changes between flow levels was statistically significant. The largest individual temperature change was at Subsite 2a, which dropped six degrees between base flow and the 310-flow level. We caution that all the temperature measurements were affected by the time of day that they were collected and the ambient air temperature. Therefore these changes may not be related only to changes in flow level. Table 3.3.11 provides the mean temperature changes for all subsites at each discharge level.

Table 3.3.11. Mean water temperatures (° C) at 5 discharge levels

Subsite	Water Temperature in Suitable Habitat (°C)				
	110 cfs	150 cfs	200 cfs	250 cfs	310 cfs
1b	17	17	17.5	17	17
2a	24	23	17.5	18	18
2b	20	20	19	19	19
2c RB	20	19	19	20	19
2c LB	20	20	20	20	20
3b	17	17	17.5	17	17
4a	19	19	17	18	18
4b	19	19	20	19	19
4c	20	19	19	17.5	20

Subsite	Water Temperature in Suitable Habitat (°C)				
	110 cfs	150 cfs	200 cfs	250 cfs	310 cfs
4d	20	19	19	19	19
5a	19	21	19	18.5	19
5bcde	20	21.5	21	19.5	19
6a	20	20.5	20	21	20
Mean Temperature – All Subsites	**19.6**	**19.6**	**18.9**	**18.7**	**18.8**

3.3.6 Habitat Complexity

Habitat complexity was a measure of the amount of exposed (i.e. above water) boulder and cobble substrate and was recorded as a percentage to the nearest 10% increment (if a range of values was entered on the data sheet, the average was computed and used in the analysis). This parameter varied between flows with an overall increase from base flow (40%) to the 310-flow level (70%). Although this increase was substantial it was not statistically significant. Therefore, we conclude that the flow levels do not provide significantly different amounts of exposed boulder and cobble .

Table 3.3.12 Habitat Complexity at Five Flow Levels

	Flow Level				
	110	150	200	250	310
Habitat Complexity (%)	40	46	50	61	70

4.0 Discussion

This study attempted to evaluate changes to FYLF habitat that would result from increased base flow levels. At the outset of the study, it was thought that preferred habitat area would decrease drastically or even be eliminated, as flows approached 250 cfs. In fact, changes in habitat area related to flow levels were relatively moderate. Below, we discuss each of the main parameters that were measured or evaluated during this study.

4.1 Habitat Area

Changes in the availability, extent and quality of FYLF habitat varied across the sites for the flow levels evaluated during this study. For the six sites that represented known FYLF breeding habitat, the total area of FYLF habitat area decreased moderately overall as discharge levels reached 200 cfs, and higher (-10% loss of suitable habitat from base flow to 310 cfs.). However, at 150 cfs, overall FYLF habitat area increased moderately (~3%) from the base flow within all habitat types. The only statistically significant change in habitat area was the comparison between 110 and 310 flow levels ($P = 0.01$, DFE = 775).

Preferred habitat area reached the highest level at the 150 cfs discharge level. However, this was not significantly greater than at other flow levels. For *preferred* habitat area, there was more habitat area at base flow compared to 200 and 310 cfs flow levels. *Marginal* habitat area was greatest at the 250 cfs flow level and was also significantly greater than at base flow, 150 cfs and 310 cfs. Although the 250 cfs level provided the greatest amount of marginal habitat, this is probably not the management goal for FYLF.

It should be noted that the changes in the amounts of *preferred* and *marginal* habitat may be explained, in part, by the study design. Because total habitat area included both *preferred* and *marginal* habitat area, these areas tended to offset each other (i.e., as *preferred* habitat area increased, *marginal* area decreased and visa-versa).

Additional sites that were measured during this study (Appendix I) exhibited a greater overall decline in FYLF habitat area (-22%) than the six FYLF sites (-10%) as discharge levels reached 310 cfs. This pattern, and the variability between sites, suggests that the geomorphology of each survey location determines the response of FYLF habitat to various flow levels. One likely explanation is that the steeper bank gradients at the additional habitats (30% steeper than the FYLF breeding sites) resulted in deeper edgewater habitats as flow levels increased. It appears that the site geomorphology (e.g., bank gradient), alignment of river bars to the flow and main thalweg, and adjacent lotic habitats (e.g., run, riffle, pool) will differentially influence the effect of flow increases on these habitats through the measured parameters used to calculate area (i.e., depths and velocities).

Results of this study contrast with previous surveys conducted in the Poe Reach during 2000 and 2001. During September 2000, an Instream Flow Incremental Methodology (IFIM) test was conducted on the reach for the 250 and 500 cfs discharge levels. Observations recorded during this event documented a decrease in the amount and quality of suitable breeding, tadpole rearing, and juvenile frog habitat at both discharge levels. In 2001, an additional flow evaluation was conducted during an emergency power outage that forced Poe Powerhouse to shut down for two days. Discharge levels during these two days fluctuated between 200 and 250 cfs. A qualitative assessment of FYLF habitat that was performed during this period showed an apparent reduction in the amount and quality of breeding, tadpole rearing, and juvenile frog habitat at all but one of nine subsites surveyed.

4.2 Depth and Velocity

Water depth and velocity at FYLF habitats increased slightly as discharge level increased. At additional habitat sites measured, depths and velocity increased more than at the FYLF subsites revealing a pattern similar to that for FYLF habitat area. It is important to note that depth and flow velocity measurements were not taken in the same locations during each flow, since these parameters determined the boundaries of preferred and marginal habitats as flows and conditions changed.

Velocity measurements at higher discharge levels were likely influenced by the presence of streambank vegetation at some sites. It is assumed that this vegetation retarded or diminished flow velocity. It is expected this shoreline vegetation would not be present if discharge levels were maintained at any of the higher levels. The magnitude of this influence is not known and was not measured, but should be tested during future studies.

Average water depth of FYLF habitat is an important factor in determining habitat quality. Increased water depths result in cooler water temperatures that may delay the onset of breeding and delay development of egg masses and tadpoles. Increased water depths may also facilitate access to FYLF habitats by predatory fish, thereby reducing the survivorship of FYLF larvae and juveniles.

4.4 Stage Height

Stage height increased by approximately 18 cm overall as flow levels increased from base flows to 310 cfs. As expected, the increase in stage height between flow levels was strongly correlated ($r = 0.99$) to discharge level with an approximate 3 cm increase for an increase of 40 cfs and an approximate 5 cm increase for a 50 cfs increase in discharge. However, increases in stage height varied between sites with increases ranging from 9 to 26.5 cm at the 310 cfs level. This variation is likely a result of differences in channel morphology between sites.

Mean stage height increases were greatest in glide habitats (21 cm at 310 cfs), followed by pools (19 cm), and runs (16 cm). However, two of the three pool habitats were at pool tails (mean increase = 16 cm) and one was in a main channel pool (26 cm increase). Stage heights were usually measured at one location in each subsite, either at the top or bottom of the survey area. Hence, these measurements may not necessarily be indicative of the entire subsite survey area. However, it is apparent that adjacent lotic habitats "absorb" flow increases differentially and thereby affect depth changes in FYLF habitats. At low-gradient cobble bar sites, increasing flows spread out across the bars resulting in only moderate increases in stage height. At high bank gradient sites, especially near vertical walls (e.g., Subsite 3b), increased flows were restricted and resulted in greater stage height increases. Increased depth is also likely an important factor that influences water temperatures, described below.

4.5 Water Temperature

Mean temperature at FYLF habitat sites decreased by 1° C from base flow to 310 cfs. Increased flows probably enhanced circulation in edgewater habitats, introducing colder water from the main channel into warmer edgewater habitats. In addition, increased flows resulted in increased water depths overall. Although a 1° C decrease in water temperature is a small change, if this lower temperature were maintained in perpetuity it could have a strong influence on FYLF ecology. Reduced temperatures could delay the onset of breeding for FYLF, extend the time required for egg masses to hatch, and extend the time required for larvae to develop and metamorphose. It is assumed that prolonging the duration of these life stages when FYLF are most vulnerable to fluctuating flows and predation would negatively affect FYLF.

4.6 Habitat Complexity

Habitat complexity, a measure of the amount of exposed boulder and cobble in edgewater habitat, was positively correlated with flow level. As flows increased, greater amounts of boulder and cobble substrate was exposed. However, none of the changes were statistically significant and they may also not be biologically significant because no studies have documented the importance of exposed boulder and cobble in FYLF habitat.

5.0 Recommendations

In an effort to improve future flow studies on the Poe Reach of the NFFR and other rivers, GANDA offers the following recommendations:

1. Conduct base flow measurements during the week prior to the flow release experiment. This will allow time for crews to spend more than one day if needed to become familiar with site logistics and to establish photo point locations prior to actual flow releases, etc.;

2. Based on the experience gained during the 2002 study, determine the amount of habitat each crew can manage successfully during the course of a 10-hour work period to avoid time-constraint and logistical problems;

3. Standardize stream measurement equipment for all crews. Marsh-McBurney flow meters should be used for all velocity measurements because of their ease of use and speed;

4. Take measures to further standardize measurement protocol. Consider establishing transect locations at fixed 5-10 m intervals at each subsite to be replicated during each flow event (transect locations were somewhat variable in 2002 by design to measure area of FYLF habitat when conditions changed during higher flows; however, this reduced statistical rigor). For average depth and flow measurements within established *preferred* and *marginal* habitat delineations (bounded by standard 30 cm depth/5 cm/sec. flow velocity, 50 cm depth/<20 cm/sec. flow velocity, respectively), measure each transect at standardized increments (e.g., 25 cm) to more accurately determine average depth and flow velocities within these habitat boundaries;

5. At each transect, measure wetted channel width with a rangefinder. Use the mean of these measurements to compare wetted channel width across discharge levels. Also, consider marking transect locations at the base flow wetted edge to measure wetted edge expansion during higher flows and stage height changes throughout the subsite;

6. Measure water temperature and air temperature from multiple, pre-established point locations to better quantify the effects of higher flows on stream temperatures;

7. At each transect, record substrate (boulder, gravel, cobble, sand or other) by point intercept at 50 cm to 1 m intervals. Use a stadia rod or flow meter to improve efficiency of data collection;

8. Quantitatively examine the influence of vegetation on velocity measurements. One method for testing this is to measure flow velocity with streambank vegetation intact followed by a second measurement with the vegetation removed;

9. Measure habitat complexity on plots between each transect (size of plot determined by distance between transects x 5 m from shore). There, record number of boulders and cobbles that extend above the water surface and estimate percent exposed above the surface, as in 2002;

10. Quantify and describe geomorphology and aquatic habitat at *each* transect by measuring and recording: bank gradient, adjacent lotic habitat (i.e., run, riffle, glide, pool, etc.), and aspect to main flow or thalweg (i.e., adjacent to, within x meters, protected by point bar, no thalweg (glide), eddy, etc.), and

11. Consult with a statistician during the study design phase of the project to determine appropriate sampling designs for the hypotheses to be tested.

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<u>*Personal Communications:*</u>

Seltenrich, C. 2002. PG&E biologist, personal communication

Pool, A. 2002. PG&E biologist, personal communication

Appendix A: FYLF Distribution, Habitat, and Life History

Appendix A

Foothill Yellow-Legged Frog (*Rana boylii*)

Life History and Habitat Information

Status:	*Federal*	Species of Concern
	State	California Species of Special Concern/Protected
	Forest Service	Sensitive

Species Description

Juveniles and Adults – The foothill yellow-legged frog (FYLF) is a moderate-sized frog, with juveniles ranging from 22 to 40 mm snout to vent length (SVL), and adults measuring from 40 to 65 mm SVL (Nussbaum et al. 1983). When they reach their maximum adult size, females are larger than males, and may measure up to 20 – 25 mm longer in SVL. The dorsal coloration of FYLFs is highly variable and in many situations blends closely with the predominant color of the surrounding substrate, making the frogs cryptic and difficult to spot. Dorsal color also appears to reflect the amount of sun exposure, with uniform dark gray or olive colored individuals typically observed in heavily shaded streams, and lighter gray, brown, tan, and yellow frogs with varying amounts of spotting found in areas that lack heavy shading (personal observations). Both juveniles and adults may have dark red coloration, often along the poorly developed dorsal lateral folds.

Many juvenile and adult FYLFs are spotted, and their skin may appear rough due to the presence of small tubercles. The tympanum is relatively small, about half the size of the eye, and is colored and roughened like the surrounding skin, often making it difficult to see (Leonard et al. 1993; Nussbaum et al. 1983). The dorsal surfaces of the rear legs are often distinctly barred, and the ventral surfaces are pale to brilliant yellow; however, the yellow coloration may be faint or lacking in younger frogs. The posterior portion of the abdomen may also be yellow or light orange in color with the remainder of the abdomen white. Dark mottling on the chin and throat is common but not always present. The webbing of the hind toes is full, slightly concave, and extends to the tip of the longest toe (Leonard et al. 1993).

During the breeding period, males may be identified by their enlarged forearms, without the need to capture them. In addition, they develop enlarged nuptial pads on the medial surfaces of the thumbs for gripping the female during amplexus, but this characteristic can only be observed if the frog is captured. Male frogs may be found in small groups in areas used for breeding, and young males may be observed in amplexus with each other. On the North Fork Feather River, male frogs have been observed on exposed substrates at mid-day calling from known oviposition sites (personal observations). The call consists of short coarse or guttural sounds with a slightly descending or ascending tone at the end of the call. These low volume calls are repeated in succession separated by silence of various lengths (personal observations). Because FYLFs are known to call primarily underwater (MacTeague and Northern 1993), this type of vocalization would presumably generate vibrations necessary to carry underwater, particularly in stream habitats. This call was also heard in early September on the Middle Fork Stanislaus River (personal observations).

Egg Masses – In coastal streams, Lind et al. (1996) found that egg masses are laid along stream margins in shallow water that is usually <1.0 m deep and in flows less than 21 cm/s. In the Sierra Nevada Mountains, recent studies have indicated that FYLFs typically deposit egg masses in shallow edgewater habitat <40 cm deep with velocities <10 cm/s (Pacific Gas and Electric Company 2001, 2002a, 2002b). FYLF egg masses are generally deposited in open, sunny areas and typically have a dark bluish tint for several days following oviposition (Ashton et al. 1998; personal observations). When first deposited, the egg mass is compact and expands as it absorbs water into a medium to large fist-sized cluster (Ashton et al. 1998), although smaller egg masses have been observed at some locations on the Middle Fork Stanislaus River (personal observations). Females normally deposit eggs in clusters of 200-300, but clusters may range from 100 to 1,000 eggs (Storer 1925; Nussbaum et al. 1983; Zeiner et al. 1988). After absorbing water, the egg mass loses its bluish color and resembles a bunch of small grapes. Individual eggs are distinctly black and are encased by clear gelatinous envelopes (Ashton et al. 1998), and as the ova develop, they can be seen elongating within the envelope (personal observations). Eggs on the outside of the mass that receive the most sunlight have been observed developing and hatching first, with the interior eggs hatching at a later date (personal observations). Depending on stream water quality and water velocity at the location of the egg mass, sediment and algae may accumulate on the mass making it very difficult to find. Within a week or two after eggs have hatched, the egg mass breaks down and the tadpoles begin to disperse (Ashton et al. 1998). This may be highly dependent on the location of the egg mass and stream conditions, such as water temperature, water depth, cover, and flows.

Tadpoles – When tadpoles emerge, they are totally black and measure less than 8 mm total length (Nussbaum et al. 1983). As tadpoles grow, they begin to turn light brown, tan, or olive, with gold flecks or dark spots scattered on the dorsal surface and tail musculature. At this stage, their cryptic coloration blends with the algae and flocculent material in shallow edgewater habitat, making them very difficult to find. Depending on the stage of development, their eyes may appear on the top of the head or slightly inset from the outline of the head when viewed from above (personal observations). Rear legs begin to develop first and become fully developed before front legs start to appear. Tadpoles retain their tail during metamorphosis, providing them with excellent propulsion and making them difficult to capture when combined with the cryptic coloration (personal observations). Tadpoles reach a maximum total length of around 55 mm, and once metamorphosed into young frogs, they measure between 22 and 27 mm total length (Nussbaum et al. 1983; Zeiner et al. 1988), with the majority of newly metamorphosed frogs measuring from 22 to 24 mm (Pacific Gas and Electric Company 2001, 2002a, 2002b).

Distribution

Historically, FYLFs were found in the Coast Ranges from the Santiam River drainage in Oregon (Mehama and Marion counties) to the San Gabriel River drainage in California (Los Angeles County), and along the west slopes of the Sierra Nevada/Cascade crest in most of central and northern California (Storer 1925; Fitch 1938; Zweifel 1955). The elevational range of the FYLF extends from near sea level to about 5,000 ft. However, specimens catalogued at the University of California Museum of Vertebrate Zoology (MVZ 35914-18) show that this species has been recorded at elevations as high as 6,000 ft in Plumas County (Zweifel 1955). Jennings and Hayes (1994) indicate that FYLFs have disappeared from about 45% of their historic range in California and 66% of their historic range in the Sierra Nevada Mountains. Based on the results of recent surveys conducted on the Pit, North Fork Feather, North Fork Mokelumne, and Middle Fork Stanislaus rivers, breeding populations of FYLFs documented on these regulated rivers have all been below 3,000 ft in elevation, with the majority of the frogs occurring at elevations below 2,500 ft. (Pacific Gas and Electric Company 2001, 2002a, 2002b; Spring Rivers 2001; Ibis Environmental, Inc. 2002).

General Life History

FYLFs are a highly aquatic amphibian, spending most or all of their life in or near streams, though frogs have been documented underground and beneath surface objects more than 50 m from water (Nussbaum et al. 1983). Adult FYLFs are primarily diurnal with high site fidelity and typically occupy small home ranges. However, from April through June, adults and subadults may move several hundred meters or more, to congregate at breeding sites. FYLFs may be active all year in the warmest localities, but may become inactive or hibernate in colder areas.

Seasonal movements of adult and recently metamorphosed FYLFs indicate a preference for different habitat types depending on seasonal requirements. Adult frogs, primarily males, will congregate along main stem rivers during spring to breed. However, adults do not typically remain in these areas during summer, returning instead to basking and foraging sites on tributaries, or retreating to cooler microhabitats along shaded river sections. They may also decrease diurnal activity during the hottest part of the summer. Zweifel (1955) noted that younger individuals typically remained by the stream until late fall and appeared earlier in the spring than adults. Observations of juvenile FYLFs have shown a strong tendency to initiate upstream migrations in late summer and early fall (Ashton et al. 1998; Twitty et al. 1967) similar to the compensating mechanism displayed by stream insects subject to downstream drift (Jennings and Hayes 1994). These movements are often correlated with the presence of upstream tributaries containing suitable habitat for FYLFs, and it is speculated that this may be an evolutionarily mechanism this species has developed to repatriate larvae that may have been washed downstream (Ashton et al. 1998).

Egg laying normally follows the period of high-flow discharge associated with winter rainfall and snowmelt, usually between late March and early June (Storer 1925; Grinnell et al. 1930; Wright and Wright 1949). Prior to the onset of breeding, adult frogs begin to appear along stream margins, especially on warm sunny days. As flows diminish and water temperatures begin to increase, males are usually the first to begin moving back to breeding areas to establish calling stations. Females arrive later when average air temperatures increase, stream flows decrease, and water temperatures reach 12 to 15°C. Breeding tends to take place in the same general area each year, unless stream conditions change and the habitat is no longer suitable for breeding. FYLF oviposition has previously been thought to be completed within a two week period (Storer 1925; Zweifel 1955; Nussbaum et al. 1983; Stebbins 1985; Jennings 1988); however, studies on Coastal streams (Kupferberg 1996; Lind et al. 1996) and Sierra Nevada streams (Pacific Gas and Electric Company 2001, 2002a, 2002b) have revealed that breeding may extend over a longer period of time. Kupferberg (1996) suggested this might be the result of late season rains or drought conditions.

Females may deposit from 100 to 1,000 eggs (Storer 1925), but more typically deposit 200 to 300 eggs in clusters attached to the sides or undersides of cobbles and boulders, or less commonly to gravel, vegetation, or submerged logs or root wads. Egg masses (clusters) are most often deposited in shallow edgewater areas <40 cm deep with little or no water flow (<10 cm/s), and eggs generally hatch in about 15 to 30 days depending on water temperature. Nussbaum et al. (1983) reported eggs hatching in about 5 days at a temperature of 20° C. FYLF tadpoles metamorphose into juvenile frogs in 3 to 4 months. During the early stages of development, tadpoles are herbivorous, feeding on diatoms and other algae (Kupferberg 1996), and as they mature will opportunistically feed on the necrotic tissue of dead tadpoles or macrofauna, if available (Ashton et al. 1998).

After metamorphosis, the diet of juvenile frogs is similar to that of adults and includes terrestrial and aquatic invertebrates such as spiders, moths, flies, beetles, water striders, snails, and grasshoppers, as well as crustaceans and molluscs. Two years are thought to be required to reach adult size (Storer 1925), with sexual maturity at 1-2 years for males and two years for females (Zweifel 1955; Nussbaum et al. 1983), although some individuals may reproduce as early as six months after metamorphosis (Jennings 1988). During studies on a tributary to the Yuba River, Van Wagner (1996) documented one-year-old males with enlarged forearms and nuptial pads that had a strong clasping reflex. He also noted that larger young-of-the-year males displayed these breeding characteristics during the fall, when both male and female adult frogs displayed breeding readiness. Of particular note, some of the larger females displayed distended abdomens and appeared gravid. Although little data are available regarding longevity of FYLFs in the wild, Van Wagner (1996) reported a female at least three years old, and based on studies of other ranids, the life span of FYLFs may be more than three years (Duellman and Trueb 1986).

Garter snakes (*Thamnophis* spp.) are the principal natural predator of tadpoles, and juvenile and adult frogs. Other natural predators that FYLFs evolved with may include aquatic insects, various fish species, birds, and mammals (Ashton et al. 1998). Moyle (1973) implicated introduced bullfrogs (*Rana catesbeiana*) in the observed reduction of FYLF populations in the Central Valley and Sierra foothills. The introduction of non-native fishes, including centrarchids (bass, sunfish, etc.), known to readily eat Rana eggs (Werschkul and Christensen 1977), and stocking of salmonids (trout) in streams where they historically did not exist, may also contribute to the disappearance or reduction of FYLF populations in Sierra streams. Additional human caused impacts to FYLFs and their habitat include, but are not limited to, construction and maintenance of dams and reservoirs, controlled stream flows, recreation, mining, logging, and livestock grazing (Jennings and Hayes 1994; Lind et al. 1996). In addition to these factors, there is increasing evidence reported by The Declining Amphibian Population Task Force (DAPTF) that the occurrence of disease, specifically the chytrid fungus, is increasing in the Sierra Nevada (Speare et al. 1998). With the increasing number of amphibian surveys in the Sierra Nevada Mountains, there is a high risk of surveyors spreading diseases among and between amphibian populations. The DAPTF has compiled procedures to minimize the spread of disease agents and parasites between study sites, which can be found in the DAPTF Fieldwork Code of Practice (http://www.mpm.edu/collect/vertzo/herp/Daptf/fcode_e.html).

Habitat Preferences

FYLFs are characteristically found close to water in association with perennial streams and ephemeral creeks that retain perennial pools through the end of summer. In general, FYLFs appear to prefer low to moderate gradient (0 to 4%) streams, particularly for breeding; however, juvenile and adult frogs may also utilize moderate to steep gradient (4 to ≥10%) creeks during the summer and early fall (personal observations). FYLFs utilize or are associated with a variety of aquatic habitat types, including: pools, riffles, runs, cascade pools, and step-pools, depending on life stage and the time of year. In California, specific habitat preferences for each life stage have been documented for streams in the Coast Ranges (Kupferberg 1996; Lind et al. 1996), and in several large river systems in the Sierra Nevada (Pacific Gas and Electric Company 2001, 2002a, 2002b; Spring Rivers 2001; Ibis Environmental, Inc. 2002). Adults preferentially utilize shallow edgewater areas with low water velocities (<10 cm/s) for breeding and egg laying, and juvenile and adult frogs may be found adjacent to riffles, cascades, main channel pools, and plunge-pools that provide escape cover.

FYLFs are found in or near streams associated with a variety of upland habitats including foothill hardwood, foothill hardwood-conifer, mixed conifer, chaparral, and coastal scrub. FYLFs have been documented on streams with both low and moderate amounts of riparian and overhanging canopy cover. Occurrence and distribution relative to stream canopy or shade may be somewhat tied to life stage (Ashton et al. 1998), but there is an observed preference for streams that offer a combination of exposed basking sites and shade (personal observations).

Little is known of the habits or habitat preferences of FYLFs during winter months at higher elevations (elevations where freezing conditions are common). FYLFs likely hibernate in nearby burrows or under cover objects such as woody debris and vegetation, or they may remain in the water where they have been found in streams with water temperatures as low as 7.5° C (personal observations).

Breeding and Egg-Laying Habitats – In rivers, breeding areas are often located within relatively close proximity to the confluences of tributary streams (Kupferberg 1996), both perennial and ephemeral streams with permanent pools (personal observations). Macro- and microhabitats utilized by FYLFs for breeding and oviposition depend largely on the availability of suitable habitat. Breeding areas are typically located in shallow edgewater areas along low gradient cobble and small boulder dominated point or lateral bars, in side channels, pool tail-outs, and side pools along river margins. In many streams, FYLF breeding habitat is often associated with main channel pools, runs, glides, or very low gradient riffles in areas with predominantly cobble, boulder, and gravel substrates.

FYLF egg masses are often attached to the sides or undersides of large cobble and boulders, although they may also be attached to small cobble, gravel/pebble substrates, vegetation, or underwater woody debris. In rivers, egg masses are typically located in relatively shallow, calm edgewater areas within 3 m of shore, and are more commonly found closer to the bottom than the water surface. Data obtained during studies conducted on the Pit, North Fork Feather, North Fork Mokelumne, and Middle Fork Stanislaus rivers (Pacific Gas and Electric Company 2001, 2002a, 2002b; Spring Rivers 2001; Ibis Environmental, Inc. 2002) indicate that these shallow breeding areas are typically <40 cm deep with velocities <10 cm/s. However, depending on the habitat type and presence of aquatic predators, oviposition may also occur in deeper water and in slightly faster currents up to 20 cm/s. Several studies have documented partial scouring of egg masses at velocities ≥20 cm/s (Kupferberg 1996; Pacific Gas and Electric Company 2002a). Egg masses are usually located in open sunny areas with little shade from riparian vegetation. Field observations have documented that eggs exposed to the sun mature more quickly than those in shade or partial shade, regardless of water temperature. In addition, eggs on the perimeter of the mass have been found to develop and hatch first, with eggs located in the center hatching several days later (personal observations).

Tadpole Habitats – Tadpoles generally occur in the same locations and habitat as that used for breeding and egg deposition, and young tadpoles appear to have some fidelity to the original egg mass site (Ashton et al. 1998). In the absence of disturbance (e.g., substantial increase in water velocity, significant drop in water level, recreation, etc.), tadpoles usually remain in the vicinity of the egg mass for several days, slowly dispersing into adjacent areas as they grow. Young tadpoles forage on diatoms or other algae on the surface of the surrounding substrate (Kupferberg 1996; Ashton et al. 1998). However, as they develop, tadpoles lose the black coloration and become more camouflaged, blending with the background. From this stage of development (approximately four weeks after hatching) until they reach metamorphosis, tadpoles are cryptic and often match the color of bottom substrates and detritus. FYLF tadpoles appear to prefer edgewater habitat where water temperatures are generally warmer (usually by at least 2 - 4° C) than the mainstream temperature. Tadpoles appear to prefer calm shallow water and will utilize substrate interstices, detritus, and aquatic vegetation for cover.

Juvenile Habitats – Following metamorphosis, juvenile frogs may be observed in groups and where numerous, may be conspicuous along rocky stream margins (personal observations). Juveniles typically remain in the vicinity of breeding locations for the remainder of the summer and fall. However, juvenile frogs have been observed on the Middle Fork Stanislaus River migrating upriver or up nearby tributaries in September (personal observations). When associated with river cobble bars, some juveniles may disperse to nearby isolated pools or side channels (personal observations). By November or December, and through the remainder of winter, juvenile frogs are typically absent from stream margins. However, depending on elevation and local weather conditions, juvenile and adult frogs may be occasionally observed on warmer winter days along streams, even when water temperatures are as low as 7.5° C (personal observations). In some streams, adult frogs may remain close to the water all winter, spending a portion of the time underwater (Van Wagner 1996).

As with adult FYLFs, juveniles are strongly associated with cobble bars and slow moving portions of streams. On the South Yuba River, Yarnell (2000) found juvenile FYLFs in wider portions of stream channels with low-relief banks. These stream sections provided protected overflow areas during winter and spring months. Second-year juveniles begin to depend upon streamside shading (shading >20%) and the cover afforded by overhanging streamside vegetation (Ashton et al. 1998), much the same as adults.

Adult Habitats – During the summer and fall, adult FYLFs appear to prefer stream channels that provide exposed basking sites and cool shady areas immediately adjacent to the water's edge. When disturbed, they typically dive into the water and take refuge on the bottom in cobble, boulder, gravel, silt, or vegetation (Stebbins 1985). Recent observations (Kupferberg 1996; Lind et al. 1996; Pacific Gas and Electric Company 2001, 2002a, 2002b) have corroborated information from Moyle (1973) that adults tend to prefer channel margins that provide some vegetative shading, either from the riparian canopy or occasionally understory vegetation bordering the water's edge. In contrast, studies on the South Yuba River found that adults appear to prefer deep, channelized stream types and pool-type habitats on a year-round basis (Yarnell 2000). These differences are likely due to the availability of preferred habitat types on different river systems. FYLFs appear to be very adaptable to varying conditions and may utilize alternate habitat types when necessary. Recent studies conducted on several river drainages in the Sierra Nevada have documented significant differences in habitat types between drainages occupied by FYLFs (personal observations).

Recent investigations into the presence and distribution of FYLFs on the North Fork Feather, North Fork Mokelumne, Middle Fork Stanislaus (Pacific Gas and Electric Company 2001, 2002a, 2002b; Ibis Environmental, Inc. 2002), and Trinity (Lind et al. 1996) rivers have noted that, except during the breeding season, adults are seldom found in stream reaches that do not provide at least a moderate amount of riparian or margin vegetative shading. Though potentially abundant during the breeding season, adults are typically observed at a reduced frequency on main stem rivers areas during the remainder of the year. Ashton et al. (1998) speculated that adults are either dispersing into streamside vegetation or adjacent tributaries, or possibly reducing diurnal activity. During the summer, some adults may remain in the vicinity of breeding sites on main stem rivers if there are cool, partly shady areas with adequate cover (Pacific Gas and Electric Company 2002a, 2002b; personal observations). However, adults seem to prefer nearby tributary streams, where overhead riparian canopy provides areas of partial sun and shade throughout the day, and air temperatures are cooler than on the main river. Perennial streams appear to be the preferred summer habitat of adults; however, ephemeral streams with perennial pools also provide suitable habitat (Pacific Gas and Electric Company 2002a, 2002b; Ibis Environmental, Inc. 2002). Adult frogs are not usually found in sections of creek that have moderately high to high amounts of low overhanging cover (shade).

As with juvenile FYLFs, adults are typically absent from stream margins by November or December through the remainder of winter. However, depending on elevation and local weather conditions, adult frogs may occasionally be observed on warmer winter days along streams (personal observations). In some streams, adult frogs may remain close to the water all winter, spending a portion of the time underwater (Van Wagner 1996).

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Appendix B: Study Plan (PG&E 2002)

Appendix C: Aerial Photographs of Survey Subsites

Appendix D: 2002 Poe FYLF Flow Study Data Forms

Appendix E: Subsite Photographs at Base Flow and 310 cfs Flow Levels

Appendix F: Graphs for Depths and Velocities – FYLF Subsites

Appendix G: Graphs for Depths and Velocities – Additional Habitat Subsites

Appendix H: Area Measurement and Missing Data Formulas

Appendix I: Additional Habitat Sites

Results of Analysis of Additional Habitats Adjacent to Subsites

Seven additional habitat areas that were within 300 m [upstream (+) or downstream (-)] of existing subsites were evaluated as outlined in Item 11 in the Parameter and Documentation section of the Final Study Plan (PG&E 2002a *rev. 9*/2002; Appendix B). When time and daylight allowed, general qualitative assessments were made of upstream and downstream additional habitats to document the presence of suitable FYLF habitat.

1. Location and General Description of Additional Habitats

1.1. Subsite 2a 300(-)

Subsite 2a 300(-) is located approximately 69 m downstream from Subsite 2a. It is a moderate-to-high gradient cobble/boulder bar along the left bank of the somewhat narrow main channel below Swimmer's Beach area. This additional subsite is 19 m long. Substrate composition for this subsite was 50 percent cobble, 40 percent boulder, and 10 percent gravel. Aquatic cover consisted of 80 percent algae/detritus and 80 percent gaps in substrate, with about 30 percent vegetation. Bankfull width measured 18 m. Wetted channel width measured 12 m at base flows and increased slightly to 16 m at the highest flow.

1.2. Subsite 2b 300(+)

Subsite 2b 300(+) is a low-gradient pool tail-out with a small cobble/boulder lateral bar on the left bank along the run portion. It is 12 m upstream from the top of Subsite 2b at Swimmer's Beach. It is 16 m in length and consists of one deep backwater pool near the bottom of the subsite and two shallow backwater pools near the top of the subsite. Across from the pools is an "island" of boulder/cobble. Substrate composition was estimated at 50 percent boulder, 20 percent cobble, 20 percent gravel/pebble and some bedrock (10%). Aquatic cover consisted of 70 percent algae/detritus, 80 percent gaps in substrate, and 40 percent aquatic vegetation. Bankfull width measured 50 m. Wetted channel width remained constant at 33 m.

1.3. Subsite 2c LB 300(+)

Subsite 2c LB 300(+) is located 32 m upstream of Subsite 2c LB. It is another low-gradient cobble/boulder lateral bar along the run portion at the top of Site 2 at Swimmer's Beach. The subsite was 40 m in length and substrate composition was estimated as 60 percent cobble, 20 percent boulder and 20 percent gravel/pebble. Aquatic cover consisted of 80 percent algae/detritus, 80 percent gaps in substrate, and 50 percent aquatic vegetation. Bankfull width measured 49 m. Wetted channel width measured 44 m at top of subsite.

1.4. Subsite 4c 300(+)

Subsite 4c 300(+) is on the right bank NFFR along riffle/run habitat just upstream of the confluence with Flea Valley Creek. This subsite was a 20 m sub-sample of a 170 m subsite. Substrate composition for Subsite 4c(+) was estimated as 40 percent cobble, 30 percent boulder, 20 percent gravel/pebble, and 10 percent sand. Aquatic cover consisted of 80 percent algae/detritus, 60 percent gaps in substrate, and little vegetation and no woody debris. Bankfull width measured 77 m. Wetted channel width ranged from 35 m to 37 m over the course of the flow study.

1.5. Subsite 5a 300(+)

Subsite 5a 300(+) is 240 m of potential habitat that extends from the top of Subsite 5a along the right bank of a moderate-gradient lateral bar. The length of habitat sub-sampled for this study was 37 m. Substrate composition for this subsite was 50 percent cobble, 20 percent boulder, 20 percent gravel/pebble, and 10 percent sand. Aquatic cover consisted of 10 percent vegetation, 50 percent algae/detritus, 30 percent gaps in substrate, and <10 percent woody debris. Bankfull width measured 79 m. Wetted channel width measured 44 m.

1.6. Subsite 5b 300(-)

Within 300 m downstream of Subsite 5a, there were two potential FYLF habitat areas approximately 100 m on the right bank immediately downstream of the subsite, and approximately 100 m on the left bank at the bottom of the 300 m downstream section along a low-gradient riffle/glide. The length of habitat (a low to- moderate bank gradient cobble bar) sub-sampled for this study was 54 m, and was located in the left bank, downstream section. Substrate composition for this subsite was 70 percent boulder, 20 percent cobble, and 10 percent gravel/pebble. Aquatic cover consisted of 10 percent vegetation, 40 percent algae/detritus, 60 percent gaps in substrate, and 10 percent woody debris. Bankfull width measured 69 m. Wetted channel width measured 33 m.

1.7. Subsite 6a 300 (+)

The right bank cobble bar area from approximately 50 m to 275 m upstream of the top of Subsite 6a contained suitable habitat for FYLF at base flows. It is a moderate-gradient boulder/cobble bar. Length of habitat sub-sampled for this study was 40 m. Substrate composition for this area was estimated as 60 percent boulder, 30 percent cobble, and 10 percent gravel/pebble. Aquatic cover consisted of 10 percent vegetation, 70 percent algae/detritus, 80 percent gaps in substrate, and <10 percent woody debris. Bankfull width measured 59 m. Wetted channel width measured 22 m at the top of the subsite.

2. Qualitative Assessments of Additional Habitats

Because of time constraints, some areas of potential *additional habitat* were not quantified per the study plan. Rather, smaller areas within these additional habitats were subsampled when time permitted (above, Section 3.1.7). When possible, qualitative assessments were also made along these additional habitat areas during the flow series, and those descriptions are provided below. In addition, certain sites did not contain any additional potential habitats within 300 m upstream and/or downstream, and those areas also discussed in this section.

2.1. 300 m Upstream of Subsite 3b

No additional FYLF habitat occurred within 300m upstream of Subsite 3b at any flow. For approximately 150 m above the subsite, the high bank-gradient point bar along the right bank was composed of large boulders, with small sections of gravel sediment. The left bank was cliff. Further upstream, a high-gradient riffle contained mostly large boulder substrate and no suitable FYLF habitat. Downstream of Subsite 3b, the NFFR was also large boulder riffle of variable gradient, mostly swift, with no suitable FYLF habitat for 300 m. We examined these areas during each of the study flow releases and took representative photographs; however, velocities continued to increase and no beneficial changes occurred for potential FYLF habitat.

2.2. 300 m Downstream of Subsite 4a

This downstream habitat from Subsite 4a is a low-to-high gradient riffle meeting a main channel pool at the lower 50 m of the subsite. It is approximately 300 m in length and is largely characterized by deep (>60 cm) edgewater and boulders along a steep gradient bank. Velocity in some backwater pools is <20 cm/s, but the pools are too deep to be considered likely habitat. There was no suitable habitat during the base flow and increased discharge levels showed no increase in the potential for FYLF habitat.

2.3. 300 m Upstream of Subsite 4d

This upstream habitat from Subsite 4d is a run/glide river type habitat. It is largely characterized by boulders and bedrock habitat with abundant sedges. The bank gradient is steep and shallow edgewater habitat is absent. Increases in river flows cannot spread laterally along the left bank and, as a result, increases in flow will increase water depths and possibly water velocity. There was no suitable habitat during the base flow and increased discharge levels showed no increase in the potential for suitable FYLF habitat.

2.4. 300 m Downstream of Subsite 4d

This downstream habitat from Subsite 4d is a run/glide. It is approximately 36 m in length and consists mainly of boulders with some cobble and relatively steep banks. Edgewater habitat was generally narrow and moderately steep. This area was evaluated at each flow and showed no suitable FYLF habitat during the base flow or increased discharge levels.

2.5. 300 m Downstream of Subsite 5a

Within 300m downstream of Subsite 5a, there was approximately 100 m of potential FYLF habitat on the right bank immediately downstream of the subsite, and there was another approximately 100 m of potential FYLF habitat on the left bank at the bottom of the 300m downstream section along a low-gradient riffle/glide. The remaining area was too swift, edgewater areas were too narrow at all flows, and the substrate was too large for suitable FYLF habitat.

Specifically, the right bank portion downstream of Subsite 5a was not considered good habitat for egg laying, as the substrates were mostly large boulder and the suitable edgewater areas were relatively narrow. However, backwater side pools did contain juvenile FYLFs at base flows. At 200 cfs, flow velocities appeared to increase along the edgewater. Although backwater areas spread out, they had shallow flow-through in some places. At 250 cfs, inundation caused these backwater edgewater areas to increase in area and depth, along with flow velocities. At 310 cfs, most of the deeper, newly-flooded backwater areas were too swift, and any other expansion was too shallow and isolated for egg laying habitat. The lower-most portion of the 100 m section along the right bank below Subsite 5a had very rapid velocities at 310 cfs.

The left bank portion downstream of Subsite 5a appeared to contain the most suitable habitat, and 54 m of the approximately 100 m of habitat was sub-sampled during the test flows (Section 3.1.7.6). The top of the 100m of habitat was somewhat protected from high-flow velocities by a point of land that deflected the current. Even so, the uppermost portion of the 100 m habitat segment saw a gradual increase in flow velocities during the test flow period until, at 310 cfs, about one-half of the edgewater habitats appeared too swift for FYLF.

Numerous juvenile FYLFs were observed in this area during base flow evaluations. New backwater areas started to form at the 150 cfs release, but they were too shallow to be considered suitable habitat. By 250 cfs, some of these backwater areas were included in the suitable habitat designation, since depths were then greater than 10 cm. By 310 cfs, there was some narrowing of suitable habitats; however, moderate amounts of potential edgewater habitat remained available.

2.6. 300 m Upstream of Subsite 5a

Additional suitable FYLF habitat occurs along a right bank, moderate-gradient boulder/cobble bar that extends for 240 m upstream from the top of Subsite 5a at base flow. Just downstream of the 37 m subsample subsite located at the top of this habitat, was a ~30 m section of fast edgewater at all flows. But, below that, a point of rock protected most of the rest of the bar from higher flow velocities, even at the higher experimental flows. This lower area was a moderate-to-steep gradient boulder/cobble bar with approximately 2-3 m of slow edgewater within suitable depths. One juvenile FYLF was seen here during the base flows. At 150 cfs, there was not much discernible change, but at 200 cfs there was inundation and apparent extension of suitable habitat in the lower gradient bank areas (bank gradient was variable). Increased flow velocities in the higher gradient bank areas and "exposed" (i.e., closer to main channel thalweg) portions of the bar. A subadult FYLF was seen at this flow. At 250 cfs, more of the same mix of positive and negative habitat changes occurred, and another juvenile FYLF was seen. At 310 cfs, there were still adequate amounts of suitable edgewater areas with low flow velocities.

2.7. 300 m Downstream of Subsite 6a

Below Subsite 6a, suitable FYLF habitat occurred from approximately 75 m to 300 m downstream of the bottom of the subsite. The area also contained a side channel at the top and a large moderate-gradient boulder/cobble bar along the right bank of the NFFR. The left bank was steep-sided with large boulder substrate. Noticeable changes in habitat conditions in the side channel area were not observed until 250 cfs, when the outlet of the side channel flow increased. There was some spreading of shallow edgewater along the interior side channel bar, and some increase of flow velocity, but did not appear detrimental. By 310 cfs, flows spilled over more of the side channel bar, and edgewater flow velocities were too fast, except in the middle portion. Downstream of the side channel area, the main boulder/cobble lateral bar had three general areas at base flow roughly divided into thirds: the top was protected from stream flows and contained suitable FYLF habitat; the middle portion was most exposed to main channel currents and received relatively high-flow velocities along the shoreline; and the bottom portion again was protected and appeared to contain good suitable habitat for FYLF. At 200 cfs, the top portion of this segment showed some spreading inland of edgewater areas, but flows along one-half were too fast. By 310 cfs, flow velocities were too fast (except on the more protected upstream portion). However, at the top of this site, edgewater spread inland and flow velocities were still within suitable ranges. The downstream-most one-third portion of the bar contained potential habitat and was protected from flow increases by bar topography. There was still potential edgewater habitat at 200 cfs, but by 250 cfs, flow velocities noticeably increased along the steeper-banked portions of the bar. At 310 cfs, overall edgewater area narrowed and flow velocities appeared to increase.

2.8. 300 m Upstream of Subsite 6a

The right bank cobble bar area from about 50 m to 275 m upstream of the top of Subsite 6a contained suitable habitat for FYLF at base flows. The upper one-third was separated from the lower two-thirds by a side channel area, apparently active only during very high flows. The left bank of the NFFR in this area was entirely too steep-sided to support frogs. The subsample section along the right bank occurred about mid-way along the lower two-thirds of cobble/boulder bar habitat (Appendix C). In general, this area saw some expansion of edgewater habitat as lower bank gradient areas became inundated, and some higher flow velocities occurred in steeper-banked areas. Near the side channel mentioned above, a constriction in the river morphology caused higher flows along the shore in this mid-section of the cobble bar, with the exception of a 10 m wide pocket protected by a large rock point that jutted into the river. Within the actual side channel area, there was no flow or outflow even during the 310 cfs release; however, there was some expansion of edgewater area shallows, and depths and substrates around most of the side channel inlet appeared beneficial for potential FYLF breeding. Upstream of this side channel area was an approximately 75 m moderate-gradient cobble bar where one juvenile FYLF was observed during the 150 cfs flow release. At 250 cfs, there was some spreading inland of the edgewater shallows, but no apparent flow velocity increases. By 250 cfs, a reverse-flow eddy appeared in the middle and upper parts of this section; however, by 310 cfs, flow velocities increased along the outermost point of the bar and the eddy had a flow velocity of approximately 5 cm/s.

3. Quantitative Assessments of Additional Habitats

3.1. Subsite 2a 300(-)

FYLF Habitat Area

At base flows, *total habitat* area was 45 m^2, but diminished to zero by the 250 cfs discharge level. At base flow, *preferred* habitat area measured 23 m^2 and *marginal* habitat measured 22 m^2. *Preferred* habitat area was lost at the 200 cfs flow, and marginal habitat area also went to zero at the 250 cfs flow level. During the three highest flows, *preferred* habitat was lost completely and all *suitable habitat* at this subsite was lost at the 250 cfs flow level (Figure 3.1.1, Table 3.1.1). Due to the steep bank gradient at this subsite, increased flows resulted in a sharp increase in water velocity without lateral pooling or inundation of the cobble bar. At the 200 cfs flow and higher, virtually all suitable habitat was eliminated. Numerous smaller, fast-moving channels appeared around larger cobble and boulder substrate, with water flow velocities increasing above marginal limits (up to 80 cm/s). Several juveniles FYLFs were observed during base and 150 cfs flows.

Figure 3.1.1. FYLF habitat area at 5 discharge levels, Subsite 2a 300(-).

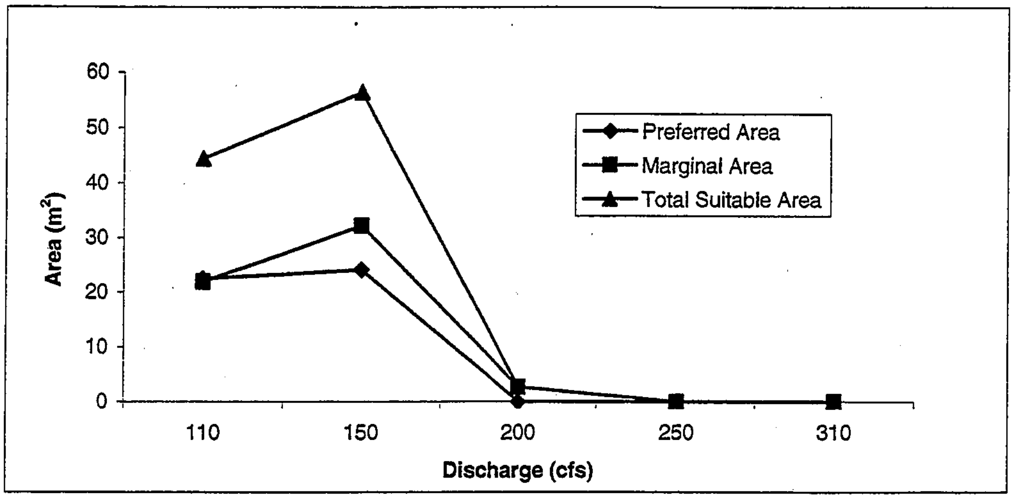


Table 3.1.1. FYLF habitat area and (%) change from base flow, Subsite 2a 300(-)

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	150	200	250	310
Preferred Habitat Area	23	24 (+7.3)	0 (-100)	0 (-100)	0 (-100)
Marginal Habitat Area	22	32 (+47.2)	3 (-87.7)	0 (-100)	0 (-100)
Total Habitat Area	45	57 (+27)	3 (-93.9)	0 (-100)	0 (-100)

Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 9 cm and mean *marginal* habitat depth was 14 cm. At the highest flow, depths were over 50 cm and not within the parameters of this study (Table 3.1.2).

Table 3.1.2. Mean depths at 5 discharge levels, Subsite 2a 300(-)

Habitat Area Measurements (m^2)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Average Depth	8.60	12.50	-	-	-
Preferred Habitat Edge Depth	13.00	16.75	-	-	-
Marginal Average Depth	14.20	17.00	16.00	-	-
Marginal Habitat Edge Depth	15.80	22.40	16.00	-	-

Mean Habitat Velocities

At base flow (110 cfs), the mean *preferred* habitat velocities were between 1 (bottom velocity) and 3 cm/s (habitat edge velocity). Mean *marginal* habitat velocities were between 14 (bottom velocity) and 15 cm/s (habitat edge velocity). At the highest flow, velocities were over 20 cm/s and not within the parameters of this study (Table 3.1.3).

Table 3.1.3. Mean velocities at 5 discharge levels, Subsite 2a 300(-)

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	**150**	**200**	**250**	**310**
Preferred Habitat Edge Velocity	2.60	4.50	-	-	-
Preferred Average Velocity @ 66%	2.20	3.75	-	-	-
Preferred Bottom Velocity	1.40	2.75	-	-	-
Marginal Habitat Edge Velocity	14.80	17.40	6.00	-	-
Marginal Average Velocity @ 66%	14.20	10.80	18.00	-	-
Marginal Bottom Velocity	13.60	8.80	6.00	-	-

Habitat Complexity and Qualitative Observations

Complexity of habitat (exposed boulder/cobble) was rated at 80 percent at base flow and fell to zero at the high flow where a steep gradient on the left bank prevented the cobble bar from increased inundation. Several juvenile frogs seen at the 110 and 150 cfs flows were not observed again during any higher flow levels. An aquatic garter snake (*T. couchii)* was observed at the subsite.

3.2. Subsite 2b 300(+)

FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area decreased (-34%) from 70 m^2 at base flow to 46 m^2 during the 310 cfs discharge. Specifically, *preferred* habitat decreased by 32 m^2, but *marginal* habitat increased by 8 m^2 (Figure 3.2.1, Table 3.2.1).

Figure 3.2.1. FYLF habitat area at 5 discharge levels, Subsite 2b 300(+).

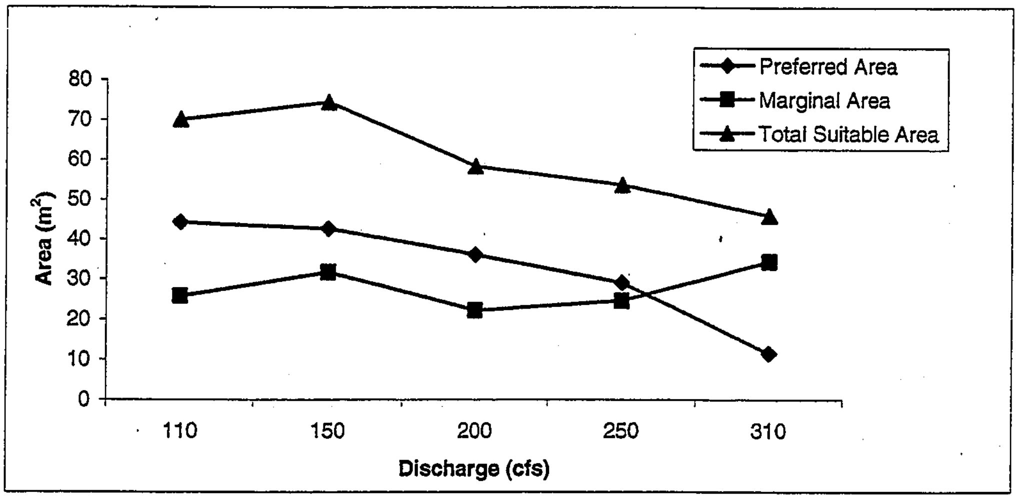


Table 3.2.1. FYLF habitat area and (%) change from base flow, Subsite 2b 300(+)

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	150	200	250	310
Preferred Habitat Area	44	43 (-3.6)	36 (-18.4)	29 (-34.4)	12 (-73.9)
Marginal Habitat Area	26	32 (+23.1)	22 (-13.8)	25 (-4.3)	34 (+33.5)
Total Habitat Area	70	75 (+6.2)	58 (-16.7)	54 (-23.3)	46 (-34.4)

Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 23 cm and mean *marginal* habitat depth was 38 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 27 cm and mean *marginal* habitat depth 43 cm (Table 3.2.2).

Table 3.2.2. Mean depths at 5 discharge levels, Subsite 2b 300(+)

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Average Depth	23.00	24.00	26.00	24.00	27.00
Preferred Habitat Edge Depth	30.00	29.00	29.00	29.00	30.00
Marginal Average Depth	38.00	41.00	38.00	42.00	43.00
Marginal Habitat Edge Depth	47.00	44.00	48.00	49.00	47.00

Mean Habitat Velocities

At base flow (110 cfs), the mean *preferred* habitat velocities were 0 for both the bottom and the habitat edge. Mean *marginal* habitat velocities were between 1 (bottom velocity) and 3 cm/s (habitat edge velocity). At the highest flow (310 cfs), mean *preferred* habitat velocities were 1 cm/s (bottom velocity) and 2 cm/s (habitat edge velocity). *Marginal* habitat flow velocities were between 6 (bottom velocity) and 9 cm/s (habitat edge velocity) (Table 3.2.3).

Table 3.2.3. Mean velocities at 5 discharge levels, Subsite 2b 300(+)

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	0.00	1.00	0.00	3.00	2.00
Preferred Average Velocity @ 66%	0.00	2.00	0.00	2.00	2.00
Preferred Bottom Velocity	0.00	1.00	0.00	1.00	1.00
Marginal Habitat Edge Velocity	3.00	6.00	3.00	6.00	9.00
Marginal Average Velocity @ 66%	2.00	5.00	3.00	3.00	6.00
Marginal Bottom Velocity	1.00	4.00	2.00	2.00	6.00

Habitat Complexity and Qualitative Observations

This subsite consisted of heterogeneous habitat composed of a cobble/boulder island surrounded by several inter-connected pools. Habitat complexity (exposed boulder/cobble) was estimated at 70 percent at base flows and decreased to 40 percent at the highest flow when the island became completely flooded and depths at the bottom of the subsite exceeded 50 cm at the habitat edge. As experimental flows increased, this island became more inundated; at 310 cfs the island was approximately 80 percent submerged, compared to the base flow. Appendix E includes photographs at both discharge levels for comparison. As the island became submerged during higher flows, we observed an overall loss of total habitat area (Table 3.2.42). The downstream portion of the subsite consisted of a large boulder, serving as a visual landmark to reference increasing water levels relative to that of the cobble/boulder island. During the first three flows, juvenile frogs were observed in both of the shallow pools and on the island.

3.3. Subsite 2c LB 300(+)

FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area remained the same at 200 m^2. *Preferred* habitat decreased by 30 m^2, while *marginal* habitat increased by 30 m^2 (Figure 3.3.1, Table 3.3.1).

Figure 3.3.1. FYLF habitat area at 5 discharge levels, Subsite 2c LB 300(+)

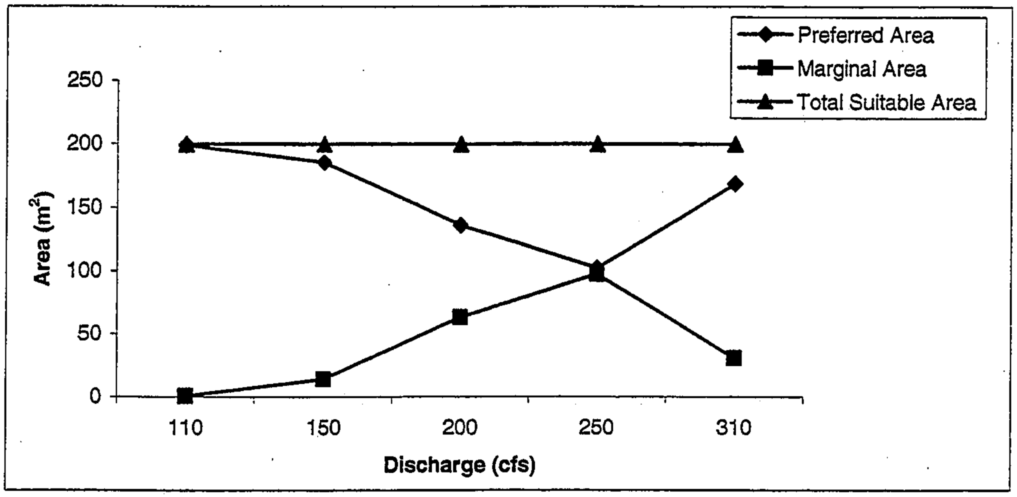


Table 3.3.1. FYLF habitat area and (%) change from base flow, Subsite 2cLB-300(+)

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	150	200	250	310
Preferred Habitat Area	199	186 (-6.8)	136 (-31.5)	102 (-48.6)	169 (-15.3)
Marginal Habitat Area	1	14 (+1700)	64 (+7850)	98 (+12100)	31 (+3800)
Total Habitat Area	200	200 (0)	200 (0)	200 (0)	200 (0)

Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 16 cm and mean *marginal* habitat depth was 27 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 16 cm and mean *marginal* habitat depth was 27 cm (Table 3.3.2).

Table 3.3.2. Mean depths at 5 discharge levels, Subsite 2c LB 300(+)

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Average Depth	16.32	15.50	15.20	14.20	16.45
Preferred Habitat Edge Depth	26.00	22.50	20.80	22.67	22.00
Marginal Average Depth	27.00	23.00	23.25	27.17	26.67
Marginal Habitat Edge Depth	31.00	27.00	27.75	30.00	31.00

Mean Habitat Velocities

At base flow (110 cfs), the mean *preferred* habitat velocities were <1 (bottom velocity) and 3 cm/s at habitat edge velocity. Mean *marginal* habitat velocities were between 0 (bottom velocity) and 2 cm/s (habitat edge velocity). At the highest flow (310 cfs), mean *preferred* habitat velocities were <1 cm/s (bottom velocity) and 3 cm/s (habitat edge velocity). Mean *marginal* habitat velocities were between 8 (bottom velocity) and 11 cm/s (habitat edge velocity) (Table 3.3.3).

Table 3.3.3. Mean velocities at 5 discharge levels, Subsite 2c LB 300(+)

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	2.67	4.00	5.00	4.67	2.83
Preferred Average Velocity @ 66%	0.64	2.20	2.60	2.20	1.25
Preferred Bottom Velocity	0.32	1.50	2.04	1.60	0.75
Marginal Habitat Edge Velocity	2.00	6.50	10.75	9.67	10.67
Marginal Average Velocity @ 66%	1.00	5.00	9.25	8.17	5.67
Marginal Bottom Velocity	0.00	4.00	7.25	4.50	7.67

Habitat Complexity and Qualitative Observations

As flows increased, inundation of this lateral cobble bar was similar to that found at Subsite 2c LB. However, habitat complexity, estimated at 50 percent during base flow, decreased to 30 percent at the highest flow. Inundation and pooling of the cobble bar decreased gradually towards the top of the site (at the 40 m linear distance transect). This subsite exhibited a lengthwise "ridge" of higher gradient along the middle of the cobble bar, and a small backwater channel (1-2 m) along the back of the bar also increased in size at higher flows, creating a partial island at the 310 cfs discharge. High amounts of marginal vegetation (50%) may have impeded water velocity measurements at this site. Crayfish were abundant throughout all flow levels.

3.4. Subsite 4c 300(+)

FYLF Habitat Area

Between base flow and the highest 310 cfs flow, *total habitat* area decreased overall by 18 m^2, with a larger decrease of 25 m^2 at the 200 cfs flow. *Preferred* habitat decreased by 10 m^2, while *marginal* habitat decreased by 8 m^2. *Preferred* area experienced a sharp decline of 57 m^2 at the 250 cfs flow, but regained 47 m^2 of habitat at the 310 cfs discharge (Figure 3.4.1, Table 3.4.1).

Figure 3.4.1. FYLF habitat area at 5 discharge levels, Subsite 4c 300(+)

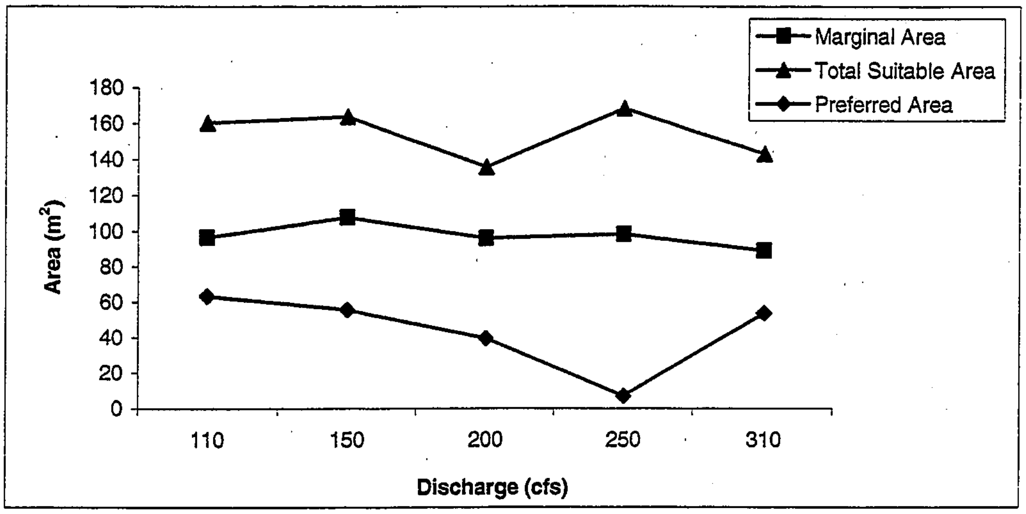


Table 3.4.1. FYLF habitat area and (%) change from base flow, Subsite 4c 300(+)

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	**150**	**200**	**250**	**310**
Preferred Habitat Area	64	56 (-12.1)	40 (-37.7)	7 (-89)	54 (-15.2)
Marginal Habitat Area	97	108 (+11.5)	96 (-0.7)	98 (+1.6)	89 (-7.9)
Total Habitat Area	161	164 (+2.1)	136 (-15.4)	168 (+4.9)	143 (-10.8)

Mean Habitat Depth

At base flow (110 cfs), the *preferred* habitat average depth was 15 cm and mean *marginal* habitat depth was 20 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 21 cm and mean *marginal* habitat depth was 34 cm (Table 3.4.2).

Table 3.4.2. Mean depths at 5 discharge levels, Subsite 4c 300(+)

Depth Measurements (cm)	Discharge Level (cfs)				
	110	**150**	**200**	**250**	**310**
Marginal Habitat Edge Depth	20.2	16.5	33.75	30.5	40.4
Marginal Average Depth	19.2	30	26.75	30	33.8
Preferred Habitat Edge Depth	18.8	28	26.75	20.6	25.8
Preferred Average Depth	15.4	21	21.5	15.6	21

Mean Habitat Velocity

At base flow (110 cfs), the mean *preferred* habitat velocities were 2 (bottom velocity) and 3 cm/s (habitat edge velocity). Mean *marginal* habitat velocities were between 6 (bottom velocity) and 10 cm/s (habitat edge velocity). At the highest flow (310 cfs), *mean preferred* habitat velocities were 1 cm/s (bottom velocity) and 2 cm/s (habitat edge velocity). Mean *marginal* habitat velocities were between 3 (bottom velocity) and 11 cm/s (habitat edge velocity) (Table 3.4.3).

Table 3.4.3. Mean velocities at 5 discharge levels, Subsite 4c 300(+)

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	3.4	2	1.75	2.8	2
Preferred Average Velocity @ 66%	1.8	3	1.25	2.8	1.8
Preferred Bottom Velocity	2.2	2.5	1	3.4	1
Marginal Habitat Edge Velocity	9.6	14.5	11.25	8.5	10.8
Marginal Average Velocity @ 66%	9.8	7	6.25	11	9.4
Marginal Bottom Velocity	5.6	4	2.75	6.5	2.6

Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) was estimated at 30 percent during base flow and decreased to less than 10% at the highest flow.

3.5. Subsite 5a 300(+) FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area decreased approximately 23 m^2 (-15%). Specifically, *preferred* habitat decreased 12 m^2, and *marginal* habitat decreased approximately 11.5 m^2 (Figure 3.5.1, Table 3.5.1).

Figure 3.5.1. FYLF habitat area at 5 discharge levels, Subsite 5a 300(+)

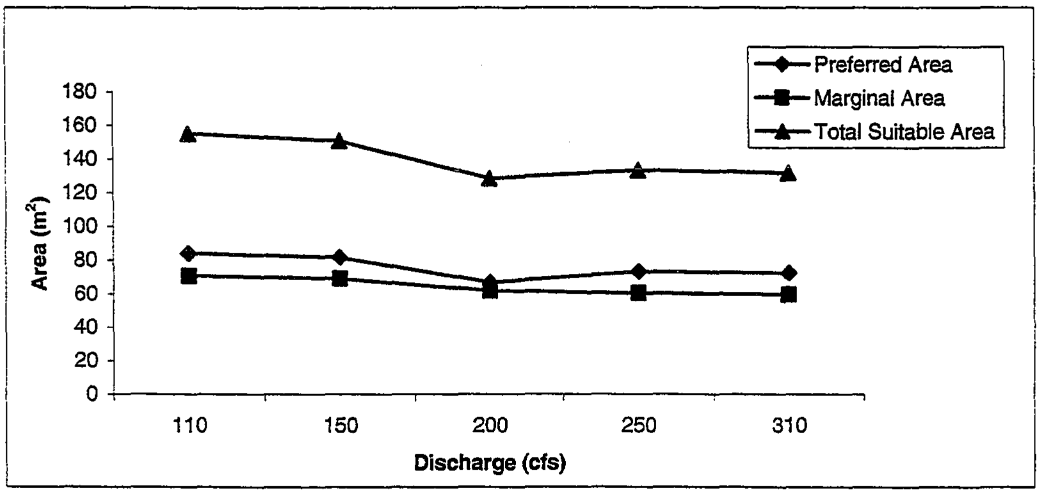


Table 3.5.1. FYLF habitat area and (%) change from base flow, Subsite 5a 300(+)

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	150	200	250	310
Preferred Habitat Area	84	82 (-2.9)	67 (-20.7)	73 (-13.2)	72 (-14.1)
Marginal Habitat Area	71	69 (-2.4)	62 (-13)	60 (-15.1)	60 (-16.2)
Total Habitat Area	155	151 (-2.6)	128 (-17.2)	133 (-14.1)	132 (-15.1)

Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 16 cm and mean *marginal* habitat depth was 39 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 15 cm and mean *marginal* habitat depth was 42 cm (Table 3.5.2).

Table 3.5.2. Mean depths at 5 discharge levels, Subsite 5a 300(+)

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Depth	29.5	29.7	28.3	30	30
Preferred Average Depth	15.7	17.8	18.7	15	15.2
Marginal Habitat Edge Depth	48	48.5	50	50	50
Marginal Average Depth	39.33	39.17	41.5	41.5	42.33

Mean Habitat Velocity

At base flow (110 cfs), the mean *preferred* habitat velocities were between 1 cm/s at the bottom and 2 cm/s at the habitat edge. Mean *marginal* habitat velocities were between 2 (bottom velocity) and 4 cm/s (habitat edge velocity). At the highest flow (310 cfs), mean *preferred* habitat velocities were 1 cm/s at the bottom and the habitat edge. Mean *marginal* habitat velocities were 5 cm/s for bottom and 12 cm/s for habitat edge (Table 3.5.3).

Table 3.5.3. Mean velocities at 5 discharge levels, Subsite 5a 300(+)

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	2	1.67	3.17	3	1
Preferred Average Velocity @ 66%	1	1	1	1	1
Preferred Bottom Velocity	1	1	1	1	1
Marginal Habitat Edge Velocity	3.5	4.17	8.17	8.5	11.67
Marginal Average Velocity @ 66%	3.17	3.5	5.83	7.17	9
Marginal Bottom Velocity	1.5	2.17	1.67	2.33	4.5

Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) at Subsite 5a 300(+) m upstream subsample site was estimated at 5 percent during base flow and increased to 10 percent during the highest flow.

3.6. Subsite 5b 300(-)

FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area decreased by approximately 82 m^2 (-34%). Specifically, *preferred* habitat decreased 58 m^2, and *marginal* habitat decreased approximately 25 m^2 (Figure 3.6.1, Table 3.6.1).

Figure 3.6.1. FYLF habitat area at 5 discharge levels, Subsite 5b 300(-)

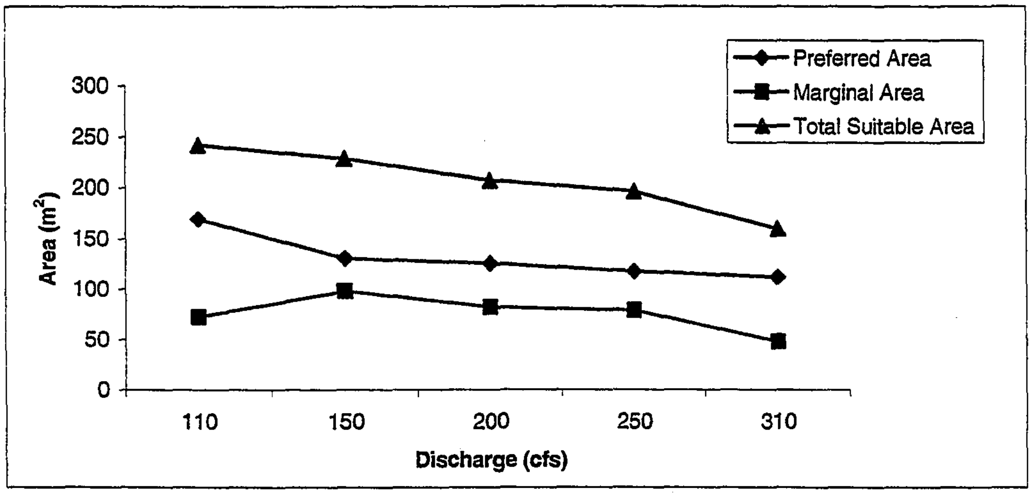


Table 3.6.1. FYLF habitat area and (%) change from base flow, Subsite 5b 300(-)

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	**150**	**200**	**250**	**310**
Preferred Habitat Area	170	131 (-22.8)	125 (-26.1)	118 (-30.6)	112 (-34)
Marginal Habitat Area	73	98 (+34.9)	82 (+12.8)	79 (+8.5)	48 (+33.9)
Total Habitat Area	242	229 (-5.5)	208 (-14.4)	197 (-18.9)	160 (-34)

Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 14 cm and mean *marginal* habitat depth was 30 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 20 cm and mean *marginal* habitat depth was 36 cm (Table 3.6.2).

Table 3.6.2. Mean depths at 5 discharge levels, Subsite 5b 300(-)

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Depth	30	30	27.4	28.5	28.1
Preferred Average Depth	14.1	17.4	14.8	18.1	20.3
Marginal Habitat Edge Depth	36.6	38.9	41.5	43.4	43.6
Marginal Average Depth	29.5	31.4	34	35.3	36.3

Mean Habitat Velocity

At base flow (110 cfs), the mean *preferred* habitat velocities were between 1 cm/s at bottom and 2 cm/s at the habitat edge. Mean *marginal* habitat velocities were between 1 (bottom velocity) and 10 cm/s (habitat edge velocity). At the highest flow (310 cfs), *preferred* flow velocities were 1 cm/s at the bottom and 3 cm/s at the habitat edge. Mean *marginal* habitat velocities were 2 cm/s for the bottom and 11 cm/s for the habitat edge (Table 3.6.3).

Table 3.6.3. Mean velocities at 5 discharge levels, Subsite 5b 300(-)

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	2.25	2.14	2.13	1.5	2.5
Preferred Average Velocity @ 66%	1	1.29	1	1.25	1.88
Preferred Bottom Velocity	1	1	1	1	1
Marginal Habitat Edge Velocity	10.25	10.38	7.75	7.88	10.88
Marginal Average Velocity @ 66%	5.75	5	4.5	5	5.5
Marginal Bottom Velocity	1	1.25	1	2.75	2

Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) at the subsample site was estimated at 60 percent during base flow and remained the same during the highest flow. Numerous juvenile FYLFs were observed along the subsample section during base flow evaluations. New backwater areas started to form at the 150 cfs release, but they were too shallow to be considered suitable habitat. At 250 cfs, some of these backwater areas were designated as suitable habitat where depths were greater than 10 cm. At 310 cfs, there was some narrowing of suitable habitats, but suitable edgewater habitat appeared generally available.

3.7. Subsite 6a 300(+)

FYLF Habitat Area

Over the range of the five discharge levels, *total habitat* area decreased by approximately 34 m^2 (-21%). *Preferred* habitat decreased 35 m^2, and *marginal* habitat increased slightly by approximately 2 m^2 (Figure 3.7.1, Table 3.7.1).

Figure 3.7.1. FYLF habitat area at 5 discharge levels, Subsite 6a 300(+)

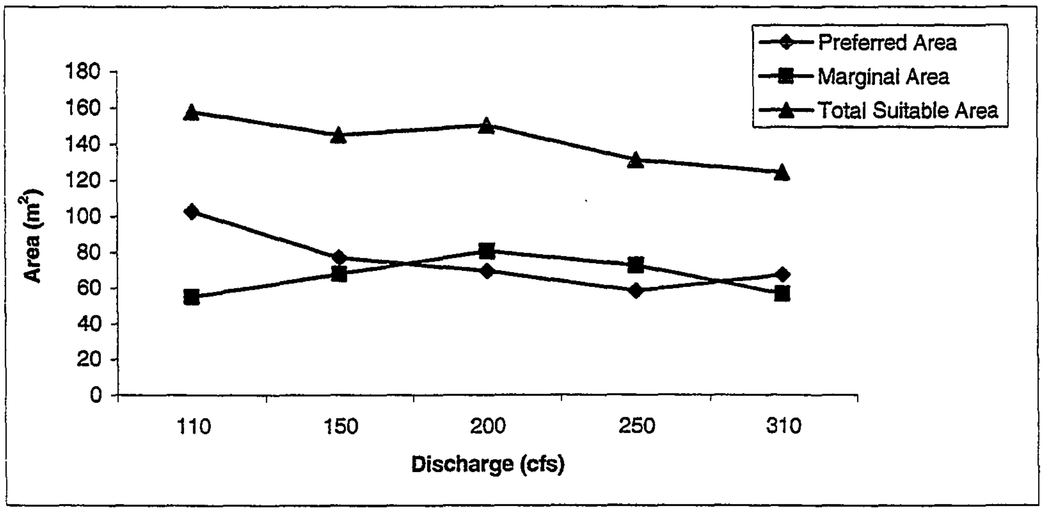


Table 3.7.1. FYLF habitat area and (%) change from base flow, Subsite 6a 300(+)

Habitat Area Measurements (m^2)	Discharge Levels (cfs)				
	110	**150**	**200**	**250**	**310**
Preferred Habitat Area	103	77 (-24.9)	70 (-32.3)	58 (-43.2)	68 (34.2)
Marginal Habitat Area	55	68 (+23.2)	81 (+46.4)	73 (+31.9)	57 (+2.9)
Total Habitat Area	158	145 (-8.1)	150 (-4.8)	131 (-17)	124 (-21.3)

Mean Habitat Depth

At base flow (110 cfs), the mean *preferred* habitat depth was 20 cm and mean *marginal* habitat depth was 38 cm. At the highest flow (310 cfs), mean *preferred* habitat depth was 19 cm and mean *marginal* habitat depth was 42 cm (Table 3.7.2).

Table 3.7.2. Mean depths at 5 discharge levels, Subsite 6a 300(+)

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Depth	29.8	24.8	28.3	28.5	30
Preferred Average Depth	20	14.2	16.3	19	19.3
Marginal Habitat Edge Depth	49	49.2	48.7	44.8	50
Marginal Average Depth	37.7	32.3	35.7	39.8	41.8

Mean Habitat Velocity

At base flow (110 cfs), the mean *preferred* habitat velocities were between 0 cm/s (bottom) and 3 cm/s (habitat edge). Mean *marginal* habitat velocities were between 3 (bottom) and 9 cm/s (habitat edge). At the highest flow (310 cfs), *preferred* habitat flow velocities were 1 cm/s for bottom and 2 cm/s at habitat edge velocities. Mean *marginal* habitat velocities were 4 cm/s for the bottom and 10 cm/s for the habitat edge.

Table 3.7.3. Mean velocities at 5 discharge levels, Subsite 6a 300(+)

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	3.17	3.4	2.33	2.83	2.17
Preferred Average Velocity @ 66%	1.5	1.8	1.33	1.33	1.33
Preferred Bottom Velocity	.33	1	1	1	1
Marginal Habitat Edge Velocity	9.17	9.5	10.5	14	10.17
Marginal Average Velocity @ 66%	6	7.33	8	9.33	7.17
Marginal Bottom Velocity	3.17	1.5	1	2	4

Habitat Complexity and Qualitative Observations

Habitat complexity (exposed boulder/cobble) was estimated at 30 percent during base flow and remained the same during the highest flow. This sub-sample area upstream of Subsite 6a was moderate-gradient boulder/cobble bar with moderate amounts of suitable edgewater habitat and a moderate potential for FYLF breeding at base flows. One juvenile FYLF was observed during the 150 cfs flow and another during the 310 cfs flow. At 200 cfs, there was some spreading of suitable edgewater areas as the lower bank gradient areas became inundated. This continued at 250 cfs and 310 cfs, but there were some higher flow velocities evident in the steeper bank gradient areas at these flows.

3.8. Additional Habitat Subsites – Pooled Results

FYLF Habitat Area

The area of *total habitat* pooled from seven additional habitat subsites sampled in the Poe

Reach showed an overall decrease of 225 m^2 (-22%) during the study period. Specifically, *preferred* habitat decreased by 200 m^2 (-29%) and *marginal* habitat decreased by 25 m^2 (-7%). Although habitat area decreased overall from the base flow to 310 cfs, the changes were not consistent with each flow level (Figure 3.3.4).

Preferred habitat decreased gradually from base flow to 310 cfs flow, with the largest drop occurring at the 250 cfs flow (-43.5% from base flow). *Preferred* habitat area increased (by 99 m^2, +25%) between 250 and 310 cfs, but not enough to show an overall increase in *preferred* habitat area. *Marginal* habitat area increased gradually up to the 250 cfs flow level, but dropped sharply at the 310 cfs flow showing an overall decrease in habitat area. *Total habitat* area decreased gradually as flows increased from base flow to 200 cfs flow levels, but did not show any change between the 200 and 250 cfs flows. *Total habitat* area decreased again at the 310 cfs flow by 78 m^2 (-9% from 250 cfs). Actual area measurements for each discharge level are shown in Table 3.3.4.

Figure 3.8.1. FYLF habitat area at 5 discharge levels, 7 additional subsites

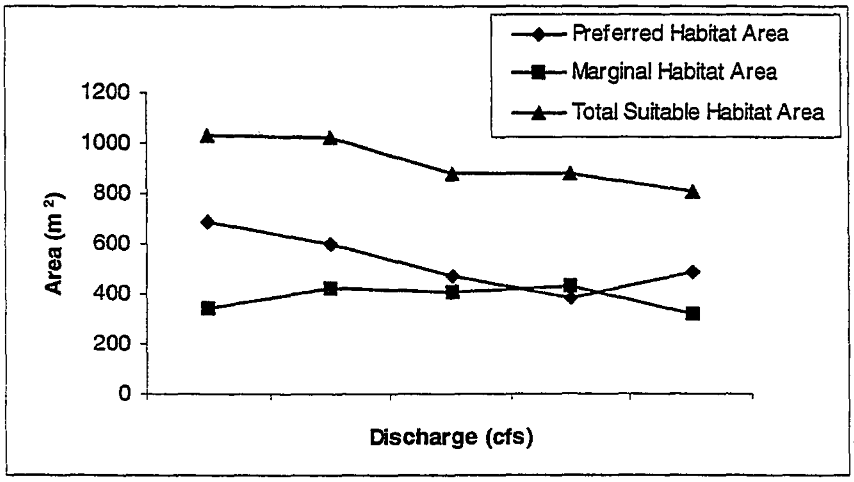


Table 3.8.1. FYLF habitat area and (%) change from base flow, 7 additional subsites

Habitat Area Measurements	Discharge Levels (cfs)				
	110	**150**	**200**	**250**	**310**
Preferred Habitat Area (m^2)	686.4	598.5 (-12.8)	474.0 (-30.9)	387.7 (-43.5)	486.3 (-29.2)
Marginal Habitat Area (m^2)	344.5	422.0 (+22.5)	409.5 (+18.9)	432.8 (+25.7)	319.3 (-7.3)
Total Habitat Area (m^2)	1030.8	1020.5 (-1.0)	883.5 (-14.3)	883.5 (-14.3)	805.6 (-21.9)

Mean Habitat Depth

Mean depth measurements increased slightly for both *preferred* and *marginal* habitats as flow levels increased (Table 3.8.2). Mean *marginal* habitat edge depth and mean *marginal* average depth each increased by 8 cm. Changes in *preferred* habitats depths were less than that for *marginal* habitats, increasing by approximately 3 cm from base flows to 310 cfs (Figure 3.8.2). Actual depth measurements are shown in Table 3.3.5. Note that depth measurements were not taken in the same spot locations during each flow, and along with velocities, actually determined the location and extent of preferred and marginal habitat boundaries.

Figure 3.8.2. Mean depths at 5 discharge levels, 7 additional subsites

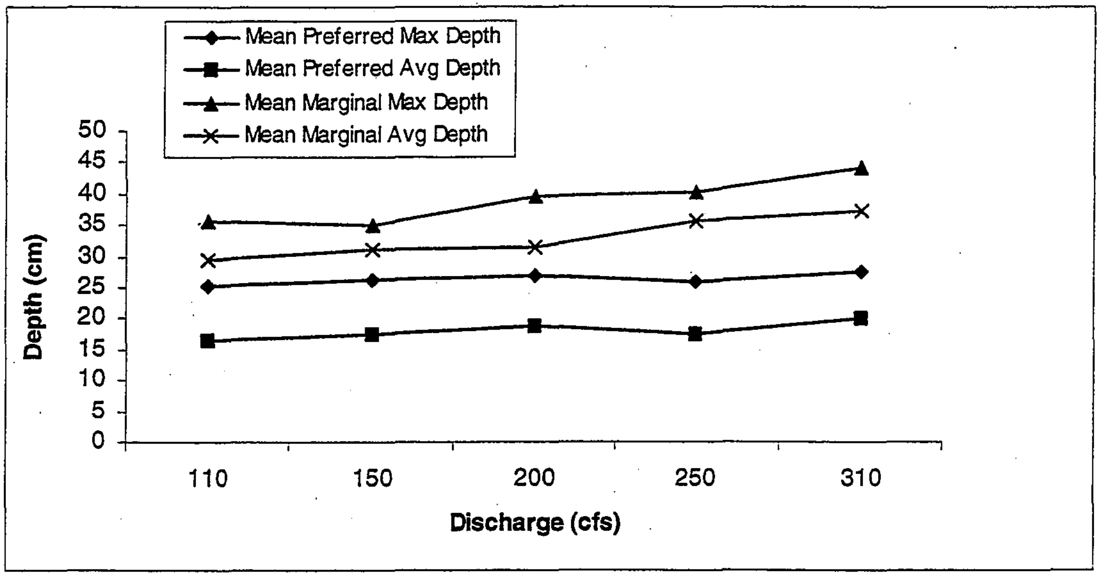


Table 3.8.2. Mean depths at 5 discharge levels, 7 additional subsites

Depth Measurements (cm)	Discharge Level (cfs)				
	110	150	200	250	310
Marginal Habitat Edge Depth	35.72	35.13	39.71	40.37	44.01
Marginal Average Depth	29.45	31.17	31.46	35.72	37.41
Preferred Habitat Edge Depth	25.34	26.38	26.99	26.08	27.72
Preferred Average Depth	16.60	17.54	18.78	17.60	19.98

Mean Habitat Velocity

In general, mean velocities changed only slightly among discharge levels at additional subsites. Mean habitat edge velocities in *marginal* habitats increased sharply from 8 cm/s at base flow to 10 cm/s at 150 cfs, dropping to 8 cm/s at 200 cfs and gradually returning to 10 cm/s by the 310 cfs flow level. Mean habitat edge velocities in *preferred* habitats decreased slightly from base flow to 310 cfs (2.6 cm/s to 2.1 cm/s). Mean bottom velocity and mean average velocities changed <1 cm/s among the discharge levels in both *preferred* and *marginal* habitats (Figure 3.8.3). Actual velocity measurements are provided in Table 3.8.3. Note that velocity measurements were not taken in the same spot locations during each flow, and, along with depths, actually determined the location and extent of preferred and marginal habitat boundaries.

Figure 3.8.3. Mean velocities at 5 discharge levels, 7 additional subsites

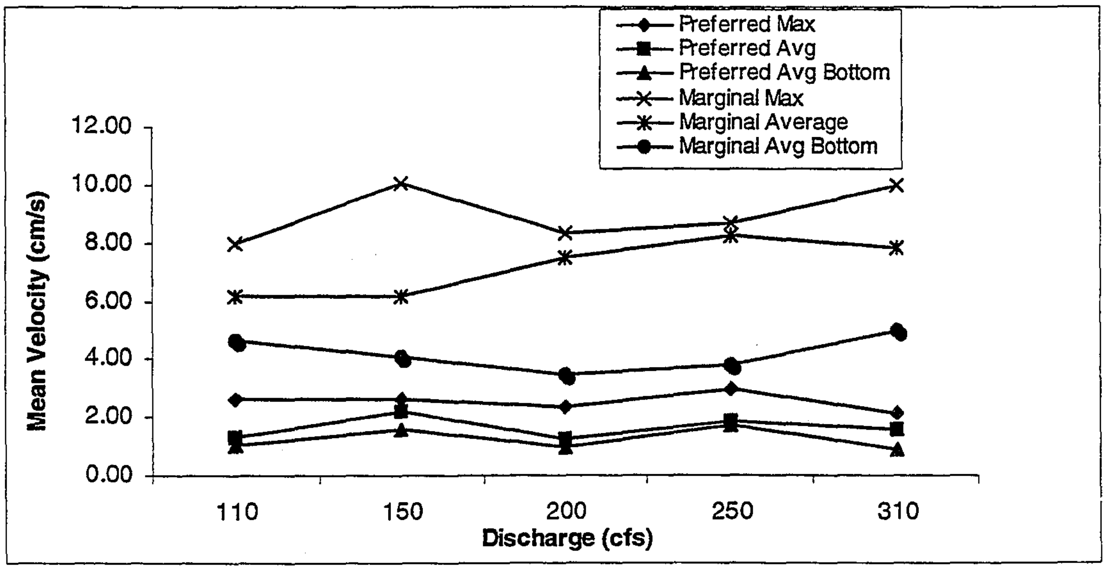
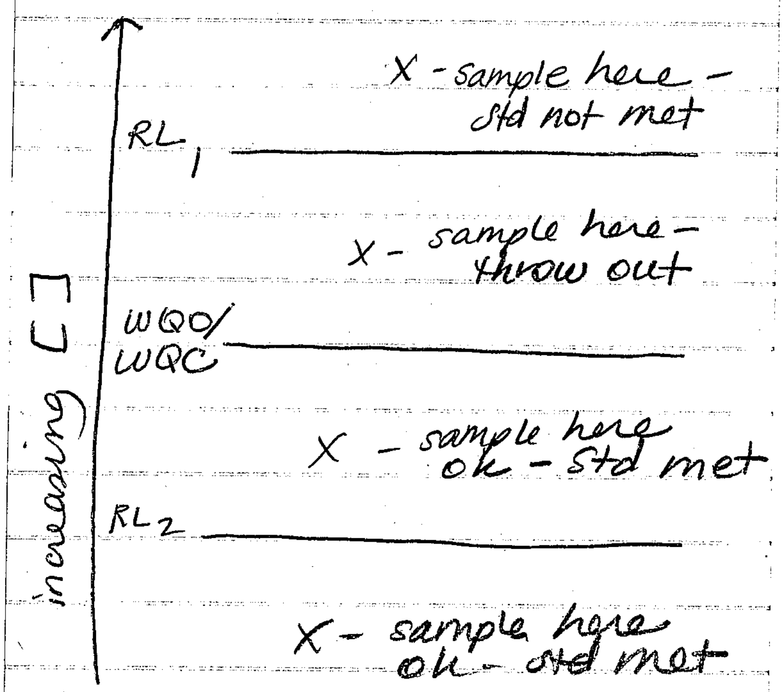
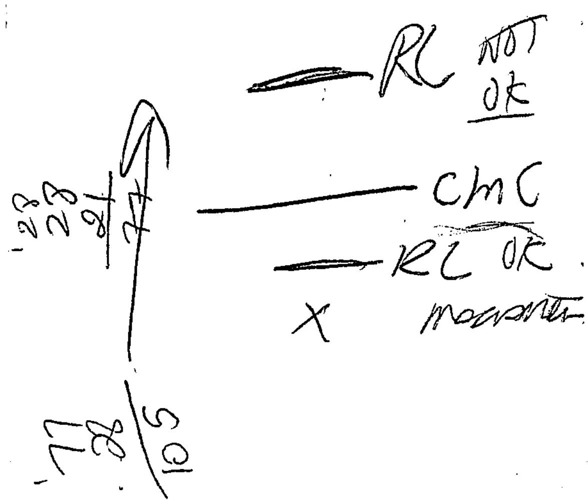


Table 3.8.3. Mean velocities at 5 discharge levels, 7 additional subsites

Velocity Measurements (cm/s)	Discharge Level (cfs)				
	110	150	200	250	310
Preferred Habitat Edge Velocity	2.62	2.62	2.34	2.96	2.13
Preferred Average Velocity @ 66%	1.31	2.19	1.26	1.90	1.62
Preferred Bottom Velocity	1.03	1.56	1.01	1.71	.93
Marginal Habitat Edge Velocity	8.	10.04	8.31	8.70	9.96
Marginal Average Velocity @ 66%	6.18	6.17	7.51	8.27	7.85
Marginal Bottom Velocity	4.63	4.09	3.45	3.80	5.02


X - sample here - std not met
RL1
X - sample here - throw out
WQO/WQC
X - sample here ok - std met
RL2
X - sample here ok - std met
increasing [ ]


RL NOT OK
RL OK
X

2003

TABLE 2

Poe FERC 2107 Project Data (North Fork Feather River)
Data Meets Policy

Station	Date	Hardness (mg/L)	Total Copper (Cu) (ug/L) MPSL, Department of Fish and Game	Total Copper Quantitation Limit (Reporting Limit), ug/L	Total Copper Criteria, Drinking Water Standards (1°, 2° MCLs), Primary MCL (ug/L)	Secondary MCL (ug/L)	Dissolved Copper (Cu) (ug/L) MPSL, Department of Fish and Game	Dissolved Copper Quantitation Limit (Reporting Limit), ug/L	Hardness based criteria for dissolved Cu for CTR and USEPA: CCC (ug/L)	CMC (ug/L)
Data Meets the Policy										
These data all Meet the Listing Policy Section 6.1.5.5 because a US EPA approved analytical method with low quatitation limit (reporting limit) and clean techniques were used to analyze the data. None of the sample concentrations are less than the reporting limit and therefore, there are no "J" flagged values.										
Poe Data Collected in 2003										
Poe-1A										
NFFR above Poe Reservoir at entrance to reservoir	March-03	33.7	1.14	0.01	*1,300*	*1,000*	0.71	0.01	*3.54*	*4.82*
	May-03	38.2	1.08	0.01	*1,300*	*1,000*	0.72	0.01	*3.94*	*5.43*
	August-03	52.5	0.51	0.01	*1,300*	*1,000*	0.43	0.01	*5.16*	*7.32*
	October-03	47.6	0.29	0.01	*1,300*	*1,000*	0.18	0.01	*4.75*	*6.68*
Poe-2A										
NFFR at NF-23 gage station	March-03	33.7	0.79	0.01	*1,300*	*1,000*	0.58	0.01	*3.54*	*4.82*
	May-03	36.3	0.87	0.01	*1,300*	*1,000*	0.62	0.01	*3.77*	*5.17*
	August-03	52.0	0.50	0.01	*1,300*	*1,000*	0.38	0.01	*5.12*	*7.26*
	October-03	46.6	0.33	0.01	*1,300*	*1,000*	0.22	0.01	*4.66*	*6.55*
Poe-3										
NFFR above Poe Powerhouse	March-03	32.7	0.77	0.01	*1,300*	*1,000*	0.60	0.01	*3.45*	*4.69*
	May-03	38.2	0.80	0.01	*1,300*	*1,000*	0.59	0.01	*3.94*	*5.43*
	August-03	56.2	0.52	0.01	*1,300*	*1,000*	0.50	0.01	*5.47*	*7.81*
	October-03	46.6	0.32	0.01	*1,300*	*1,000*	0.29	0.01	*4.66*	*6.55*
Poe-5										
NFFR below Poe Dam	March-03	31.7	0.93	0.01	*1,300*	*1,000*	0.75	0.01	*3.36*	*4.55*
	May-03	36.3	1.01	0.01	*1,300*	*1,000*	0.70	0.01	*3.77*	*5.17*
	August-03	51.4	0.64	0.01	*1,300*	*1,000*	0.56	0.01	*5.07*	*7.18*
	October-03	45.2	0.34	0.01	*1,300*	*1,000*	0.33	0.01	*4.54*	*6.36*
Poe-7										
NFFR upstream of Big Bend Dam	March-03	30.7	1.18	0.01	*1,300*	*1,000*	0.65	0.01	*3.26*	*4.42*
	May-03	37.2	0.96	0.01	*1,300*	*1,000*	0.65	0.01	*3.85*	*5.29*
	August-03	53.0	0.52	0.01	*1,300*	*1,000*	0.42	0.01	*5.21*	*7.39*
	October-03	46.6	0.30	0.01	*1,300*	*1,000*	0.26	0.01	*4.66*	*6.55*

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Station	Date	Hardness (mg/L)	Total Copper (Cu) (ug/L) MPSL, Department of Fish and Game	Total Copper Quantitation Limit (Reporting Limit), ug/L	Total Copper Criteria, Drinking Water Standards (1°, 2° MCLs), Primary MCL (ug/L)	Secondary MCL (ug/L)	Dissolved Copper (Cu) (ug/L) MPSL, Department of Fish and Game	Dissolved Copper Quantitation Limit (Reporting Limit), ug/L	Hardness based criteria for dissolved Cu for CTR and USEPA CCC (ug/L)	CMC (ug/L)

Data Meets the Policy

These data all Meet the Listing Policy Section 6.1.5.5 because a US EPA approved analytical method with low quatitation limit (reporting limit) and clean techniques were used to analyze the data. None of the sample concentrations are less than the reporting limit and therefore, there are no "J" flagged values.

Station	Date	Hardness (mg/L)	Total Cu	Total Cu QL	Primary MCL	Secondary MCL	Dissolved Cu	Dissolved Cu QL	CCC	CMC
Flea Valley Creek										
Flea Valley Creek near mouth, Poe Project	March-03	61.9	0.40	0.01	*1,300*	*1,000*	0.29	0.01	*5.94*	*8.55*
	May-03	61.7	0.36	0.01	*1,300*	*1,000*	0.21	0.01	*5.93*	*8.53*
	August-03	78.5	0.68	0.01	*1,300*	*1,000*	0.30	0.01	*7.28*	*10.70*
	October-03	72.4	0.32	0.01	*1,300*	*1,000*	0.16	0.01	*6.80*	*9.91*
Mill Creek										
Mill Creek near mouth, Poe Project	March-03	30.7	0.16	0.01	*1,300*	*1,000*	0.13	0.01	*3.26*	*4.42*
	May-03	29.4	0.19	0.01	*1,300*	*1,000*	0.06	0.01	*3.15*	*4.24*
	August-03	41.5	0.20	0.01	*1,300*	*1,000*	0.17	0.01	*4.22*	*5.87*
	October-03	40.0	0.04	0.01	*1,300*	*1,000*	0.05	0.01	*4.09*	*5.67*

FOOTNOTES:

Not Sampled = Was not sampled for during project

NOTE: there are no J flagged values for this sample set because the quantitation limit (reporting limit) was lower than the sample concentrations that were detected.

CTR = USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California, California Toxics Rule (CTR)

USEPA = US Environmental Protection Agency National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

NOTE: there were no exceedances of any criteria

POE FERC 2107 Project Data (North Fork Feather River)
ALL DATA

Station	Sampling Date	Total Hardness (mg/L)	Total Copper (Cu) (ug/L)	Total Copper J Flag	Total Copper Quantitation Limit (Reporting Limit), ug/L	Total Copper Criteria, Drinking Water Standards (1°, 2° MCLs) Primary MCL (ug/L)	Secondary MCL (ug/L)	Dissolved Copper (Cu) (ug/L)	Dissolved Copper J Flag	Dissolved Copper Quantitation Limit (Reporting Limit), ug/L	Hardness based criteria for dissolved Cu CTR and USEPA CCC (ug/L)	CMC (ug/L)
ALL DATA												
This table represents all data collected over the period 1999-2003 for total and dissolved copper analysis on the Poe Project of the North Fork Feather River (NFFR). The subsequent worksheets break down the data into data that Meet the Listing Policy Section 6.1.5.5 and data that Do Not Meet the Listing Policy.												
Poe Data Collected in 2003												
All metals samples were analyzed by Marine Pollution Studies Laboratory, Department of Fish and Game (a trace clean metals laboratory in Moss Landing)												
Poe-1A												
NFFR above Poe Reservoir at entrance to reservoir	March-03	33.7	1.14		0.01	*1,300*	*1,000*	0.71		0.01	*3.54*	*4.82*
	May-03	38.2	1.08		0.01	*1,300*	*1,000*	0.72		0.01	*3.94*	*5.43*
	August-03	52.5	0.51		0.01	*1,300*	*1,000*	0.43		0.01	*5.16*	*7.32*
	October-03	47.6	0.29		0.01	*1,300*	*1,000*	0.18		0.01	*4.75*	*6.68*
Poe-2A												
NFFR at NF-23 gage station	March-03	33.7	0.79		0.01	*1,300*	*1,000*	0.58		0.01	*3.54*	*4.82*
	May-03	36.3	0.87		0.01	*1,300*	*1,000*	0.62		0.01	*3.77*	*5.17*
	August-03	52.0	0.50		0.01	*1,300*	*1,000*	0.38		0.01	*5.12*	*7.26*
	October-03	46.6	0.33		0.01	*1,300*	*1,000*	0.22		0.01	*4.66*	*6.55*
Poe-3												
NFFR above Poe Powerhouse	March-03	32.7	0.77		0.01	*1,300*	*1,000*	0.60		0.01	*3.45*	*4.69*
	May-03	38.2	0.80		0.01	*1,300*	*1,000*	0.59		0.01	*3.94*	*5.43*
	August-03	56.2	0.52		0.01	*1,300*	*1,000*	0.50		0.01	*5.47*	*7.81*
	October-03	46.6	0.32		0.01	*1,300*	*1,000*	0.29		0.01	*4.66*	*6.55*
Poe-5												
NFFR below Poe Dam	March-03	31.7	0.93		0.01	*1,300*	*1,000*	0.75		0.01	*3.36*	*4.55*
	May-03	36.3	1.01		0.01	*1,300*	*1,000*	0.70		0.01	*3.77*	*5.17*
	August-03	51.4	0.64		0.01	*1,300*	*1,000*	0.56		0.01	*5.07*	*7.18*
	October-03	45.2	0.34		0.01	*1,300*	*1,000*	0.33		0.01	*4.54*	*6.36*
Poe-7												
NFFR upstream of Big Bend Dam	March-03	30.7	1.18		0.01	*1,300*	*1,000*	0.65		0.01	*3.26*	*4.42*
	May-03	37.2	0.96		0.01	*1,300*	*1,000*	0.65		0.01	*3.85*	*5.29*
	August-03	53.0	0.52		0.01	*1,300*	*1,000*	0.42		0.01	*5.21*	*7.39*
	October-03	46.6	0.30		0.01	*1,300*	*1,000*	0.26		0.01	*4.66*	*6.55*
Flea Valley Creek												
Flea Valley Creek near mouth, Poe Project	March-03	61.9	0.40		0.01	*1,300*	*1,000*	0.29		0.01	*5.94*	*8.55*
	May-03	61.7	0.36		0.01	*1,300*	*1,000*	0.21		0.01	*5.93*	*8.53*
	August-03	78.5	0.68		0.01	*1,300*	*1,000*	0.30		0.01	*7.28*	*10.70*
	October-03	72.4	0.32		0.01	*1,300*	*1,000*	0.16		0.01	*6.80*	*9.91*
Mill Creek												
Mill Creek near mouth, Poe Project	March-03	30.7	0.16		0.01	*1,300*	*1,000*	0.13		0.01	*3.26*	*4.42*
	May-03	29.4	0.19		0.01	*1,300*	*1,000*	0.06		0.01	*3.15*	*4.24*
	August-03	41.5	0.20		0.01	*1,300*	*1,000*	0.17		0.01	*4.22*	*5.87*
	October-03	40.0	0.04		0.01	*1,300*	*1,000*	0.05		0.01	*4.09*	*5.67*

TABLE 1

POE FERC 2107 Project Data (North Fork Feather River)
ALL DATA

Station	Sampling Date	Total Hardness (mg/L)	Total Copper (Cu) (ug/L)	Total Copper J Flag	Total Copper Quantitation Limit (Reporting Limit), ug/L	Total Copper Criteria, Drinking Water Standards (1°, 2° MCLs) Primary MCL (ug/L)	Secondary MCL (ug/L)	Dissolved Copper (Cu) (ug/L)	Dissolved Copper J Flag	Dissolved Copper Quantitiation Limit (Reporting Limit), ug/L	Hardness based criteria for dissolved Cu CTR and USEPA CCC (ug/L)	CMC (ug/L)

ALL DATA

This table represents all data collected over the period 1999-2003 for total and dissolved copper analysis on the Poe Project of the North Fork Feather River (NFFR). The subsequent worksheets break down the data into data that Meet the Listing Policy Section 6.1.5.5 and data that Do Not Meet the Listing Policy.

FOOTNOTES:

Not Sampled = Was not sampled for during project

Blue font and J= Estimated value below the reporting limit and above method detection limit, approximately 60% error associated with this estimated value

CTR = USEPA 40 CFR Part 131, Water Quality Standards; Establishment on Numeric Criteria for Priority Toxic Pollutants for the State of California, California Toxics Rule (CTR)

USEPA = US Environmental Protection Agency National Ambient Water Quality Criteria, Freshwater Aquatic Life Protection Recommended Criteria.

CCC = Continuous concentration (4-day average)

CMC = Maximum concentration (1-hour average)

NOTE: there were no exceedances of any criteria

99-00

TABLE 1

POE FERC 2107 Project Data (North Fork Feather River)
ALL DATA

Station	Sampling Date	Total Hardness (mg/L)	Total Copper (Cu) (ug/L)	Total Copper J Flag	Total Copper Quantitation Limit (Reporting Limit), ug/L	Total Copper Criteria, Drinking Water Standards (1°, 2° MCLs) Primary MCL (ug/L)	Secondary MCL (ug/L)	Dissolved Copper (Cu) (ug/L)	Dissolved Copper J Flag	Dissolved Copper Quantitation Limit (Reporting Limit), ug/L	Hardness based criteria for dissolved Cu CTR and USEPA CCC (ug/L)	CMC (ug/L)
ALL DATA												
This table represents all data collected over the period 1999-2003 for total and dissolved copper analysis on the Poe Project of the North Fork Feather River (NFFR). The subsequent worksheets break down the data into data that Meet the Listing Policy Section 6.1.5.5 and data that Do Not Meet the Listing Policy.												
Poe Data collected from 1999-2000												
Sequoia Laboratory in Pleasant Hill analyzed samples from March 1999, all other samples analyzed by Severn Trent Laboratories (formally Chromalab) in Pleasanton												
Poe-1A												
Above Poe Reservoir	March-99	41.0	3.5		2.0	*1,300*	*1,000*	Not Sampled				
	June-99	39.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	July-99	39.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	August-99	40.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	September-99	56.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	December-99	40.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	March-00	43.0	<0.4		5.0	*1,300*	*1,000*	Not Sampled				
Poe-2												
North Fork Feather River at Pulga	March-99	35.0	3.1		2.0	*1,300*	*1,000*	Not Sampled				
	June-99	39.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	July-99	43.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	August-99	40.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	September-99	59.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	December-99	41.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	March-00	36.0	<0.4		5.0	*1,300*	*1,000*	Not Sampled				
Poe-3												
Above Poe Powerhouse	March-99	38.0	2.8		2.0	*1,300*	*1,000*	Not Sampled				
	June-99	42.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	July-99	45.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	August-99	46.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	September-99	58.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	December-99	42.0	<5.0		5.0	*1,300*	*1,000*	Not Sampled				
	March-00	37.0	<0.4		5.0	*1,300*	*1,000*	Not Sampled				

00-01

TABLE 1

POE FERC 2107 Project Data (North Fork Feather River)
ALL DATA

Station	Sampling Date	Total Hardness (mg/L)	Total Copper (Cu) (ug/L)	Total Copper J Flag	Total Copper Quantitation Limit (Reporting Limit), ug/L	Total Copper Criteria, Drinking Water Standards (1°, 2° MCLs) Primary MCL (ug/L)	Secondary MCL (ug/L)	Dissolved Copper (Cu) (ug/L)	Dissolved Copper J Flag	Dissolved Copper Quantitiation Limit (Reporting Limit), ug/L	Hardness based criteria for dissolved Cu CTR and USEPA CCC (ug/L)	CMC (ug/L)

ALL DATA

This table represents all data collected over the period 1999-2003 for total and dissolved copper analysis on the Poe Project of the North Fork Feather River (NFFR). The subsequent worksheets break down the data into data that Meet the Listing Policy Section 6.1.5.5 and data that Do Not Meet the Listing Policy.

Poe Data Collected From 2000-2001 (Spoil Pile)

All metals samples were analyzed by Severn Trent Laboratories in Pleasanton

Station	Sampling Date	Total Hardness (mg/L)	Total Copper (Cu) (ug/L)	Total Copper J Flag	Total Copper Quantitation Limit (Reporting Limit), ug/L	Primary MCL (ug/L)	Secondary MCL (ug/L)	Dissolved Copper (Cu) (ug/L)	Dissolved Copper J Flag	Dissolved Copper Quantitiation Limit (Reporting Limit), ug/L	CCC (ug/L)	CMC (ug/L)
Poe-S1A Culvert flow from Adit No. 2	April-00	35	2.3	J	5.0	1,300	1,000	Not Sampled				
	March-01	35	6.0		5.0	1,300	1,000	Not Sampled				
Poe-S1B Surface flow into culvert	April-00	Not Sampled	Not Sampled					Not Sampled				
	March-01	35	5.2		5.0	1,300	1,000	Not Sampled				
Poe-S2 NFFR upstream of culvert inflow	April-00	35	2.6	J	5.0	1,300	1,000	Not Sampled				
	March-01	35	<0.3		5.0	1,300	1,000	Not Sampled				
Poe-S3 NFFR immediately dowNot Sampledtream of culvert inflow	April-00	35	1.2	J	5.0	1,300	1,000	Not Sampled				
	March-01	35	<0.3		5.0	1,300	1,000	Not Sampled				
Poe-S4 NFFR above Poe Powerhouse, approximately 0.5 miles dowNot Sampledtream of	April-00	35	1.2	J	5.0	1,300	1,000	Not Sampled				
	March-01	35	<0.3		5.0	1,300	1,000	Not Sampled				
Poe-S5 Poe Powerhouse Tailrace outflow to NFFR	April-00	—	Not Sampled		5.0	1,300	1,000	Not Sampled				
	March-01	35	<0.3		5.0	1,300	1,000	Not Sampled				

TABLE 1

45972
3448

01-02

POE FERC 2107 Project Data (North Fork Feather River)
ALL DATA

Station	Sampling Date	Total Hardness (mg/L)	Total Copper (Cu) (ug/L)	Total Copper J Flag	Total Copper Quantitation Limit (Reporting Limit), ug/L	Total Copper Criteria, Drinking Water Standards (1°, 2° MCLs) Primary MCL (ug/L)	Secondary MCL (ug/L)	Dissolved Copper (Cu) (ug/L)	Dissolved Copper J Flag	Dissolved Copper Quantitation Limit (Reporting Limit), ug/L	Hardness based criteria for dissolved Cu CTR and USEPA CCC (ug/L)	CMC (ug/L)
ALL DATA												
This table represents all data collected over the period 1999-2003 for total and dissolved copper analysis on the Poe Project of the North Fork Feather River (NFFR). The subsequent worksheets break down the data into data that Meet the Listing Policy Section 6.1.5.5 and data that Do Not Meet the Listing Policy.												
Poe Data Collected From 2001-2002 (Spoil Pile) All metals samples were analyzed by Severn Trent Laboratories in Pleasanton												
Poe-Adit Seepage flow from floor of Adit No. 2 tunnel exit, test condition	Nov-01 (DRY)	Not Sampled	Not Sampled					Not Sampled				
	Jan-02 (WET)	56	<0.3		5.0	1,300	1,000	<0.3		5.0	5.46	7.78
Poe-L1 NFFR upstream of Adit No. 1, background condition	Nov-01 (DRY)	47	1.2	J	5.0	1,300	1,000	<0.3		5.0	4.70	6.60
	Jan-02 (WET)	37	8.4		5.0	1,300	1,000	<0.3		5.0	3.88	5.27
Poe-L2 NFFR upstream of Adit No. 2, test condition	Nov-01 (DRY)	47	1.1	J	5.0	1,300	1,000	0.5	J	5.0	4.70	6.60
	Jan-02 (WET)	38	5.4		5.0	1,300	1,000	<0.3		5.0	3.92	5.40
Poe-L3 Samplestream of Adit No. 2, test condition	Nov-01 (DRY)	47	1.5	J	5.0	1,300	1,000	0.4	J	5.0	4.70	6.60
	Jan-02 (WET)	38	5.2		5.0	1,300	1,000	<0.3		5.0	3.92	5.40
Poe-L4 Adit No. 2 leakage culvert below railroad grade, test condition	Nov-01 (DRY)	46	2.0	J	5.0	1,300	1,000	<0.3		5.0	4.61	6.47
	Jan-02 (WET)	55	<0.3		5.0	1,300	1,000	<0.3		5.0	5.37	7.65
Poe-L5 Adit No. 2 leakage culvert at inflow to NFFR, test condition	Nov-01 (DRY)	50	1.7	J	5.0	1,300	1,000	<0.3		5.0	4.95	6.99
	Jan-02 (WET)	62	8.4		5.0	1,300	1,000	<0.3		5.0	5.95	8.57
Poe-L6 Poe Powerhouse Tailrace, background condition	Nov-01 (DRY)	47	1.6	J	5.0	1,300	1,000	<0.3		5.0	4.70	6.60
	Jan-02 (WET)	36	8.4		5.0	1,300	1,000	<0.3		5.0	3.74	5.13
Poe-T1 Tributary stream flowing into NFFR upstream of Adit No. 1, background condition	Nov-01 (DRY)	Not Sampled	Not Sampled					Not Sampled				
	Jan-02 (WET)	87	<0.3		5.0	1,300	1,000	<0.3		5.0	7.95	11.79

Pacific Gas and Electric Company™

Tammie Candelario
Senior Director
Environmental and
Technical & Land Services

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Post-It® Fax Note 7671	Date 5/3/07 # of pages ▸ 10
To Dorena Goding	From PK
Co./Dept.	Co.
Phone #	Phone #
Fax #	Fax #

rec'd 4/9/07

April 2, 2007

Mr. Peter Kozelka
TMDL Liaison, Water Division (WTR-2)
U.S. Environmental Protection Agency, Region IX
75 Hawthorne Street
San Francisco, CA 94105

Dear Mr Kozelka:

Attached you will find Pacific Gas and Electric Company's (PG&E) detailed response to the U.S. Environmental Protection Agency's (USEPA) recommendation for CWA 303(d) listing of the North Fork Feather River (NFFR) for copper as outlined in a letter to the State Water Resources Control Board (SWRCB) dated March 8, 2007. We are submitting a fact sheet that explains PG&E's recommendation and includes tables of the data that are listed as evidence in the original SWRCB fact sheet.

PG&E recommends Do Not List for the NFFR for copper because the data indicate that none of the total or dissolved water quality criteria were exceeded for any of the measured total and dissolved sample concentrations, respectively.

If you have any questions please contact Sara Everitt at 415-973-0707.

Sincerely,

Tammie Candelario

cc: Craig Wilson, SWRCB

Attachment

PG&E's Comments on the USEPA Proposed Listing of the

North Fork Feather River for Copper

WATER SEGMENT: North Fork Feather River (below Lake Almanor)

POLLUTANT: Copper

STATUS OF 303(d) LISTING: The water segment is not listed on the Proposed CWA Section 303(d) List of Water Quality Limited Segments Table (Revised October 25, 2006); however, the U. S. Environmental Protection Agency (USEPA) Region IX has suggested including this water segment on the 303(d) list in a letter dated March 8, 2007 to the State Water Resource Control Board (SWRCB).

SWRCB STAFF BASIS: After review of the available data and information, SWRCB staff conclude that the water body-pollutant combination should not be placed on the section 303(d) list because applicable water quality standards are being met (Final November 2006 Fact Sheet).

PG&E'S RECOMMENDATION: Do Not List

PG&E COMMENTS: Available water quality data support the conclusion of Do Not List. None of the dissolved copper data that has been collected exceeds the applicable dissolved criteria.

The November 2006 fact sheet for the North Fork Feather River (NFFR) below Lake Almanor indicates that only 10 of 124 samples exceed the recommended criteria. However, all of the sample results that were considered 'exceedances' were representative of total concentrations that were inadvertently compared to 'dissolved' concentration criteria from the California Toxics Rule (CTR) and/or USEPA.

There were a total of 115 samples collected during the monitoring years 1999-2003. Of these samples, 73 were analyzed for total copper and 42 were analyzed for dissolved copper (PG&E 2003). None of the 73 total copper samples exceeded the total copper criteria (i.e., drinking water standards). None of the 42 dissolved copper samples exceeded the applicable criteria (i.e., CTR and USEPA criteria for dissolved concentrations).

Furthermore, the proposed listing of the NFFR is based upon the use of historical water quality data that does not meet the SWRCB's sampling criteria of section 6.1.5.5 of the *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* (Listing Policy). Section 6.1.5.5 of the Listing Policy specifically states that "When the sample value is less than the quantitation limit and the quantitation limit is greater than the water quality standard, objective, criterion or evaluation guideline, the results shall not be used in the analysis."

The data collected during 1999-2002 do not meet the Listing Policy criteria because the sample data concentrations were less than the quantitation limit (Reporting Limit) and the quantitation limit was greater than the water quality standard (CTR and/or USEPA criteria). Additionally much of the data was flagged as an estimate. Data are presented in Table 1 (All data collected between 1999-2003), Table 2 (Data that Do Meet the Listing Policy), and Table 3 (Data that Do Not Meet the Listing Policy).

Lastly, all of the data collected in 2003 meets the SWRCB's sampling criteria of section 6.1.5.5 of the Listing Policy and therefore can be used to make an evaluation of the water segment (Table 2). There were a total of 7 monitoring stations in 2003, with samples collected 4 times during the year for both total and dissolved copper concentrations for a total of 56 samples. Of the 56 samples, 28 samples were collected in 2003 for dissolved copper and none of them exceeded the recommended criteria. Therefore, the water segment should not be listed on the 303(d) list.

References

Pacific Gas and Electric Company (PG&E) 2003. Poe Hydroelectric Project, FERC No. 2107, *Final Application for License.*

State Water Resource Control Board (SWRCB) 2004. *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List,* Adopted September 2004.

154b

Dorena
May 1, 2007

North Fork Feather River, Cu, Do Not List Recommendation Data Assessment

Summation: 2 out of 71 dissolved Cu samples exceed – Recommendation remains as Do Not List

Historic Water Quality Data (ok = value is usable and did not exceed either the CTR CCC and/or CMC values)

Poe 1A total Cu
03/99 – ok, compared to both CCC and CMC   Dissolved not sampled
06/99 – ok
07/99 – ok
08/99 – ok
09/99 – ok, compared to both CCC and CMC
12/99 – ok
03/00 – ok, compared to both CCC and CMC

Poe – 2
03/99 – ok, compared to both CCC and CMC
06/99 – ok
07/99 – ok
08/99 – ok
09/99 – ok, compared to both CCC and CMC
12/99 – ok
03/00 – ok

Poe – 3
03/99 – ok, compared to both CCC and CMC
06/99 – ok
07/99 – ok
08/99 – ok
09/99 – ok, compared to both CCC and CMC
12/99 – ok
03/00 – ok

Spoil Pile Sampling

04/00 (total Cu)
✓ Poe S1A – J flagged, RL above CCC, not CMC, sample did not exceed either CCC or CMC.   Dissolved not sampled
✓ Poe S2 - J flagged, RL above CCC, not CMC, sample did not exceed either CCC or CMC.
✓ Poe S3 - J flagged, RL above CCC, not CMC, sample did not exceed either CCC or CMC.
✓ Poe S4 - J flagged, RL above CCC, not CMC, sample did not exceed either CCC or CMC.

04/01
✓ Poe S1A - RL above CCC, not CMC, sample exceeds both the CCC or CMC.
✓ Poe S1B - RL above CCC, not CMC, sample exceeds only the CCC not CMC.

Poe S2 - RL above CCC, not CMC, sample did not exceed either CCC or CMC.
Poe S3 - RL above CCC, not CMC, sample did not exceed either CCC or CMC.
Poe S4 - RL above CCC, not CMC, sample did not exceed either CCC or CMC.
Poe S5 - RL above CCC, not CMC, sample did not exceed either CCC or CMC.
Poe – Adit Jan 2002 was non-detect. Could not use.

<u>2003 Water Quality Data</u> Dissolved Cu

All samples compared to both the CCC and CMC.

Poe 1A
03/03 – ok
05/03 – ok
08/03 – ok
10/03 – ok

Poe 2A
03/03 – ok
05/03 – ok
08/03 – ok
10/03 – ok

Poe 3
03/03 – ok
05/03 – ok
08/03 – ok
10/03 – ok

Poe 5
03/03 – ok
05/03 – ok
08/03 – ok
10/03 – ok

Poe 7
03/03 – ok
05/03 – ok
08/03 – ok
10/03 – ok

Flea Valley Creek
03/03 – ok
05/03 – ok
08/03 – ok
10/03 – ok

Mill Creek
03/03 – ok

05/03 – ok √
08/03 – ok √
10/03 – ok √

Table 5 - Water Quality Sampling near Poe Spoil Piles – wet conditions — Dissolved Cu

1/3/02
Poe L1 – RL exceeds CCC, not CMC, sample doesn't exceed the CMC.
Poe T1 – sample does not exceed either the CCC or CMC.
Poe L2 - RL exceeds CCC, not CMC, sample doesn't exceed the CMC.
Poe L3 - sample does not exceed either the CCC or CMC.
Poe Adit - sample does not exceed either the CCC or CMC.
Poe L4 - sample does not exceed either the CCC or CMC.

none exceed √

11/26/01
Poe L1 - sample does not exceed either the CCC or CMC.
Poe L2 – J flagged, sample does not exceed either the CCC or CMC.
Poe L3 - J flagged, sample does not exceed either the CCC or CMC.
Poe L4 - sample does not exceed either the CCC or CMC.
Poe L5 - sample does not exceed either the CCC or CMC.
Poe L6 - sample does not exceed either the CCC or CMC.

data is dissolved when compared to the CTR.

Historic H_2O Quality Data 3/99, 6/99 - 9/99, 12/99, 3/00

March 99 Poe 1A = 0/1 ok (can compare to both)
June 99 Poe 1A = 0/1 ok
July 99 " = 0/1 ok
Aug 99 " = 0/1 ok
Sept 99 " = 0/1 ok (can compare to both ccc + cmc)
Dec 99 " = 0/1 ok
March 00 " = 0/1 ok (can compare to both)

POE-2
03/99 = 0/1 ok (compared to both)
6/99 = ↓ ok
7/99 ↓ ok
8/99 ↓ ok
9/99 ↓ ok (compared to both)
12/99 ↓ ok
3/00 ↓ ok

POE-3
3/99 0/1 ok (compared to both)
6/99 " ok
7/99 " ok
8/99 " ok
9/99 " ok (compared to both)
12/99 " ok
3/00 " ok

N = 21 samples (~~or 42 if double~~)

none exceed, all dissolved

Spoil Pile Sampling

all samples on this page compared to both CCC + CMC.

4/00 RL = .0050 mg/L

Poe S1A J 0/1 (compared to both CCC + CMC) RL above CCC not CMC
Poe S2 J 0/1 (") "
Poe S3 J 0/1 (") "
Poe S4 J 0/1 (") "

4/01 RL = .0050 mg/L

Poe S1A 1/1 (exceeds both the CCC + CMC) "
Poe S1B 1/1 (exceeds just the CCC) "
Poe S2 0/1 "
Poe S3 0/1 "
Poe S4 0/1 2/10 "
Poe S5 0/1 "

Poe-Adit Jan. 2002 RL = ~~.0005~~ 0.005
Non-Detect

RL = .005 mg/L

Poe L1 Nov 2001 0/1 (< 0.0003)
Poe L1 Jan 2002 1/1 (exceeds both CCC + CMC)
Poe L2 11/01 0/1 (.00052)
Poe L2 1/02 1/1 (exceeds just the CCC)

Poe L3 11/01 0/1 (.00035)
Poe L3 1/02 1/1 (exceeds the CCC)

Poe L4 11/01 0/0 (<.0003) same for L5 + L6
Poe L4 1/02 N/D

Poe L5 11/01 0/0
Poe L5 1/02 1/1 (exceeds the CCC)

6/20

N=20 (w/ 1 N/D sample not included)

* all samples on this page compared to both the CCC + CMC

Poe L6 1/01 0/0 (compared to both)
1/02 1/1 (exceeds both CCC + CMC)

Poe T1 1/02 N/D

2003 H_2O Quality Data

Poe 1A 3/03 0/0 ok
5/03 0/0 ok
8/03 0/0 ok
10/03 0/0 ok

Poe 2A 3/03 0/0 ok
5/03 0/0
8/03 0/0
10/03 0/0

Poe 3 3/03 0/0 ok
5/03 0/0
8/03 0/0
10/03 0/0

Poe-5 3/03 0/0 ok
5/03 0/0
8/03 0/0
10/03 0/0

Poe 7 3/03 0/0 ok
5/03 0/0
8/03 0/0
10/03 0/0

Flea Valley Creek
3/03 0/0 ok
5/03 0/0
8/03 0/0
10/03 0/0

Mill creek ok
3/03 0/0
5/03 0/0
8/03 0/0
10/03 0/0

0/28

N = 30 plus 1 N/D sample not included
1/30 exceed

IF RL + MDLs counted: 20 more samples

From Table 4
W.Q. sampling near spoil piles for Poe Project - Dry conditions

11/26/01

Poe L1	0/0	compared to CCC + CMC
L2	0/0	↓
L3	↓	
L4		
L5		
L6	↓	↓

WQ sampling as above - wet conditions

1/3/02

L1	0/0	"
T1	↓	↓
L2		
L3		
Poe - Adit		
L4	↓	↓

N = 0/12

12
20
21
30
83

85
20
105

154a + b
158
470

Region 5

Water Segment: Feather River, North Fork (below Lake Almanor)

Pollutant: Copper

Decision: Do Not List

Weight of Evidence: This pollutant is being considered for placement on the section 303(d) list under section 3.1 of the Listing Policy. Under section 3.1 a single line of evidence is necessary to assess listing status.

One line of evidence is available in the administrative record to assess this pollutant. Ten measurements exceeded the water quality objective but the minimum number of exceedances were low enough that the pollutant/water body combination did not require listing.

Based on the readily available data and information, the weight of evidence indicates that there is sufficient justification against placing this water segment-pollutant combination on the section 303(d) list in the Water Quality Limited Segments category.

This conclusion is based on the staff findings that:
1. The data used satisfies the data quality requirements of section 6.1.4 of the Policy.
2. The data used satisfies the data quantity requirements of section 6.1.5 of the Policy.
3. Ten of 124 samples exceeded the CTR freshwater criteria and this does not exceed the allowable frequency listed in Table 3.1 of the Listing Policy.
4. Pursuant to section 3.11 of the Listing Policy, no additional data and information are available indicating that standards are not met.

SWRCB Staff Recommendation: After review of the available data and information, SWRCB staff concludes that the water body-pollutant combination should not be placed on the section 303(d) list because applicable water quality standards for the pollutant are not exceeded.

Lines of Evidence:

Numeric Line of Evidence Pollutant-Water

Beneficial Use: AG - Agricultural Supply, CM - Commercial and Sport Fishing (CA), CO - Cold Freshwater Habitat, MI - Fish Migration, MU - Municipal & Domestic, NA - Navigation, R1 - Water Contact Recreation, R2 - Non-Contact Recreation, RA - Rare & Endangered Species, SP - Fish Spawning, WA - Warm Freshwater Habitat, WI - Wildlife Habitat

Matrix: Water

Water Quality Objective/ Water Quality Criterion: All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life.

10 OF 124 samples

CTR Freshwater Criteria. 13 ppb

Data Used to Assess Water Quality:	Exceedance of standard occurred and the were collected at Poe-S2, Poe S-3, Poe S-4, Poe S-1A, Poe S-1B, Poe L-1, Poe L-2, Poe L-3, Poe L-5, Poe L-6 (PG&E, 2003).
Spatial Representation:	Samples were collected above the Poe Reservoir (Poe 1-a), NFFR at Pulga (Poe-2), above the Poe Powerhouse (Poe-3); spoil pile samples were collected at Poe-S1A, NFFR upstream of culvert inflow (Poe-S2), NFFR above Poe Powerhouse, approximately 0.5 miles downstream of culvert inflow (Poe S-3), Poe S-4, RL and MDL. 2001-02 spoil pile samples were collected at Poe-adit, Poe L-1, NFFR downstream of Adit No. 2 (Poe L2), Poe L3, Adit No. 2 leakage culvert at inflow to NFFR (Poe L4), Poe L-5, Poe L-6, Poe T-1. In 2003, samples were collected at Poe 1-a, Poe 2-a, Poe 3, Poe-5, Poe-7, Flea Valley Creek and Mill Creek
Temporal Representation:	Samples were collected in March, Jun-Sept. and Dec. 99 and March 00; spoil pile samples were collected in April 00; Nov 01 and Jan 02. In 2003, samples were collected in March, May, Aug., and Oct.
Data Quality Assessment:	Data from PG&E reports are considered of adequate quality per section 6.1.4 of the Policy.

this is the reporting limit

this is the method detection limit, not a location

Spoil Piles (Dissolved)

11/26/01
Poe L1, L2, L3, L4, L5, L6 (6)

1/3/02 Poe L1, T1, L2, L3, Poe-Adit, L4 (6)

April 2000 Cu mg/L
Poe S1A, S2, S3, S4,
only 4 samples right

march, June-Sept, Dec 99, 3/00 - water

Cu (ug/L) doesn't specify dissolved
Poe 1A - 7 samples
Poe 2 - 7
Poe 3 - 7

Spoil Piles (more detailed)

5.15
154b

NFFR Temperature Assessment Studies in chronological order

Compiled by Scott Tu
May 28, 2004

Woodward-Clyde Consultants (WCC, May and December, 1985), 1985-1986

MITEMP model was developed for Lake Almanor (*LA-MITEMP*) and Butt Valley Reservoir (*BVR-MITEMP*) using data of 1985-1986. Selective withdrawal using curtain concept was tested with MITEMP.
SNTEMP model was developed for Belden (*Belden-SNTEMP*), Rock Creek (*RC-SNTEMP*), Cresta (*Cresta-SNTEMP*) and Poe (*Poe-SNTEMP*) using data of 1985

Bureau Of Reclamation, July 1995

A 1:40 scaled hydraulic model, covering an area approximately 800 feet by 1400 feet offshore Prattville Intake, was built and tested. Test scenarios included WCC curtain (400 feet long), a modified large curtain (1250 feet), hooded pipe inlet and excavated approach channel. Relative performance of cold-water withdrawal rate was compared among the various scenarios. No conclusive recommendation was made for the absolute temperature reduction.

University of Iowa Study (IHR 2004), 2002-2003

The *hydraulic model* encompassed a 3 miles by 2 miles area of lake Almanor. The most recent surveyed bathymetry, including the cold-water channel excavated in the 1920s, was built into the model. The model was a distorted model (horizontal scale 220 and vertical scale 40) and was calibrated with result from a pair of testboxes to account for the flow adjustment by distortion effect. The model was validated with observation data. Modification scenarios tested in the model included six sizes of curtains, long and short hooded pipe inlet options, additional excavation, levees removal and bottom sill. Testing environmental condition considered a range of water surface elevations and strengths of thermal stratification for different Butt Valley Powerhouse flow rates. Under the 'static' condition, test data indicated the Curtain 4 with levee removal would enable Prattville Intake to release water 4 to 5 °C colder during July and August than the Intake presently can release.

UNFFR (PG&E, 2002), FERC 2105 re-licensing, 2000-2003

Seneca-SNTEMP developed for Seneca Reach using data 2000-2001
Belden-SNTEMP fine-tuned for Belden Reach using data 2000-2001
LA-MITEMP fine-tuned for Lake Almanor using data 2000-2001
BVR-MITEMP fine-tuned for Butt Valley Reservoir using data 2000-2001

Jones and Stokes (Jones and Stokes, 2004), 2003-2004

A Dissolved Oxygen model (**W2**) developed for Lake Almanor using data 2000-2001. Changes in Lake Almanor cold-water fishery habitat by curtain as determined with DO and temperature were evaluated for 2000 and 2001.

Bechtel and TRPA (2004), 2003-present

LA-MITEMP was enhanced to incorporate withdrawal capability specific to Curtain 4 characteristics with and without levees that were studied in the University of Iowa hydraulic model (IIHR, 2004). The study determined that the various cold-water conservation measures, such as the 'fence' concept, the 'timing' of curtain deployment and the blending of Canyon Dam from upper gates, all have little effect on temperature release through the Prattville Intake. The enhanced LA-MITEMP was used to simulate 33 years re-operated Lake Almanor based on the terms and conditions specified in the Settlement Agreement (PG&E, April 2004a). Daily average temperatures and their statistics at the various outlet locations were compared among four Prattville Intake scenarios – existing, modified with curtain, modified with curtain and with levees removed, and modified with curtain, levees removed and blending at Canyon Dam outflows. The study suggested installation of curtain at Prattville Intake, along with the removal of the levees as additional control measure, could result in a reduction in the outflow temperatures at Butt Valley Powerhouse by 2.5- 3.7 °C in June-August period. BVR-MITEMP was used to simulate the temperatures in the Butt Valley Reservoir. There is generally a rise in the temperatures when traveling through Butt Valley Reservoir, and consequently reduces the effectiveness of the Prattville Intake curtain.
A watershed approach is adopted for the entire NFFR. All SNTEMP models for Seneca and Belden stream reaches were thermally connected with the upstream conditions predicted by MITEMP. Three statistic rankings were established and NFFR stream temperature longitudinal profiles from Canyon Dam up to above Belden Powerhouse were simulated. The 'mean' value (50% exceedance) and the 'reasonable extreme' (25% exceedance) bracket the reasonable variation of temperatures. Temperature level associated with 'rare' event, as defined by the 10% exceedance, provided the 'extreme' case.
In progress: BVR-MITEMP is being further evaluated for its reasonableness of simulating cold-water inflow condition, i.e., Prattville Intake modified with a curtain. Various control measures to minimize the 'warming' through Butt Valley Reservoir are under investigation. Upon completion of the study, the result will be extended to all downstream stream reach using SNTEMP models for Belden, Rock Creek, Cresta and Poe.

Rock Creek-Cresta (PG&E, 2003 and 2004), FERC 1962 post-license study, Condition 4C, 2002-2003

RC-SNTEMP and Cresta-SNTEMP were improved to account for major tributaries using data 2002-2003. Controllable factors with higher flow release versus non-controllable

factors under the existing Prattville Intake condition was evaluated (TRPA, 2003). Both SNTEMP models were used to continue the watershed study associated with upstream improvement scenarios (Bechtel and TRPA, 2004). Three statistical rankings and longitudinal profiles up to above the Cresta Powerhouse are documented (PG&E, May 2004).
Belden-SNTEMP was improved to include Rock Creek Reservoir using data 2003 (PG&E, 2004). Model checked well with special Caribou 1 test in 2003.

Poe (PG&E, December 2003), FERC 2107 re-licensing, 1999-present

Poe-SNTEMP was fine-tuned for Poe Reach using data 1999-2000 and further validated with data 2003. Temperature assessment associated with possible upstream improvements was assessed using hypothetical assumption at the time of the licensing document preparation (PG&E, December 2003a).
In progress: Watershed approach would apply to this reach and more model runs are expected and to be determined through the Poe Collaborative.

REFERCENCES

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IIHR, Hydroscience and Engineering, 2004, Lake Almanor cold-water Feasibility Study: Hydraulic Model, FINAL, prepared for Pacific Gas and Electric Company

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Jones and Stokes, March 2004, Simulation of Temperature and Dissolved Oxygen in Lake Almanor, California, Using the CE_QUAL-W2 Water Quality Model, Final Draft, prepared for Pacific Gas and Electric Company

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Woodward-Clyde Consultants, May 1986, Rock Creek-Cresta Project Cold Water Feasibility Study, Volume 1, Final Report, prepared for Pacific Gas and Electric Company, Department of Engineering Research, San Ramon, California

Woodward-Clyde Consultants, December 1986, Rock Creek-Cresta Project Cold Water Feasibility Study, Phase II, Final Report, prepared for Pacific Gas and Electric Company, Department of Engineering Research, San Ramon, California

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1546

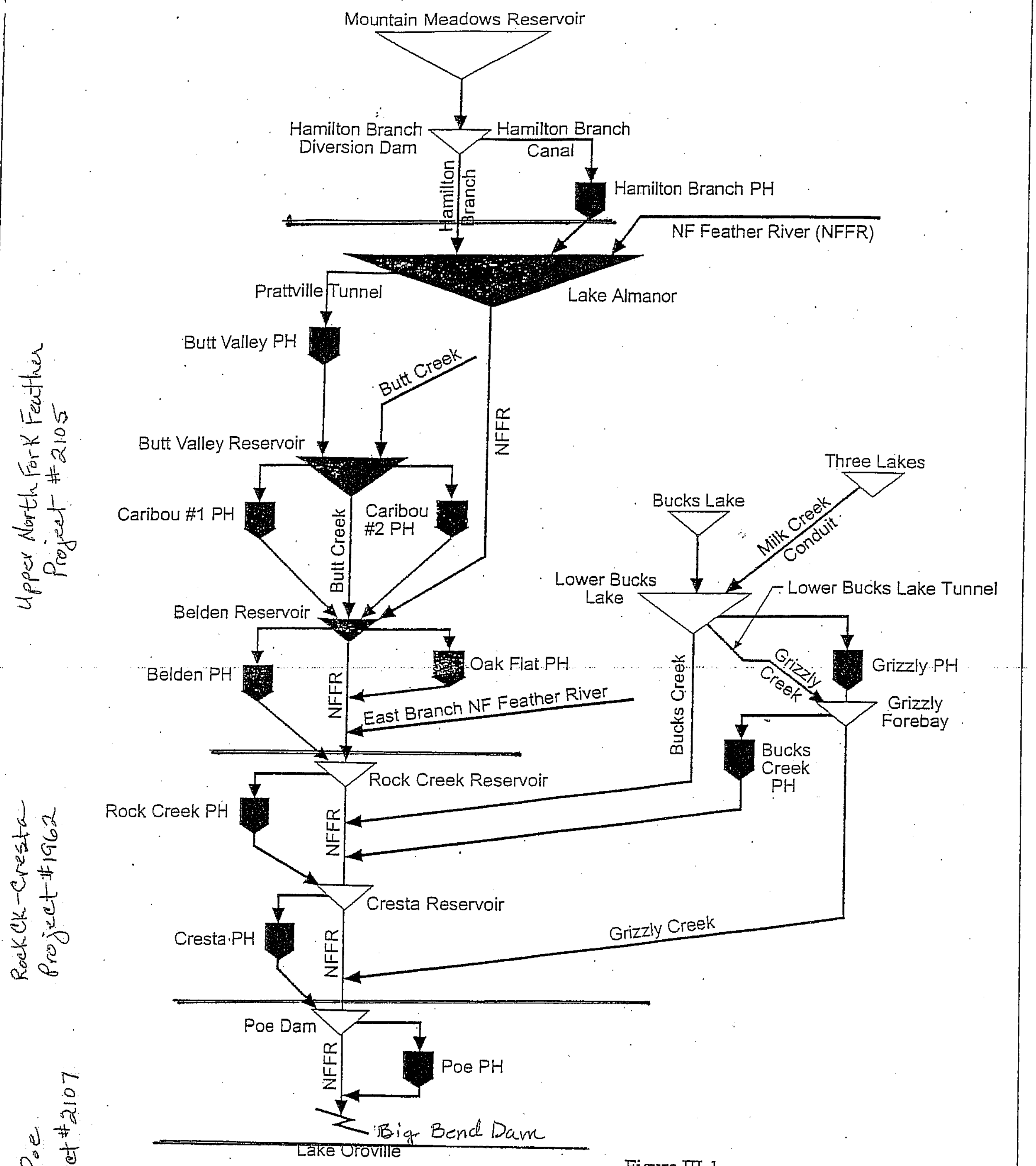

Figure III-1
Schematic Diagram of the North Fork Feather River System

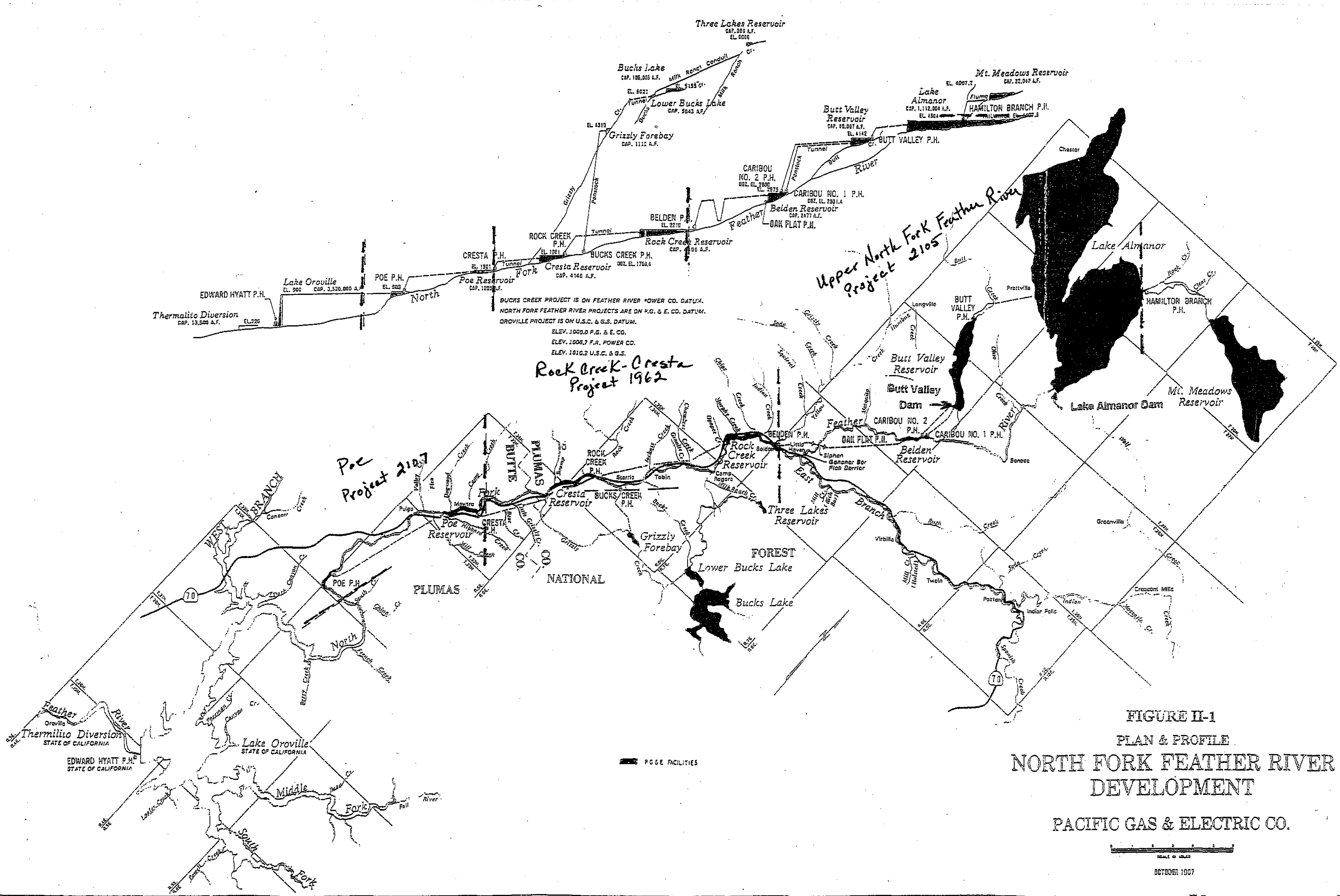

FIGURE II-1
PLAN & PROFILE
NORTH FORK FEATHER RIVER DEVELOPMENT
PACIFIC GAS & ELECTRIC CO.
OCTOBER 1997