Year	Average Proportion of Sand (one year prior)	Average Proportion of Sand	Average Particle Size (one year prior)	Average Particle Size (D-50)	Observed coho redds in Lagunitas Creek	Notes Specifies if the total number of coho redds includes the redds counted above Shafter Bridge	ESTIMATE steelhead juvenile population	ESTIMATE coho juvenile population
1981		0.05		57.4				
1982		0.03		46.5	65	may include shafter to peters dam		
1991		0.05		39.7	34	may include shafter to peters dam		
1993		0.02		41.6				
1995		0.04		46.0	70	may include shafter to peters dam	26,130	2,686
1996	0.04	0.04	46.0	49.1	98	may include shafter to peters dam	13,806	2,468
1997	0.04	0.04	49.1	38.9	66	tocaloma-shafter using 97-98 sum	35,121	8,678
1998	0.04	0.02	38.9	50.2	89	tocaloma-shafter using 98-99 sum	26,774	727
1999	0.02	0.04	50.2	61.2	119	tocaloma-shafter using 99-00 sum	27,555	2,553
2000	0.04	0.03	61.2	52.4	100	tocaloma-shafter using 00-01 sum	22,175	2,273
2001	0.03	0.02	52.4	56.4	65	tocaloma-shafter using 01-02 sum	24,300	7,011
2002	0.02	0.06	56.4	60.6	58	tocaloma-shafter using 02-03 sum	42,200	7,675
2003	0.06	0.05	60.6	58.3	92	tocaloma-shafter using 03-04 sum	25,067	5,952
2004	0.05	0.08	58.3	42.3	79	tocaloma-shafter using 04-05 sum	29,163	4,560
2005*	0.08	na	na	na	38	tocaloma-shafter using 05-06 sum	24,930	8,597
2006	na	0.08	42.3	42.3	101	tocaloma-shafter using 06-07 sum	23,338	463
2007	0.08	0.06	42.3	36.0	68	tocaloma-shafter using 07-08 sum	28,031	18,442
2008	0.06	0.09	36.0	31.8	19	tocaloma-shafter using 08-09 sum	50,682	7,539

*A sediment survey was not done in 2005
Note: Shaded area is post-1995, following issuance of SWRCB Order WR95-17.

Table 9. Annual bed surface composition characteristics, coho redd observations, and juvenile steelhead and coho population estimates for mainstem Lagunitas Creek, 1981-2008 (data source: Hecht 2010 and MMWD).

Lagunitas Creek Fishery Program Costs 1997 - 2009

REVISED 7/3/2010

Marin Municipal Water District

FISCAL YEAR	COST CATEGORY: Total District Staff Labor	Direct Program Costs	Consulting Services	Capital Projects	Capital Equipment	TOTAL
1997	$92,872	$20,000	$101,457		$0	$214,329
1998	$174,744	$161,022	$72,229	$469,533	$9,878	$887,406
1999	$173,534	$103,709	$68,238		$40,584	$386,065
2000	$227,657	$66,255	$93,908		$2,617	$390,437
2001	$261,032	$88,639	$94,968		$0	$444,639
2002	$292,788	$55,739	$88,963		$16,007	$453,497
2003	$263,061	$92,666	$97,453		$0	$453,180
2004	$353,573	$102,702	$100,726		$0	$557,001
2005	$337,025	$106,593	$126,377		$0	$569,995
2006	$562,559	$118,158	$60,186		$19,291	$760,194
2007	$459,703	$117,702	$222,531		$0	$799,936
2008	$388,471	$42,566	$53,788		$0	$484,825
2009	$430,586	$38,971	$285,742		$0	$755,299
TOTAL	**$4,017,605**	**$1,114,722**	**$1,466,566**	**$469,533**	**$88,377**	**$7,156,803**

Notes:

Fiscal Year	- The fiscal year ending on June 30th (fiscal years run July 1 - June 30); except 2009 where costs were counted through Dec. '09. (FY'10)
District Staff Labor	- All District staff salaries, wages, and benefits; all aspects of the Lagunitas fisheries program.
Direct Program Costs	- All materials, supplies, permit fees, tools, equipment, heavy equipment rental, construction and engineering contracts; plus the USGS gage.
Consulting Services	- All environmental consulting services for Lagunitas fishery resource monitoring surveys and studies.
Capital Equipment	- Capital purchases for Lagunitas program (heavy equipment & survey equipment).

Table 10. Marin Municipal Water District costs for the Lagunitas Creek fishery program, 1997 - 2009.

MARIN MUNICIPAL WATER DISTRICT - GRANTS OVERVIEW - LAGUNITAS CREEK WATERSHED: 1997 - 2009

FUNDED PROJECTS - Grant Funding Received by MMWD for Projects in the Lagunitas Creek Watershed

MMWD PROJECT #	TITLE	DESCRIPTION		FUNDING GRANTED	MMWD COST SHARE	TOTAL PROJECT COST
R-05019	**Lagunitas Creek Sediment Reduction - Peters Dam Area**	Restoration treatment at 27 sites identified in assessment done by PWA.	CA Fish & Game Fisheries Restoration Grant Program	$91,755	$77,969	$169,724
R-05019	**Lagunitas Creek Sediment Reduction - Peters Dam Area**	Restoration treatment at some of the 27 sites (above) identified in assessment done by PWA.	Prop 13 - Nonpoint Source Pollution Program, (lead agency is Marin County)	$99,234	$70,490	$169,724
R-05019	**Lagunitas Creek Watershed Sediment Reduction and Enhancement Project** (MMWD portion of proposal: **Roads MOU/GIS Mapping Project**)	MMWD portion of project proposal: develop GIS map of dirt roads in Laguntitas Creek watershed	Prop 13 - Nonpoint Source Pollution Program, lead agency is Marin County	$27,621	$7,023	$34,644
		misc costs associated with sediment budget, project assessment and reporting for above two projects	Prop 13 - Nonpoint Source Pollution Program, lead agency is Marin County	$12,509	$0	$12,509
SAP Recieving Order #9300000011	**San Geronimo Creek Bank Stabilization Project**	Stabilize two stream bank erosion sites along San Geronimo Creek	CA Fish & Game Fisheries Restoration Grant Program	$37,391	$19,851	$57,242
R-01200	**Lagunitas Creek Watershed Sediment Management Projects - Federal Lands**	Erosion control projects on federal lands, to reduce sediment impact to Lagunitas Creek fish populations.	Federal funds passed through CA Fish & Game Fisheries Restoration Grant Program	$284,944	$100,657	$385,601
R-02017	**Lagunitas Creek Riparian Management Projects - State Lands**	Establish riparian vegetation along 500 ft. of stream bank in Samuel P. Taylor Park.	CA Fish & Game Fisheries Restoration Grant Program	$16,247	$3,002	$19,249
R-02016	**Lagunitas Creek Watershed Roads Improvements - MMWD Lands**	Improve road drainage, for sediment reduction, along dirt roads on MMWD lands.	CA Fish & Game Fisheries Restoration Grant Program	$79,080	$5,863	$84,943
R-01100	**San Geronimo Creek Watershed Planning Program**	A study/planning effort to identify sediment source sites in San Geronimo Creek Watershed - resulted in report provided by Stetson Engineers.	CA Fish & Game Fisheries Restoration Grant Program	$43,000	$23,407	$66,407
			TOTAL	**$691,781**	**$308,262**	**$1,000,043**
			Percent Cost Share		**31%**	

Table 11. MMWD grants overview for the Lagunitas Creek watershed 1997 - 2009.

WILLIS EVANS WATERSHED HABITAT IMPROVEMENT GRANT PROGRAM FY2001-2007 - Lagunitas Waterhsed Projects Funded by MMWD				
Year(s)	**TITLE**	**DESCRIPTION**	**GRANTEE**	**MMWD FUNDING AWARDED**
2005/'07	**Marin Trout in the Classroom**	Train and support 20 teachers in Marin for "Trout in the Classroom" program, which includes hatching salmonid eggs and maintaining fry in classroom aquariums. With local agency permission, fish are later released into local reservoirs under DFG permit.	North Bay Chapter Trout Unlimited with CA DFG	$4,688
2005/'07	**Landowner Outreach in the Lagunitas and Walker Creek Watersheds**	The goal of this project is to encourage landowners to effectively maintain restoration projects previously implemented on their property. Historic projects will be evaluated and then survey/evaluation findings will be published in the RCD's "Land Steward" newsletter.	Marin RCD	$10,078
2005/'07	**Native Riparian Revegetation, Salmonid Monitoring, and Watershed Education for San Geronimo Creek**	1. Conducting four native plant propagation workshops; 2. Riparian revegetation along San Geronimo and Larson Creek sections located on San Geronimo Golf Course; 3. Spawner monitoring on San Geronimo Creek tributaries.	SPAWN	$14,000
2005/'07	**Woodacre Creek @ Park Street - Fish Passage Restoration**	Remove undersized culvert and replace with a natural channel, open-bottomed arch. Restored crossing will improve access to 1.3 miles of upstream spawning and rearing habitat for salmonids in Woodacre Creek and its East and West Forks.	County of Marin Public Works Department	$15,000
2003/'05	**Steelhead and Coho Haven**	Funding to purchase incubators for steelhead in the classroom projects. Student activities: removal of non-native plants, installation of native plants and irrigation system, willow-wall, and other creek-based activities.	Wilderness Way	$750
2003/'05	**Fire Road Erosion Mitigation, Samuel P. Taylor State Park**	Drainage work on two fire roads in S. P. Taylor State Park, for the purpose of 1) keeping sediment from entering Lagunitas Creek and Deadman's Gulch Creek, and 2) improve road surface.	Bicycle Trails Council of Marin	$5,000
2003/'05	**Biodiversity Inventory of Lower Walker and Lagunitas Creek**	Inventory, map and create a database of invertebrates in lower Walker Creek and lower Lagunitas Creek. This is an expansion of an existing Tomales Bay Biodiversity Inventory.	Point Reyes National Seashore Association	$8,600
2003/'05	**Barnabe Creek Fish Passage Program/San Geronimo Valley Creeks Fish Passage**	Planning activities identified as pre-requisites for a culvert removal/replacement project. Funded activities include engineering planning and feasibility work.	Salmon Protection and Watershed Network (SPAWN)	$7,024
2003/'05	**University of California Tomales Bay Water Quality Project**	Study of animal agriculture facilities in order to develop plans/actions for waste management that would reduce pollutant loading to bay waters, and disseminate information. This multi-year effort began in 1999 and concluded during the 2003-04 season.	Regents of the University of California	$6,640
2003/'05	**Book: Lagunitas Creek, Hope in Restoration**	Production of a 60 page book about the processes, flora and fauna in Lagunitas Creek, including text written from a scientific perspective, poetry and prose, and beautiful photographs.	Todd Pickering	$8,165
2001/'02	**Wilderness Way Watershed Program (San Geronimo)**	Support Wilderness Way projects, that include: Larsen Creek revegetation, stream bank, and trail improvements; field trips; classroom steelhead rearing; watershed model; etc.	Wilderness Way	$3,000
2001/'02	**Salmonid and Salmonid Habitat Protection Program**	Support SPAWN activities: habitat restoration, salmon and water quality monitoring, erosion control, fish rescue, fish barrier survey, community outreach and education.	Salmon Protection and Watershed Network (SPAWN)	$3,000
2001/'02	**Crescent Ave./Woodacre Improvement Club Culvert "Daylighting" and Restoration**	Remove a 200-foot long culvert to daylight and improve fish passage in a section of a tributary to San Geronimo Creek; enhance stream habitat downstream of the culvert.	Waterways Restoration Institute/San Geronimo Planning Group - Marin County Public Works	$25,000
			TOTAL WILLIS EVANS FUNDED PROJECTS	**$110,945**

Table 11. MMWD grants overview for the Lagunitas Creek watershed 1997 - 2009.

APPENDICES

APPENDIX A

State Water Resourced Control Board
Order WR95-17

APPENDIX A

State Water Resources Control Board Order WR 95-17

Order: Marin Municipal Water District
Pages 109-118

ORDER: WR 95-17

LAGUNITAS CREEK

Order Amending Water Rights and Requiring Changes in Water Diversion Practices to Protect Fishing Resources and to Prevent Unauthorized Diversion and Use of Water

October 26, 1995

STATE WATER RESOURCES CONTROL BOARD
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

below. The order deletes specified permit and license terms which are inconsistent with the newly established requirements.

ORDER

Based on the evidence in the record and the findings set forth in this order, the diversion of water from Lagunitas Creek by Marin Municipal Water District, North Marin Water District, and Waldo Giacomini shall be subject to the provisions below:

MARIN MUNICIPAL WATER DISTRICT

IT IS HEREBY ORDERED that Water Right Permits 5633, 9390, and 18546 (Applications 9892, 14278, 26242) are amended to include the following conditions:

1. **Instream Flow Requirement:** Permittee shall make a metered release of at least one cubic foot per second (cfs) directly below Peters Dam at all times and shall bypass or release sufficient water from Kent Lake to maintain the following minimum instream flow requirements, as measured in cfs at the U.S. Geologic Service gage at Taylor State Park.

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LAGUNITAS CREEK
MINIMUM INSTREAM FLOW REQUIREMENTS

Normal Year Requirements			
Time Period			*Flow (cfs)*
November 1/15*	-	December 31	20
January 1	-	March 15	25
March 16	-	March 31	20
April 1	-	April 30	16
May 1	-	June 15	12
June 16	-	November 1/15*	8

Dry Year Requirements			
Time Period			*Flow (cfs)*
November 1/15*	-	March 31	20
April 1	-	April 30	14
May 1	-	June 15	10
June 16	-	November 1/15*	6

* *The minimum flow of 20 cfs in November shall begin following the first storm that produces a "trigger" flow of 25 cfs as measured at the USGS gage at Taylor State Park. In the absence of a storm causing a "trigger" flow, the 20 cfs flow requirement shall become effective on November 15 of each year.*

2. **Upstream Migration Flows**: To provide for the upstream migration of anadromous fish, Permittee shall ensure that four upstream migration flows are provided between November 1 and February 3, as described below. An "upstream migration flow" is defined as a continuous flow of at least 35 cfs that exists for 3 days as measured at the USGS gage at Taylor State Park. A "trigger" flow is defined as a flow of 25 cfs between November 1 and December 31, or a flow of 30 cfs between January 1 and January 31, as measured at the USGS gage at Taylor State Park. Permittee shall attempt to provide upstream migration flows that coincide with natural runoff from storm events.

   a. The first upstream migration flow shall be provided in conjunction with the first storm that occurs after

November 1 that produces a trigger flow of 25 cfs at the park gage. The minimum spawning flow of 20 cfs shall then be maintained for the rest of the month. If no storm produces a trigger flow before November 15, Permittee shall release sufficient water from Kent Lake to provide an upstream migration flow beginning on November 15.

b. A second upstream migration flow shall be provided in conjunction with a storm that occurs after November 4 that produces a trigger flow of 25 cfs at the park gage. If a second trigger flow of 25 cfs does not occur before December 1, Permittee shall release sufficient water from Kent Lake to provide an upstream migration flow beginning on December 1.

c. A third upstream migration flow shall be provided in conjunction with a storm that occurs after December 4 that produces a trigger flow of 25 cfs at the park gage. If a trigger flow of 25 cfs does not occur before January 1, Permittee shall release sufficient water from Kent Lake to provide an upstream migration flow beginning on January 1.

d. A fourth upstream migration flow shall be provided in conjunction with a storm that occurs after January 4 that produces a trigger flow of 30 cfs at the park gage. If a trigger flow of 30 cfs does not occur before February 1, Permittee shall release sufficient water from Kent Lake to provide an upstream migration flow beginning on February 1.

3. **Water Year Classification**: The water year classification shall be determined on January 1 and April 1 of each year, based on precipitation as measured at the Kent rain gage.

111.

The January 1 water year classification shall be based on the total precipitation measured during the preceding 15 month period. If the total precipitation during this 15 month period is less than 48 inches, Permittee shall maintain the dry-year flow requirements from January 1 through March 31. If the total precipitation during this 15 month period is 48 inches or greater, Permittee shall maintain the normal year flow requirements from January 1 through March 31. The April 1 water year classification shall be based on the total precipitation during the preceding 6 month period. If the total precipitation during this 6 month period is less than 28 inches, Permittee shall maintain the dry year flow requirements from April 1 to the first upstream migration flow in November. If the total precipitation during this six-month period is 28 inches or greater, Permittee shall maintain the normal year flow standard from April 1 to the first upstream migration flow in November.

4. **Water Temperature**: Permittee shall bypass or release sufficient water from Kent Lake to maintain a mean daily water temperature of 58 degrees Fahrenheit, or less, between May 1 and October 31, as measured at the USGS gage at Taylor State Park. From November 1 through April 30, permittee shall bypass or release sufficient water from Kent Lake to maintain a mean daily water temperature of 56 degrees Fahrenheit, or less, as measured at the USGS gage at Taylor State Park.

5. **Special Circumstances**: In the event Permittee determines that it cannot meet the flow and/or water temperature conditions described above, Permittee shall immediately notify the Department of Fish and Game (DFG), the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS) and the Chief of the Division of Water Rights. The notification shall include specific information

explaining the condition that cannot be met, the reason the condition cannot be met, and the length of time that the condition cannot be met. Permittee shall consult with DFG, USFWS and NMFS in an attempt to develop a plan of operation that is acceptable to DFG, USFWS, NMFS and the Permittee. If a plan acceptable to Permittee, DFG, USFWS, and NMFS is developed, the plan should be submitted for review by the Chief of the Division of Water Rights. If DFG, USFWS, NMFS and Permittee cannot reach agreement within a reasonable period of time, Permittee shall submit a proposed plan of operation for review by the Chief of the Division of Water Rights, to include:

a. The reasons or justification for the modification of the flow or temperature requirements;

b. A specific plan of operation, including the proposed release schedule from Kent Lake;

c. A description of other measures to be taken by the Permittee to deal with any deficiencies in water supply, including whether the Permittee will declare a water supply emergency and impose mandatory water conservation measures; and

d. Measures to be taken by Permittee to mitigate any potential adverse impacts to the fishery resources in Lagunitas Creek due to the Permittee's inability to meet the flow or temperature requirements specified in this permit.

Permittee shall be responsible for complying with requirements of the California Environmental Quality Act.

The Chief of the Division of Water Rights shall review the District's proposed plan of operation, and if acceptable, shall approve the proposed plan.

6. **Ramping**: Permittee shall make every reasonable effort to control releases from Kent Lake in order to minimize rapid changes in flow in Lagunitas Creek, except as necessary to provide the upstream migration flows required under this permit.

7. **Control of Sediment**: Permittee shall prepare a Sediment Management Plan that describes measures that should be taken to reduce sedimentation and to provide an appreciable improvement in the fishery habitat within the Lagunitas Creek watershed. During the development of the plan, Permittee shall coordinate with appropriate public agencies, and provide an opportunity for input by local environmental groups, property owners in the area, and the general public. Within one year from the date of this order, Permittee shall submit a draft Sedimentation Management Plan to the State Water Resources Control Board for review by the Chief of the Division of Water Rights that describes:

   a. Specific sediment management programs and projects.

   b. Agency responsible for each program or project.

   c. Estimated costs for each program or project.

   d. Time schedule for implementation of each program or project.

   e. Public participation process.

   f. Monitoring program.

g. Reporting procedures.

Permittee shall also submit a copy of the draft Sedimentation Management Plan to the Regional Water Quality Control Board (Regional Board), DFG, USFWS and NMFS at the time the draft plan is submitted to the State Water Resources Control Board. The Regional Board, DFG, USFWS, and NMFS shall have the opportunity to review and comment on the draft plan.

Following consideration of any comments provided by the Regional Board, DFG, USFWS, NMFS and the Chief of the Division of Water Rights, Permittee shall prepare and submit a final Sedimentation Management Plan to the State Water Resources Control Board for approval by the Chief of the Division of Water Rights. Permittee shall provide copies of the final Sedimentation Management Plan to the Regional Board, DFG, USFWS, and NMFS at the time it submits the plan to the State Water Resources Control Board. The Regional Board, DFG, USFWS, and NMFS shall have the opportunity to review and comment upon the final plan prior to approval by the Chief of the Division of Water Rights. The Chief of the Division of Water Rights shall notify the SWRCB Board Members if the final Sedimentation Management Plan submitted by Permittee is not acceptable. Following approval of an acceptable Sedimentation Management Plan, Permittee shall provide the appropriate level of funding and resources to ensure effective implementation of the measures described in the plan.

8. **Riparian Management Plan**: Permittee shall prepare a Riparian Management Plan that describes measures to be taken to improve the riparian vegetation and woody debris within the Lagunitas Creek watershed in order to improve habitat for fishery resources. During the development of the plan, Permittee shall coordinate with appropriate public agencies,

and provide an opportunity for input by local environmental groups, property owners in the area, and the general public. Within one year of the date of this order, Permittee shall submit a draft Riparian Management Plan to the State Water Resources Control Board for review by the Chief of the Division of Water Rights that describes:

a. Specific riparian management programs and projects

b. Party responsible for each program or project.

c. Estimated costs for each program or project.

d. Time schedule for implementation of each program or project.

e. Public participation process.

f. Monitoring program.

g. Reporting procedures.

Permittee shall also submit a copy of the draft Riparian Management Plan to DFG, USFWS and NMFS at the time the draft plan is submitted to the State Water Resources Control Board. The DFG, USFWS, and NMFS shall have the opportunity to review and comment on the draft plan.

Following consideration of any comments provided by the DFG, USFWS, NMFS and the Chief of the Division of Water Rights, Permittee shall prepare and submit a final Riparian Management Plan to the State Water Resources Control Board for approval by the Chief of the Division of Water Rights. Permittee shall provide copies of the final Riparian Management Plan to DFG, USFWS, and NMFS at the time it submits the plan to the State Water Resources Control Board. The DFG, USFWS, and NMFS shall have the opportunity to review and comment upon the final plan prior to approval by the Chief of the Division of Water Rights. The Chief of the Division of Water Rights shall notify the SWRCB Board Members if the final Riparian Management Plan submitted by Permittee is not acceptable. Following approval of an acceptable Riparian Management Plan, Permittee shall provide the appropriate level of funding and resources to ensure effective implementation of the measures described in the plan.

9. **Monitoring of Fishery Resources**: Permittee shall be responsible for monitoring the coho salmon, steelhead and freshwater shrimp populations in Lagunitas Creek. Within six months, Permittee shall submit to the State Water Resources Control Board, for the approval of the Chief of Division of Water Rights, a workplan that describes the scope of the monitoring studies to be conducted. During the development of the workplan, Permittee shall consult with the DFG, USFWS and NMFS regarding the scope and duration of the monitoring studies. Following the approval of a plan that is acceptable to the Chief of the Division of Water Rights, the monitoring studies shall be conducted in accordance with the scope of work and time schedule described in the work plan. Permittee shall provide sufficient funding and resources to assure satisfactory completion of the monitoring studies. Annual reports shall be submitted to the Chief of the Division of Water Rights, by December 31 of each year, until the monitoring studies are completed.

10. **Gages**: In order to document compliance with the terms of this permit, Permittee shall ensure that a continuous record is maintained of the daily flow and temperature at the USGS gage at Taylor State Park. That data shall be made available

to the State Water Resources Control Board upon request, in a format acceptable to the Chief of the Division of Water Rights.

11. **Reporting**: Permittee shall submit a report to the State Water Resources Control Board by December 31 of each year that verifies Permittee's compliance with permit conditions for the previous water year ending September 30. The report shall be submitted to the Division of Water Rights in a format designated by the Chief of the Division of Water Rights.

IT IS FURTHER ORDERED that:

1. Conditions 19, 20, 21, 22, 23, 24, 25, 26, and 27 are deleted from amended Permit 5633 issued on May 20, 1982. (Application 9892).

2. Conditions 19, 21, 22, 23, 24, 25, 26, 27, 28 and 29 are deleted from amended Permit 9390 issued on May 20, 1982 (Application 14278).

3. Conditions 21, 23, 24, 25, 26, 27, 28, 29, 30 and 31 are deleted from Permit 18546 (Application 26242).

4. Amended Permit 12800 issued on May 20, 1982 (Application 17317) is amended to include the following condition:

   Permittee shall not release water from Nicasio Reservoir directly into Lagunitas Creek, or its tributaries, between the base of Peters Dam and the confluence of Nicasio Creek and Lagunitas Creek.

5. Conditions 12, 18, 19, 20, 21, 22, 23, 24, 25, and 26 are deleted from amended Permit 12800 issued on May 20, 1982 (Application 17317).

APPENDIX B

LAGUNITAS CREEK TECHNICAL ADVISORY COMMITTEE (TAC)

Charter and Operating Procedures

Approved by the TAC on 11/09/07

LAGUNITAS CREEK TECHNICAL ADVISORY COMMITTEE (TAC)

Charter and Operating Procedures

Approved by the TAC on 11/09/07

CHARTER:

The Lagunitas Creek Technical Advisory Committee (TAC) is a collaborative, multi-party forum that provides its members the opportunity to leverage resources to implement programs and projects that will provide multiple benefits for water resources in the Lagunitas Creek watershed. The TAC serves as the information-sharing forum for its members on fisheries, water quality and ecosystem restoration issues in the Lagunitas Creek watershed, and the TAC offers advice to all of its members on optimal approaches to benefit the environment of the watershed.

The TAC consists of members representing public agencies and non-governmental organizations with resource management responsibilities and/or conducting activities within the Lagunitas Creek watershed. All participating entities have equal standing on the TAC.

The TAC will periodically review and provide input to these participating entities regarding the development and implementation of plans, policies, and practices that may affect the fisheries, water quality and the aquatic ecosystem of the watershed. This advice is non-binding on the participating entities, and the TAC is not the exclusive source of such advice. Through this process, the participating entities hope to ensure: 1) that each entity benefits from the ideas and input of the committee members; 2) that interested agencies, community members, and the general public have access to information regarding any plans, policies, and projects; and 3) that the committee members and general public have adequate opportunities to comment on plans, policies, and the implementation of projects by participating entities.

Members of the TAC may partner together to develop projects and joint proposals for grant funding from local, state or federal agencies. The TAC may participate in the development of these projects by providing a forum for the partners to discuss the project with and secure advice from other participating entities.

The TAC will meet two to four times per year. The TAC may create subcommittees to allow for a more focused discussion on specific issues.

DEFINITIONS:

TAC - Lagunitas Creek Technical Advisory Committee.

Entity – A public agency or private, non-profit organization,

Participating Entity – A public agency or private, non-profit organization that has agreed to the TAC's operating procedures.

Member – A representative or alternate to the TAC

DECISION MAKING:

The TAC will attempt to achieve consensus on decisions before it, and if that is not possible, will then rely on a majority vote among members present.

STRUCTURE:

Each participating entity will appoint one (1) representative and one (1) alternate to be a member of the TAC. Both the representative and alternate can attend and participate in TAC meetings. However, in the event that a vote is ever taken to render a decision, only the representative or the alternate (sitting in for the representative) can cast a vote.

CHAIR:

The TAC will have a Chair at each meeting. The Chair will be assigned to the participating entities, on a rotating schedule, for a specified length of time, as decided by the TAC; for example, the Chair's term would last for a period of one (1) year. The person serving as the Chair will be appointed by that person's agency/organization. The Chair will select an alternate who will serve as Chair in the event that the Chair can not attend a particular meeting.

For at least the first year, the representative from the Marin Municipal Water District will serve as the Chair of the TAC.

SECRETARY:

The TAC will have a Secretary at each meeting, to record the minutes of the meetings. The person serving as the Secretary will be appointed by the Chair of the TAC. There will also be an alternate selected who will serve as Secretary in the event that the regular Secretary can not attend a particular meeting.

For at least the first year, the Marin Municipal Water District will supply the staff support of the Secretary and other functions needed to host 2 to 3 meetings a year.

MEETINGS:

There will be an agenda for each meeting. The agenda, and any accompanying information, will be submitted to TAC members prior to the meeting and posted in a public venue (e.g., public library, newspaper, web site, and/or public meeting board).

The minutes from each meeting will be recorded during the meeting, by the Secretary, and included as an attachment to the agenda for the subsequent meeting. Approval of the preceding meetings minutes will be an action item on the agenda of each TAC meeting.

Meetings will be held at a venue that is accessible to the TAC members and the public.

At least one meeting each year will consist of a field trip to conduct a site visit of the Lagunitas Creek watershed or of a location that is relevant to the focus of the TAC.

APPENDIX C

Memorandum of Understanding (MOU) for Maintenance and Management of Unpaved Roads in the Lagunitas Creek Watershed 2001

MEMORANDUM OF UNDERSTANDING

Among the
MARIN MUNICIPAL WATER DISTRICT,
COUNTY OF MARIN,
MARIN COUNTY OPEN SPACE DISTRICT,
CALIFORNIA DEPARTMENT OF PARKS AND RECREATION,
NATIONAL PARK SERVICE, and
MARIN COUNTY RESOURCE CONSERVATION DISTRICT
For
MAINTENANCE AND MANAGEMENT OF UNPAVED ROADS
IN THE LAGUNITAS CREEK WATERSHED

This Memorandum of Understanding, dated October 29, 2001, is by and between the Marin Municipal Water District (MMWD); the County of Marin (County), acting through the Marin County Board of Supervisors (Supervisors), Marin County Fire Department (MCFD), Marin County Department of Public Works (DPW), and Marin County Community Development Agency (MCCDA); the Marin County Open Space District; the California Department of Parks and Recreation (State Parks); the National Park Service (NPS); and the Marin County Resource Conservation District (MCRCD).

RECITALS

WHEREAS the parties to this Memorandum of Understanding (hereafter "Agreement") own, manage, or have an interest in the management of lands and waters within the 103-square mile Lagunitas Creek watershed, the largest watershed in Marin County; and

WHEREAS Lagunitas Creek and some of its tributaries support populations of threatened and endangered species per the federal and state Endangered Species Acts, including coho salmon, steelhead trout, California freshwater shrimp, and California red-legged frog; and

WHEREAS streambed sedimentation is one of the main factors constraining habitat values for coho salmon and steelhead trout using Lagunitas Creek and its tributaries for spawning, rearing, and migration; and

WHEREAS the supply of fine sediments has been linked to erosion throughout the watershed with unpaved roads having been identified as one of the most significant causes of erosion and a direct source of fine sediment; and

WHEREAS all parties to this Agreement recognize that proper maintenance and management of unpaved roads under their ownership, jurisdiction, or influence within the Lagunitas Creek watershed can reduce streambed sedimentation and thereby enhance habitat for coho salmon, steelhead trout, and California freshwater shrimp; and

WHEREAS it is the goal of all parties to this Agreement to enhance coho salmon, steelhead trout and California freshwater shrimp habitat within the Lagunitas Creek watershed, particularly, but not exclusively, those portions of the watershed downstream of Kent Lake and Nicasio Reservoir, by maintaining and managing unpaved roads, or encouraging the maintenance and management of unpaved roads, to minimize soil loss, reduce erosion potential, and reduce the amount of sediments entering Lagunitas Creek, while accommodating the appropriate uses designated for these roads; and

WHEREAS it is the goal of all parties to this Agreement to manage and maintain unpaved roads in a condition that will allow for use of these roads during emergency situations with minimal damage or wear that could increase erosion; and

WHEREAS it is the intent of all parties to this Agreement to encourage a cooperative relationship among the parties to implement a consistent approach to the maintenance and management of unpaved roads in the Lagunitas Creek watershed; and

WHEREAS all parties to this Agreement acknowledge that funding constraints could affect implementation of the desires expressed in this Agreement and that implementation of this Agreement's terms could be altered, delayed, limited or even prevented if funding sources are not identified or made available.

AGREEMENT

NOW, THEREFORE the parties to this Agreement agree to:

1. Model road maintenance and management activities as set forth in the document entitled: *Guidelines for the Maintenance and Management of Unpaved Roads in the Lagunitas Creek Watershed* (Attachment A), including the manuals referenced in that document, and as may be amended from time to time. In addition, the parties may adopt other manuals or handbooks by consensus to augment or replace the above guidelines and/or manuals as deemed necessary.

2. Implement the actions in this Agreement in compliance with all applicable federal, state, and local environmental laws and regulations.

3. Acknowledge the fact that nothing in this Agreement negates any laws, regulations, or policies.

4. Act consistently with this Agreement when developing policies, plans, or projects; when exercising regulatory authority, or conducting environmental review; or when otherwise conducting work related to unpaved roads in the Lagunitas Creek watershed; and to encourage others to do so.

5. Provide the other parties to this Agreement with information relevant to unpaved road management in the Lagunitas Creek watershed. This may include maps and data about individual roads, internal policies for road maintenance and/or management, and training or other educational information.

6. Strive to inspect, on an annual basis, all actively used, unpaved roads on public lands, and encourage or assist, when requested, with inspections on private lands, for the purpose of identifying where routine maintenance or repairs are needed; and undertake routine maintenance in a timely manner as resources permit.

7. Meet, at least annually, to discuss the status of each agency's efforts, singly and cooperatively to reduce road-related sedimentation in the Lagunitas Creek watershed; to review existing, or consider new sediment reduction techniques; to coordinate grant-funding requests; and to discuss other matters pertinent to fulfilling the purpose of this Agreement.

8. Identify and map the entire system of unpaved roads subject to this Agreement, designating each road according to its categories of use and whether the road is actively used, unneeded, or abandoned. The mapping and designation of roads on private property will only be accomplished with the voluntary cooperation of the landowner. This mapping will be updated annually as necessary.

9. Identify non-routine repairs and long-term sediment reduction projects on each agency's actively used unpaved roads that are not funded within each agency's annual maintenance budget.

10. Identify unneeded and abandoned roads and consider such roads for closure or conversion to recreational trails; and coordinate the closure or conversion of such roads in those situations where roads cross property boundaries and pass from one ownership to another, or provide access to another agencies facilities.

11. Develop strategies, and identify funding mechanisms, to accomplish specific non-routine repairs or long-term sediment reduction projects on actively used unpaved roads, by means of phasing, sharing staff or equipment, and cooperative grant-seeking.

12. Develop strategies, and identify funding, to accomplish specific road closures or conversions, by means of phasing, sharing staff or equipment, and cooperative grant-seeking.

13. Make a good faith effort to implement long-term repairs and closures or conversions, recognizing each agency's budget constraints and other land management responsibilities and priorities.

14. Strive to meet the schedule of milestones for road maintenance and management in the Lagunitas Creek watershed as indicated in Table 1 (attached) of this Agreement.

15. Recognize that the terms of this Agreement are subject to the availability of funding, personnel and other essential resources, and that each party has the sole authority and responsibility regarding decisions and matters in its own jurisdiction.

This Agreement has no termination date and may be revised as necessary. Each party to this Agreement may withdraw from this Agreement upon written notice to all other parties.

The parties agree that this Agreement does not constitute any legal admission or opinion as to the subject matter, nor does it confer any additional legal rights, liabilities or obligations between the parties or to third parties that do not already exist in law.

Marin Municipal Water District

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President, Board of Directors
Attest:

County of Marin

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President, Board of Supervisors
Attest:

California Department of Parks and Recreation

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Superintendent, Marin District Parks
Attest:

National Park Service

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Superintendent, Point Reyes NS
Attest:

Marin County Resource Conservation District

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President, Board of Directors
Attest:

Marin County Open Space District

____
President, Board of Directors
Attest:

Table 1: Milestones for Implementing the Memorandum of Understanding (MOU) for Maintenance and Management of Unpaved Roads in the Lagunitas Creek Watershed.

MOU Agreement Number	MILESTONE	IMPLEMENTATION YEAR*
1	Model maintenance and management activities following MOU Guidelines	2001
2	Comply with environmental laws and regulations	2001
3	Acknowledge MOU does not negate laws, regulations, or policies	2001
4	Follow MOU in policy development, planning, or regulatory authority	2001
5	Sharing of information among the parties to the MOU	2001
6	Conduct annual inspections of actively used, unpaved roads	2002
7	Annual coordination meeting of all parties to the MOU	2002
8	Identify and map the unpaved roads system in the Lagunitas Creek watershed	2002
9	Identify non-routine road repair and long-term sediment reduction projects	2003
10	Identify unneeded and abandoned roads for closure or conversion	2003
11, 13	Implement non-routine road repairs and long-term projects in the Primary Resource Area**	2005
12, 13	Implement road closures or conversions in the Primary Resource Area**	2010
11, 13	Implement non-routine road repairs and long-term projects in the Secondary Resource Area**	2010
12, 13	Implement road closures or conversions in the Secondary Resource Area**	2015

***** The Implementation Year represents the latest year by which the milestone will be implemented or completed. Milestones can and are encouraged to be implemented prior to the Implementation year, if possible. Once implemented, the milestone will remain in effect in perpetuity, unless revised or rescinded by the parties to the MOU.

****** See MOU Guidelines for descriptions and mapping of the Primary and Secondary Resource Areas.

ATTACHMENT A
GUIDELINES FOR THE MAINTENANCE AND MANAGEMENT OF UNPAVED ROADS IN THE LAGUNITAS CREEK WATERSHED

I. BACKGROUND

Lagunitas Creek drains much of west-central Marin County, California and is the largest watershed in the county, encompassing 103 square miles. It originates on Mt. Tamalpais and flows eight miles through four reservoirs operated by the Marin Municipal Water District. Kent Lake is the fourth reservoir along the mainstem of Lagunitas Creek. From Kent Lake, Lagunitas Creek flows about 14 miles before emptying into Tomales Bay. Nicasio Creek is a major tributary to Lagunitas Creek, which is regulated by Nicasio Reservoir about one mile upstream from its confluence with Lagunitas Creek. The Marin Municipal Water District also operates Nicasio Reservoir. Downstream of Kent Lake, there are four major tributaries with no dams: San Geronimo Creek, Devil=s Gulch, Cheda Creek, and Olema Creek. Other notable tributaries in the watershed include (listed in a downstream direction): Woodacre Creek, Bates Canyon, Creamery Gulch, Larsen Creek, Arroyo Road Creek, Irving Creek, Barnabe Creek, Deadman=s Gulch, McIsaac Creek, Fenceline Creek, Blueline Creek, and Quarry Gulch.

Lagunitas Creek and its major tributaries downstream of Kent Lake (including Nicasio Creek downstream of Nicasio Reservoir) support populations of coho salmon and steelhead trout. These populations are listed as Athreatened≅ species under the federal Endangered Species Act and are within the Central California Coast Evolutionarily Significant Unit (ESU). In addition, as of this writing, coho salmon are candidate species for listing under the state Endangered Species Act. California freshwater shrimp also occur in Lagunitas Creek and Olema Creek. These shrimp are listed as an Aendangered≅ species under the federal and state Endangered Species Acts. The populations of coho and freshwater shrimp in Lagunitas Creek have been recognized to be some of the most significant populations for these species in California. Other listed species that occur in the Lagunitas Creek watershed include California red-legged frog and northern spotted owl.

Streambed sedimentation is one of the main factors that have been identified as constraining habitat values for coho salmon and steelhead, which use Lagunitas Creek, and its tributary streams for spawning and rearing. Degraded streambed conditions have been attributed to the excessive load of fine sediments that enter the stream channel. The supply of fine sediments has been linked to erosion throughout the watershed. Unpaved roads have been identified as one of the most significant causes of erosion and a direct source of fine sediments. Unpaved roads can be both a chronic source of fine sediment, through continual gullying or erosion, and a source of large sediment loading through episodic failures of entire sections of roads.

Many of the unpaved roads in the Lagunitas Creek watershed are owned or maintained by the Marin Municipal Water District (MMWD), County of Marin (County), Marin County Open Space District (MCOSD), California State Parks Department (State Parks), and

National Park Service (NPS). These unpaved roads provide a variety of uses including: access to water supply and other publicly owned facilities, fire protection, emergency response access, and recreation. Some of the roads also provide access to Pacific Gas and Electric (PG&E) and Pacific Bell for maintenance of utility lines.

The remaining unpaved roads in the watershed are privately owned. The Marin County Resource Conservation District (MCRCD) has developed cooperative programs with some of these private landowners for the maintenance of their lands using Best Management Practices to reduce erosion and sedimentation.

The agencies mentioned here also own, maintain, or have programs for the maintenance of lands in portions of Marin County outside of the Lagunitas Creek watershed. Some of these other areas also support California freshwater shrimp, coho salmon, or steelhead trout.

Runoff from unpaved roads within the portion of the Lagunitas Creek watershed downstream of Kent Lake and Nicasio Reservoir drain into streams that provide habitat for coho salmon, steelhead trout, and freshwater shrimp. Runoff from unpaved roads that are within the portion of the watershed upstream of Kent Lake and Nicasio Reservoir drain into these reservoirs or reservoirs upstream of Kent Lake. The reservoirs at least partially trap sediment associated with water draining into them. Sediment that is trapped in these reservoirs may reduce the water storage capacity of the reservoir but does not directly effect sedimentation within in the creek, downstream of the reservoir.

II. GOALS AND OBJECTIVES

These guidelines are intended to provide useful information to manage and maintain all unpaved roads in the most beneficial ways possible; to minimize soil loss from unpaved roads, to reduce the potential for erosion; and reduce the amount of sediments entering Lagunitas Creek from unpaved roads. The guidelines are suggested techniques and practices to be implemented on a voluntary basis.

Recognizing that many unpaved roads in the watershed are important access roads that may be used year-round, it is also the goal of these guidelines to provide information for managing and maintaining actively used, unpaved roads in a condition that will allow for use of these roads for recreation and during emergency situations with minimal damage or wear that could increase erosion.

III. DEFINITIONS

<u>Abandoned Roads</u> - These include old logging roads and other old access roads that are no longer used and are not maintained.

<u>Active Road</u> - An unpaved road, currently subject to at least periodic vehicle use.

Closed Road - A road that is permanently closed to all use.

Emergency Access Road - An unpaved road identified by Marin County Fire Department as a primary road for fire protection and other emergency response.

Primary Resource Area - The portion of the Lagunitas Creek watershed that is downstream of Kent Lake and Nicasio Reservoir (note - this does include the San Geronimo and Olema Creek basins).

Seasonal Closure - Closing a road to certain uses each year during the wet season.

Secondary Resource Area - The portion of the Lagunitas Creek watershed that is upstream of Kent Lake and Nicasio Reservoir

Unneeded Roads - Existing, unpaved roads that do not support or provide access to infrastructure (i.e., pipelines, storage tanks, pump stations, utility lines, livestock watering troughs, etc.), do not provide access routes for emergency services (fire, medical aide, search and rescue), or are not essential access routes for management of public lands.

Unpaved Road - A road that does not have a paved surface and consists mostly of native soil material; some sections of these roads have had a rock base added. Unpaved roads are also commonly referred to as fire roads or forest and ranch roads.

IV. GEOGRAPHICAL EXTENT OF THE GUIDELINES

a. The focus of these guidelines is on unpaved roads within the portion of the Lagunitas Creek watershed that is downstream of Kent Lake and Nicasio Reservoir. This area is identified as the primary resource area, shown in Figure 1. This includes the watersheds of San Geronimo Creek, Devil=s Gulch, Cheda Creek, the Nicasio Creek watershed downstream of Nicasio Reservoir, Olema Creek, and all other smaller tributaries. The active, unpaved roads within this primary resource area are listed in Table A-1 and located in Figure 2.

b. These guidelines also extend to the Lagunitas Creek watershed upstream of Kent Lake and Nicasio Reservoir. This area is identified as the secondary resource area.

V. STANDARDS FOR ROAD MAINTENANCE AND MANAGEMENT

a. **Reference Manuals** - A number of good and practical manuals have been developed related to proper maintenance and management of unpaved roads. Five are particularly noteworthy and applicable to the Lagunitas Creek watershed. These manuals can be relied upon for road maintenance and management practices and are the source of many of the standards recommended in these guidelines:

FIGURE 1: PRIMARY AND SECONDARY RESOURCES AREAS FOR ROAD MAINTENANCE WITHIN THE LAGUNITAS CREEK WATERSHED.

FIGURE 2: MAP OF ACTIVE UNPAVED ROADS WITH THE PRIMARY RESOURCE AREA FOR ROAD MAINTENANCE OF THE LAGUNITAS CREEK WATERSHED.

TABLE A-1: Named and Active Unpaved Roads Within the Primary Resource Area, for road maintenance, of the Lagunitas Creek Watershed (listed from upstream to downstream).

ROAD NAME	OTHER NAMES	SUB-DRAINAGE
Whites Hill	Loma Alta	San Geronimo Creek
Dixon Fire-East	Dixon Ridge; Roys Redwoods	San Geronimo Creek
Moon Mountain	Moon Hill	San Geronimo Creek
French Ranch		San Geronimo Creek
Summit	Buckeye Circle, Summit	San Geronimo Creek
Conifer	Carson	San Geronimo Creek
Sylvestris	Armstrong, Hunt Camp	San Geronimo Creek
Tamarack	Manzanita.	San Geronimo Creek
San Geronimo Ridge	Pine Mountain Truck Trail Road	San Geronimo/Lagunitas Creek
Mt. Barnabe		San Geronimo/Lagunitas Creek
Shafter Grade		Lagunitas Creek
Bike Path	Old Railroad Grade	Lagunitas Creek
Sandy Beach		Lagunitas Creek
Devil=s Gulch		Devils Gulch
Indian Hill		Devils Gulch/Cheda Creek
Cheda Ranch	Cheda Ranch East & Cheda Ranch West	Cheda Creek
McIsaac Ranch	Back Ranch	Lagunitas Creek
Zanardi Ranch		Lagunitas Creek
Jewell Trail		Lagunitas Creek
Bolinas Ridge		Lagunitas/Olema Creek
Randall Trail		Olema Creek

i. ***Handbook for Forest and Ranch Roads: A Guide for planning, designing, constructing, and closing wildland roads***. 1994. Prepared by William E. Weaver and Danny Hagans, Pacific Watershed Associates; for The Mendocino County Resource Conservation District, in cooperation with the California Department of Forestry and Fire Protection and the U.S.D.A. Soil Conservation Service. June, 1994. Available from Mendocino County Resource Conservation District, Ukiah, Ca.

ii. ***Groundwork: A Handbook for Erosion Control in North Central California***. 1987. Marin County Resource Conservation District By Liza Prunuske. Available from Marin County Resource Conservation District, Point Reyes Station, Ca.

iii. ***A Guide for Road Closure and Obliteration in the Forest Service***. 1996. By Jeffry E. Moll, San Dimas Technology & Development Center, Technology & Development Program, U.S. Department of Agriculture, Forest Service. June, 1996, 7700 Engineering, 9677 1205, 4E41L03.

iv. ***Oregon Road/Stream Crossing Restoration Guide***. 1999. By E. George Robison, Albert Mirati, and Marganne Allen. Advanced Fish Passage Training Version, June, 1999. Oregon Department of Forestry. Available online, through the internet, at http://www.nwr.noaa.gov/1salmon/salmesa/4ddocs/orfishps.htm

v. ***Fish Passage Design at Road Culverts: A design manual for fish passage at road crossings***. 1999. Washington Department of Fish and Wildlife, Habitat and Lands Program, Environmental Engineering Division. Available online at http://www.wa.gov/wdfw/hab/engineer/cm/toc.htm.

b. **Maintenance Activities** - Regular maintenance activities are actions taken periodically to maintain existing unpaved roads in stable condition. Some of these activities can be performed routinely while others can be performed when necessary. Most of the work needed to maintain roads should be conducted during the dry season, when the likelihood of spring rain storms has past, when soil and water conditions allow for most types of work, and when there is still time to complete work prior to the onset of winter rains. Some winter maintenance activities are appropriate, efficient, and warranted.

Maintenance activities will vary for individual roads, depending upon the type and use associated with each road. These guidelines generally address unpaved roads that are used for vehicle access. However, some unpaved roads in the watershed are essentially trails that are used primarily for recreation and have very limited vehicle use. The frequency and level of maintenance performed on an individual road should be consistent with the goals of these guidelines but can be geared to the type and amount of use that road is designated for.

i. **Inspections** - Walking or driving inspections should be conducted on all active, unpaved roads to identify and inventory where maintenance or repairs are needed. Driving inspections in most kinds of 4-wheeled vehicles should only be conducted on roads that are dry so that driving over the road surface creates no rutting or other unstable conditions. Driving inspections using an all-terrain-vehicle (ATV) during the wet season may be appropriate, without causing damage.

Each landowner should develop a schedule for road inspections. At a minimum, agencies and private landowners should strive to conduct annual inspections on all active roads. They should be scheduled to allow enough time to plan for and implement annual maintenance and repairs. Inspections during or just after storm events can also provide very useful opportunities to observe drainage patterns on a road and identify specific locations where drainage improvement can be made.

ii. **Vegetation and Debris Clearing** - Trees, branches and other debris should be removed from road surfaces and drainage facilities (i.e., culverts, trash racks, side ditches, etc.) to maintain access on the roadbed and proper drainage. Live vegetation growing out to or over the roadbed may be cut back as is needed to maintain clearance for vehicles or other equipment. Emergency access roads require 10 feet of horizontal clearance and 12.5 feet vertical clearance. Vegetation clearance outside of or beyond the width of the roadway is not within the scope of these guidelines. Debris that is generated by vegetation clearing, and the equipment used to clear vegetation, should be handled to minimize the chance of transporting invasive seeds or infected vegetation (with a pathogen such as sudden oak death) to non-infected areas.

iii. **Winter Maintenance Actions** - Winter maintenance to perform minor work for culvert clearing, drainage ditch relief, and other drainage improvements can be an effective technique to prevent larger, more serve drainage and erosion problems from developing. This type of work is typically handwork.

iv. **Grading** - Road grading can be a significant contributor to erosion since it results in exposed soils that are susceptible to erosion during subsequent rain events. Each road should be assessed for the type and amount of grading that is applicable to the uses of that particular road. Assessments and maintenance can consider the most appropriate road surface standard, road prism slope, and surface drainage features. Graded surfaces should be smooth and compacted. When feasible, grading should be conducted on slightly damp soils. Graded surfaces that are too dry will not compact and can result in subsequent erosion and runoff of the uncompacted material. If insufficient soil moisture exists at the time of the grading, the soil can be moistened as needed to aid compaction. Soils that are graded should be handled in a manner to minimize the chance of transporting invasive seed or pathogens (in the soils) to non-infected areas.

<u>Road Surface Standards</u> - Road surfaces should be graded only when needed to maintain a stable running surface and to maintain the desired surface drainage. In some cases, such as some emergency access roads, the road surface may need to be maintained to native mineral soil and prevent grass and herbaceous vegetation, so that the road can serve as a effective fire break. Many other roads can be allowed to have some herbaceous vegetation growing on the road surface. In some circumstances, such as steep road segments and at stream crossings, the road surface

may need to be hardened with base rock or other appropriate materials, as warranted by the condition of the road surface.

Road Prism Slope - Outsloping is generally the preferred surface drainage design since it disperses and drains surface runoff across the outer edge of the road prism, preventing a concentration and diversion of runoff along a road. Properly constructed outsloped roads also tend to require less attention, for maintenance or repairs, since there are no drainage features to maintain. Roads should be graded to maintain outsloping wherever possible. Insloped and crowned roads collect and concentrate road runoff into an inboard ditch that can cause erosion, through gullying of the ditch, and often require more drainage features in the form of ditch-relief culverts. However, insloping is preferred in some circumstances. For example, outsloping may not be appropriate where the road surface is composed of fine, highly erodible soils, on well-used, steep curves where there is a real danger of a vehicle sliding off of the road, and where winter travel is required on these unpaved roads. Crowned roads may be preferred on some roads that are not cut into a hillside but run across the top of a ridge or through a flat area.

All unpaved roads in the Lagunitas Creek watershed should be outsloped where it is appropriate to do so. This may entail extensive work on roads that are currently insloped or crowned, in some cases requiring reconstruction of entire sections of a road, and generally requiring a greater level of effort and commitment of resources than occurs during routine road grading.

Surface Drainage Features - Waterbars, rolling dips, wet crossings, culverts, and drainage ditches should be maintained to facilitate surface drainage off of and away from unpaved roads. Waterbars may need to be rebuilt annually while rolling dips, wet crossings and culverts require less maintenance and should only be maintained as needed. Most drainage features should have riprap or other energy dissipator maintained at their downstream outlets. Waterbars and rolling dips should be placed at the proper spacing for the length and pitch of the road. Culverts should be maintained to keep their inlets clear from loose debris and sediment.

c. **Road Repairs** - Repairs are actions needed to replace road drainage facilities such as regrading, replacing old culverts, stabilizing roadside erosion sites, rebuilding or relocating chronically unstable road sections, or other actions that are not part of the regular maintenance program. Road repair designs should incorporate the concepts of designing for failure and disconnecting roads from streams. This entails designing and constructing drainage features that minimize damage that can be caused by failures of culverts and stream crossings. Also, should a failure occur along a roadway, such as a washout or landslide, the resulting sediment will be more likely to run onto a hillside slope and not directly into a stream channel. Overflow swales, across a road surface, at stream crossings, is another example of how to disconnect a road from a stream. If stream flows get so high that they over top the culvert, the overflow swale can keep the water in the stream course and prevent the overflow from running along the roadway and eroding the road surface.

i. **Regrading Road Prism** - Converting an insloped or crowned road prism to an outsloped road may fall into the category of a road repair.

ii. **Repairing Culverts/Stream Crossings** - Improperly installed culverts can be a chronic source of erosion and require continual maintenance. Improperly installed or degraded culverts can also sometimes impair fish passage.

The preferred repair options for a culvert will depend upon its location, be it a coho/steelhead bearing stream, a non-fish-bearing stream, or a roadside-ditch-relief culvert. When culverts are to be replaced, the preferred approach may not be to replace it with another culvert but with a bridge, ford, wet crossing, or other structure.

<u>Coho/Steelhead Bearing Stream Crossings</u> - The repair in these circumstances should be to remove the old culvert and fill, restore the natural stream channel, and construct a bridge over the stream.

<u>Non-Coho/Steelhead Bearing Stream or Drainage Crossings</u> - The preferred repairs, in order of priority, are to: 1) restore the natural channel and construct a bridge over the stream/drainage; 2) replace the culvert with a ford or wet crossing; 3) replace the culvert with a plate arch or pipe arch (i.e., bottomless or oval) culvert; 4) replace the culvert with a round, double-lined, smooth bore plastic culvert; or 5) replace the culvert with a round, corrugated metal pipe (CMP) culvert.

<u>Roadside Drainage Ditch Relief Culverts</u> - The preferred repairs, in order of priority, are to: 1) out slope the road so that culverts are unnecessary; 2) replace the culvert with a wet crossing or rolling dip; 3) replace the culvert with a round, double-lined, smooth bore plastic culvert; or 4) replace the culvert with a round CMP culvert.

When culverts are replaced with new culverts, provisions can be made to safely convey the water under the road and provide adequate stabilizing features. Culverts placed in a natural channel should be placed at the same grade as the channel bed. They should be sized large enough to meet flood-stage requirements, not just normal storm flows, after taking into account site-specific water velocity considerations. Designing culverts to pass the 100-year flood discharge is recommended, to accommodate passage of water and at least the smaller associated debris. The inlet should be placed on or slightly below, but not above, the waterway. The outlet should be placed and protected in a way to not erode any side-cast material in the road prism. Riprap or other energy dissipators can be placed below outlets.

iii. **Stabilizing Erosion Sites** - Road related erosion sites can be repaired depending on the severity of the erosion problem. An engineer, registered forester, geologist, or other suitably qualified person, knowledgeable in the appropriate techniques for erosion control and soil stabilization should develop the repairs. Biotechnical techniques should be employed wherever possible. Native plants species and seed mixes should be used for any revegetation prescribed in the repair, to the greatest extent practicable.

iv. **Relocating Road Sections of Chronic Sedimentation** - Some sections of unpaved roads, in the Lagunitas Creek watershed, have been constructed across unstable slopes or across seeps and other types of wetlands. Equipment and recreational use of these sections perpetuates frequent and severe slipping and rutting, causing the soils to erode during rainstorms. Either by design, from long term use, or from erosion, some road sections are entrenched, where the land slopes up on both sides of the road. Entrenched roads provide no drainage relief from the road surface. Runoff is funneled onto the road surface and increases the potential for erosion. These sections can be a chronic source of sediment and require more frequent and extensive maintenance. In these circumstances, the best long-term approach for maintenance and repair may be to relocate the road to more stable areas. Relocations should include closing the abandoned section (see part VI.b., below). Another solution may be to pave or otherwise harden the road surface, as long as the runoff from these hardened sections is adequately dissipated where it flows off the road.

d. **Managing Road Usage** - Not all unpaved roads are designed or maintained for year-round use. Unpaved roads are most susceptible to erosion during the wet season. During this sensitive period, it may be most appropriate to manage some unpaved roads according to the following seasonal usage conditions.

i. **Seasonal Closures to Vehicles** - All unpaved roads on public lands should be closed to vehicles and heavy equipment during the wet season, except for all-terrain-vehicles (ATVs), or as may be necessary during emergency circumstances.

ii. **Seasonal Closures to Recreational Use** - Each public agency owning land in the Lagunitas Creek Watershed should identify any unpaved roads, which warrant being closed to bicycle and equestrian use during the wet season. Seasonal closures may be warranted on roads that have not been upgraded or maintained, and on sections of roads that run through wetlands or are otherwise particularly wet during the winter and early spring. All unpaved roads on public lands can remain open to foot traffic all year long, except in the unusual case of a road that may need to be closed to all use because of risk to public safety (such as from a significant landslide, rock slide, or other threat).

VI. LONG-TERM MANAGEMENT ACTIONS

a. **Construction of New Roads** - Currently, no new unpaved roads are being considered for construction on any of the publicly owned lands in the Lagunitas Creek watershed. However, the need for a new road on public land may arise. New roads on private land may also be constructed in the future. In addition, any road relocation projects that are implemented may be equivalent to constructing a new road, depending upon its length and location.

Any new road construction should follow the standards prescribed in these guidelines and reference manuals recommended. New roads should be designed to the highest standards. The designers should consider and plan for elements of: location, road prism, road surface, stream crossings, drainage features, and landing layouts. Construction should plan for the appropriate types of equipment to be used, the sequencing and time of year for each phase of construction (i.e., clearing, grubbing, grading, compaction), locations and use of staging areas, stockpiling or removal of soils, erosion control measures to be implemented during construction, regular inspections and repairs to erosion control features as needed, and requirements for any special construction techniques.

b. **Closure and Removal or Conversion of Unneeded and Abandoned Roads** - Some of the existing unpaved roads in the Lagunitas Creek watershed are no longer needed for vehicular access or have been abandoned altogether. These roads, particularly the abandoned roads, pose a potential for failure with significant soil loss (mass wasting). Failures can occur at unmaintained stream crossings where fill and culverts have been placed and where debris is clogging the culvert. Failures or chronic erosion can also occur at other unmaintained drainage features. The long-term management strategy for these roads should be to close and remove them or to convert them to trails. Essentially, if an unpaved road is not needed, it should not be kept as a road.

i. **Identification and Treatment of Unneeded and Abandoned Roads** - The agencies that own or manage unpaved roads within the Lagunitas Creek watershed should identify all unneeded and abandoned roads within their influence. Once the unneeded and abandoned roads are identified, each road should be identified for closure and removal or for conversion to a trail. The agencies should coordinate this effort, collectively, as needed to accomplish the task.

ii. **Schedule of Closures/Conversions** - Unneeded and abandoned roads within the primary resource area (see Figure 1) should be given higher priority for closure/removal or conversion than roads in the secondary resource area or in other parts of the County.

iii. **Standards for Closing Roads** - Unneeded and abandoned unpaved roads should be closed and removed following the guidelines specified in Chapter IX of *Handbook for Forest and Ranch Roads: A Guide for planning, designing, constructing, and closing wildland roads* and in *A Guide for Road Closure and Obliteration in the Forest Service* (see Section Va above). These guidelines indicate that not every foot of a road necessarily has to be removed but to treat road segments that have potential to generate erosion and yield sediment. Elements of road closure generally include: removing all stream crossings (culvert and fill); regrading to natural contours; blocking the end of the road; treating unstable areas; creating proper runoff; implementing erosion control measures; implementing a revegetation program; and post-closure monitoring.

iii. **Conversion of Roads to Trails** - Some roads are unneeded but still provide access for recreational use. In these circumstances, the road can be converted to a trail. Many of the same guidelines for road closure should be implemented on these roads except that at least a single track would be retained. These roads should be converted to the type of trail needed for the desired use (equestrian, bicycle, and/or hiking use).

VII. EMERGENCY SITUATIONS

Certain emergency situations will arise during which it may not be possible to follow the standards described in these guidelines. Such emergency situations are unplanned activities that may include: fire response, medical aid calls, search and rescue operations, and emergency repair of infrastructure or other facilities (including facilities on private property). Situations that should not be considered emergencies would include such circumstances as: repair of infrastructure or other facilities that have been progressively deteriorating over time; routine maintenance activities; or any planned activity.

Figure 1. Resource Areas for Dirt Road Maintenance in the Lagunitas Creek Watershed

APPENDIX D

Memorandum of Understanding (MOU) for Woody Debris Management in the Lagunitas Creek Watershed 2007

MEMORANDUM OF UNDERSTANDING

Among the
MARIN MUNICIPAL WATER DISTRICT,
COUNTY OF MARIN,
MARIN COUNTY OPEN SPACE DISTRICT,
CALIFORNIA DEPARTMENT OF PARKS AND RECREATION,
NATIONAL PARK SERVICE, and
MARIN COUNTY RESOURCE CONSERVATION DISTRICT
For
WOODY DEBRIS MANAGEMENT
In RIPARIAN AREAS of the LAGUNITAS CREEK WATERSHED

Final: February 1, 2007

This Memorandum of Understanding, dated February 1, 2007, is by and between the Marin Municipal Water District (MMWD); the County of Marin (County), acting through the Marin County Board of Supervisors (Supervisors); the Marin County Open Space District; the California Department of Parks and Recreation (State Parks); the National Park Service (NPS); and the Marin County Resource Conservation District (MCRCD).

RECITALS

WHEREAS, the parties to this Memorandum of Understanding (hereafter "Agreement") own, manage, or have an interest in the management of lands and waters within the 103-square mile Lagunitas Creek watershed, the largest watershed in Marin County; and

WHEREAS, the Lagunitas Creek watershed supports populations of threatened and endangered species listed under the federal and state Endangered Species Acts, including coho salmon, steelhead trout, California freshwater shrimp, and California red-legged frog; and

WHEREAS, the construction of roads, trails, structures and dams (including Peters Dam) and past practices of tree removal from the creek and its riparian areas, have reduced the amount of naturally occurring woody debris in Lagunitas Creek; and

WHEREAS, trees in the vicinity of creeks will, over time, be delivered to the stream channel under natural conditions; and

WHEREAS, the riparian forest provides shade and stream temperature control, increases streambank stability, provides opportunities for overhanging banks and cavities, enhances food production, and improves habitat complexity; and

WHEREAS, the riparian forest is the source of natural woody debris in the system for recruitment of woody debris into the stream channel; and

WHEREAS, woody debris creates and maintains beneficial instream habitat for coho and steelhead by increasing pools, providing cover and refuge, providing foraging sites, and providing flow diversity by varying water velocity and depth; and

WHEREAS, riparian vegetation and woody debris create and maintain beneficial instream habitat for California freshwater shrimp by extending roots into the water column which shrimp attach to and feed from and by creating deep water habitat along the shoreline which shrimp require; and

WHEREAS, all parties to this Agreement recognize that proper management of woody debris in riparian areas under their ownership, jurisdiction, or influence within the Lagunitas Creek watershed can enhance habitat for coho salmon, steelhead trout, and California freshwater shrimp; and

WHEREAS, it is the goal of all parties to this Agreement to enhance coho salmon, steelhead trout and California freshwater shrimp habitat within the Lagunitas Creek watershed, specifically focusing on salmon bearing streams, by supporting the self-sustaining natural recruitment of woody debris; and

WHEREAS, it is the intent of all parties to this Agreement to encourage a cooperative relationship among the parties to implement a consistent approach to the management of woody debris in riparian areas of the salmon bearing streams in the Lagunitas Creek watershed; and

WHEREAS, all parties to this Agreement acknowledge that implementation of this Agreement and its associated Best Management Practices should be supported and funded wherever possible as resources permit.

AGREEMENT

NOW, THEREFORE, the parties to this Agreement agree to:

1. Come to an understanding of the guidelines regarding the management and prioritization of naturally occurring woody debris and potential woody debris (i.e. standing trees), in riparian areas, <u>for stream habitat enhancement,</u> as outlined in the *Best Management Practices for Woody Debris in Riparian Areas of Salmon Bearing Streams in the Lagunitas Creek Watershed*.

2. Protect the natural source areas for future wood recruitment within riparian areas and, as resources permit, identify and undertake riparian reforestation projects needed to enhance habitat complexity.

3. Incorporate bioengineering techniques, such as the use of large woody debris and willow brush mattresses, into streambank stabilization structures in order to further promote the presence of wood in the channel and encourage a forested bank as a source of future recruitment.

4. Identify specific large and/or long-term woody debris enhancement projects on each agency's stretch of the creek that cannot be funded within each agency's annual budget.

5. Meet, at least annually, with all other agency project managers responsible for this woody debris MOU, as convened by MMWD, to develop strategies, and identify funding mechanisms, to accomplish specific large and/or long-term woody debris enhancement projects by means of phasing, sharing staff or equipment, and cooperative grant-seeking; for problem solving, idea sharing and potential project coordination to support natural woody debris recruitment through minimal intervention and natural riparian forest regeneration; to review existing, or consider new habitat complexity enhancement techniques; and to discuss other matters pertinent to fulfilling the goals of this Agreement. MMWD will provide a summary of this meeting to the Lagunitas Technical Advisory Committee that will include a compilation of any monitoring reports from or communication with the signatory agencies.

6. Meet, at least annually, among each agency's own maintenance staff responsible for woody debris management, as convened by each agency, for training, problem solving, and idea sharing to support natural woody debris recruitment through minimal intervention and natural riparian forest regeneration; to review existing, or consider new habitat complexity enhancement techniques; to review any monitoring reports; and discuss other matters pertinent to fulfilling the goals of this Agreement.

7. Support the transport by MMWD of large woody debris from above Peters Dam to Lagunitas Creek downstream of the dam in an effort to mitigate the effects of the dam on natural woody debris recruitment.

8. Support making woody debris available to other parties for use in biotechnical and other stream habitat enhancement projects within the Lagunitas Creek watershed.

9. Provide the other parties to this Agreement with on-going information relevant to woody debris management in riparian areas of the Lagunitas Creek watershed. This may include maps and data about individual sites, and training or other educational information.

10. Act consistently with this Agreement when developing policies, plans, or projects; when exercising regulatory authority or conducting environmental review; or when otherwise conducting work related to woody debris in the Lagunitas Creek watershed; and encourage others to do so.

11. Implement the actions in this Agreement in compliance with all applicable federal, state, and local environmental laws and regulations.

12. Acknowledge the fact that nothing in this Agreement negates any laws, regulations, or policies; including previous agreements related to woody debris management.

13. Recognize that the terms of this Agreement are subject to the availability of funding, personnel and other essential resources, and that each party has the sole authority and responsibility regarding decisions and matters in its own jurisdiction.

This Agreement has no termination date and may be revised as necessary. Each party to this Agreement may withdraw from this Agreement upon written notice to all other parties.

The parties agree that this Agreement does not constitute any legal admission or opinion as to the subject matter, nor does it confer any additional legal rights, liabilities or obligations between the parties or to third parties that do not already exist in law.

Marin Municipal Water District

President, Board of Directors
Attest: Stephanie Cushing-Frost

County of Marin

Charles McGlashan, President Pro-Tem
Attest: Diane Patterson

California Department of Parks and Recreation

Superintendent, Marin District Parks
Attest: Darlene Neal

National Park Service

Superintendent, Point Reyes NS
Attest:

Marin County Resource Conservation District

Hank Corda
President, Board of Directors
Attest:

Marin County Open Space District

Charles McGlashan, President Pro-Tem
Attest: Sharon McNamee

Best Management Practices for Woody Debris in Riparian Areas of Salmon Bearing Streams of the Lagunitas Creek Watershed
Final: February 1, 2007

The natural recruitment of woody debris into a creek is a long-term and self-sustaining process which supports habitat diversity and species abundance. The best way to promote this process is to allow nature to take its course with minimal disturbance. That being stated, it is acknowledged that the lands of the Lagunitas Creek watershed serve purposes beyond the preservation of nature, including, but not limited to, residences, watershed protection and management for water supply, recreation, transportation, and agriculture.

The following best management practices are understood and agreed on by all parties to be used as guidelines for the development of a self-sustaining system for the natural recruitment and treatment of woody debris in coho bearing streams of the Lagunitas Creek watershed. For further information, please call one of the Marin Municipal Water District resource professionals listed in Appendix C.

PRIORITIZATION

<u>The highest priority use for woody debris and potential woody debris (standing trees) in the riparian corridor is for stream habitat enhancement.</u>

DEFINITIONS

Downed Wood - Any fallen tree or woody pieces of any size in one of the three Zones described below (includes Large Woody Debris, Small Woody Debris and Debris Jams).

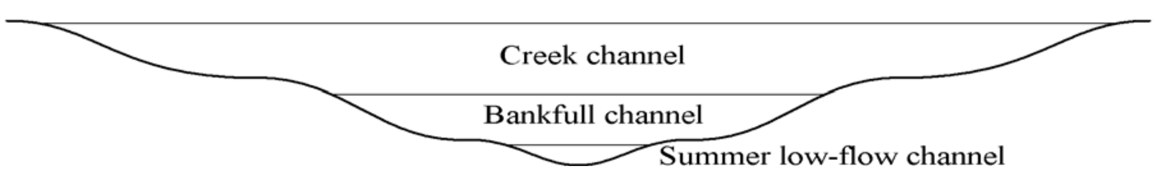
Large Woody Debris - downed wood in one of the three Zones described below that is:

a) greater than 12 inches in diameter, at any point, and at least ten feet long including rootball, if attached; <u>or</u>
b) of any size when attached to a rootball or stump greater than three feet in diameter.

Standing Trees - Live or dead trees in one of the three Zones described below (i.e. potential large woody debris).

ZONES

Creek Channel Zone - The area between the left and right banks of a creek including the wet channel, gravel bars, and vegetated islands. In many cases this is larger than what is traditionally known as the "bankfull" channel (see drawing).



Recruitment Zone – the area on either side of the creek channel which includes the floodplain (the area adjacent to the creek channel that could be inundated by high stream flows of any magnitude and transport woody debris into the creek) <u>and</u> extends 200 feet upslope beyond the floodplain. (See Appendix A for a general guide to the area in question.)

Kent Lake Zone –the area around Kent Lake where large woody debris can be collected for use as stream habitat enhancement.

BEST MANAGEMENT PRACTICES

The treatment of “Standing Trees,” “Downed Wood” and “Large Woody Debris” is here divided into four categories:

1) Standing Trees in the Recruitment Zone,

2) Downed Wood in the Recruitment Zone,

3) Wood in the Creek Channel, and

4) Wood in the Kent Lake Zone.

STANDING TREES IN THE RECRUITMENT ZONE:

Standing trees greater than six (6) inches diameter at breast height (DBH) for conifers and twelve (12) inches DBH for non-conifers, and within the recruitment zone as defined above, and including the uphill sides of roads and trails, should not be felled.

However, a standing tree of this size and in this zone may occasionally cause concern for safety because it is diseased or old. If so, a registered professional forester or similarly accredited professional should determine in writing that the tree poses an imminent threat to public safety and recommend a course of action. If such a tree must be cut, and is downhill from a road or trail, every effort should be made to fell it toward the creek and leave it as intact as possible. If such a tree is on the uphill side of a road or trail, it should be placed as intact as possible at a safe and accessible site until its usefulness as stream enhancement can be determined; if it is determined that the tree is not useful for this purpose, it shall be moved to the downslope side of the road/trail and released in a safe manner. If none of the above is possible, see “Unusual Situations and Emergencies.”

DOWNED WOOD IN THE RECRUITMENT ZONE

Downed wood, within the recruitment zone, should not be cut or moved.

However, downed wood in this zone may occasionally block access to a road or trail. If so, a step by step process to determine the best course of action should be followed:

1) Treat wood that is lying partly in the creek channel as ‘Wood in the Creek Channel’ which is discussed in the next section, or
2) Move wood, intact, out of the way and towards the creek, or
3) Cut the minimal number of branches to clear the obstruction, or
4) For trails, reroute the path around the wood, or
5) For trails, cut steps into the wood or construct steps over the wood to provide access.

If none of the above is a possible way forward, then see “Unusual Situations and Emergencies.”

WOOD IN THE CREEK CHANNEL

Any and all wood in the creek channel (standing trees, downed wood, large woody debris, small woody debris and debris jams) should not be cut or moved.

However, a piece of wood or a debris jam in the creek channel may occasionally cause concern for public facilities by way of threatening bank stability, public safety or obstruction of roads or trails. If so, see "Unusual Situations and Emergencies." Moving or removing such wood may require consultation with, or a permit from, the US Army Corps of Engineers, the SF Bay Regional Water Quality Control Board, and/or a Lake or Streambed Alteration Agreement from the California Department of Fish and Game.

WOOD IN THE KENT LAKE ZONE

Any and all wood in the Kent Lake Zone should be assessed for its potential as large woody debris, which should be prioritized for stream habitat enhancement using above guidelines modified to facilitate transport.

UNUSUAL SITUATIONS AND EMERGENCIES

Any discrepancy between the Woody Debris MOU, including these Best Management Practices, and an agency's preferred plan of action should be resolved through the following steps:

1) Identify the problem and its urgency;
2) If the problem is an immediate emergency or professional consultation is unavailable (see #3) before the problem is likely to become an immediate emergency, then follow the Fish4C guidelines (Appendix B); if otherwise, then
3) Call for a team of appropriately qualified professionals (Appendix C), consisting of a minimum of at least one individual from each of at least two signatory or resource agencies to make a recommendation.
4) Clarify the plan of action.
5) Document the problem, consultation (if any) and course of action taken.
6) Contact the MMWD Fisheries Department at (415) 945-1193 and provide the following information: the size and type of log relocated, presence of a rootball, and final location of log.

FURTHER READING

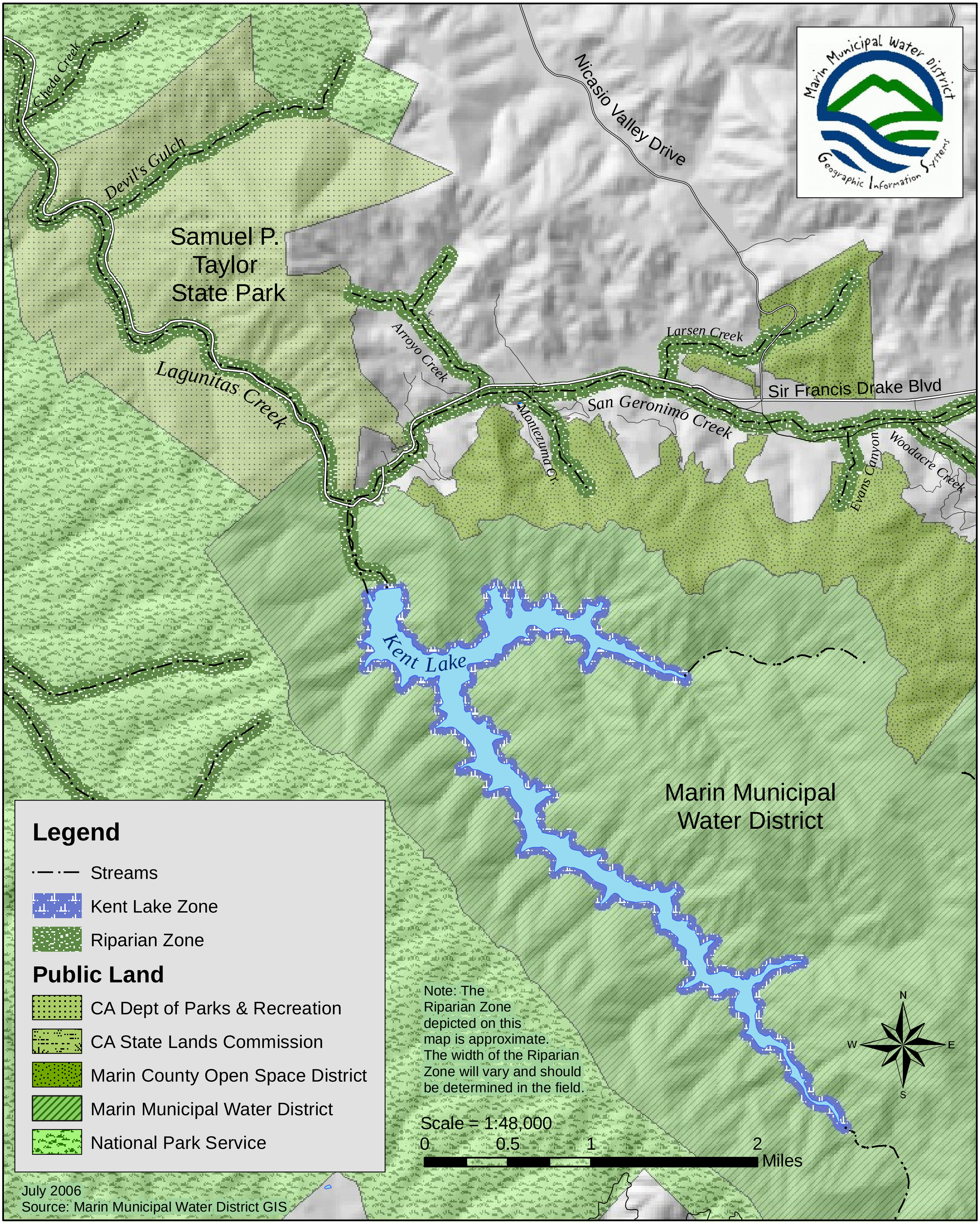
The Ecology and Management of Wood in World Rivers, eds. Gregory, Boyer and Gurnell. This book is a collection of papers on the importance, function and management of wood in rivers and the riparian corridor. MMWD Fisheries Department has a copy of this book.

Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (Dec 2004). FishNet4C. This document has a section on woody debris with accompanying best management practices for creeks alongside roads. It can be downloaded at:
http://www.fishnet4c.org/projects_roads_manual.html

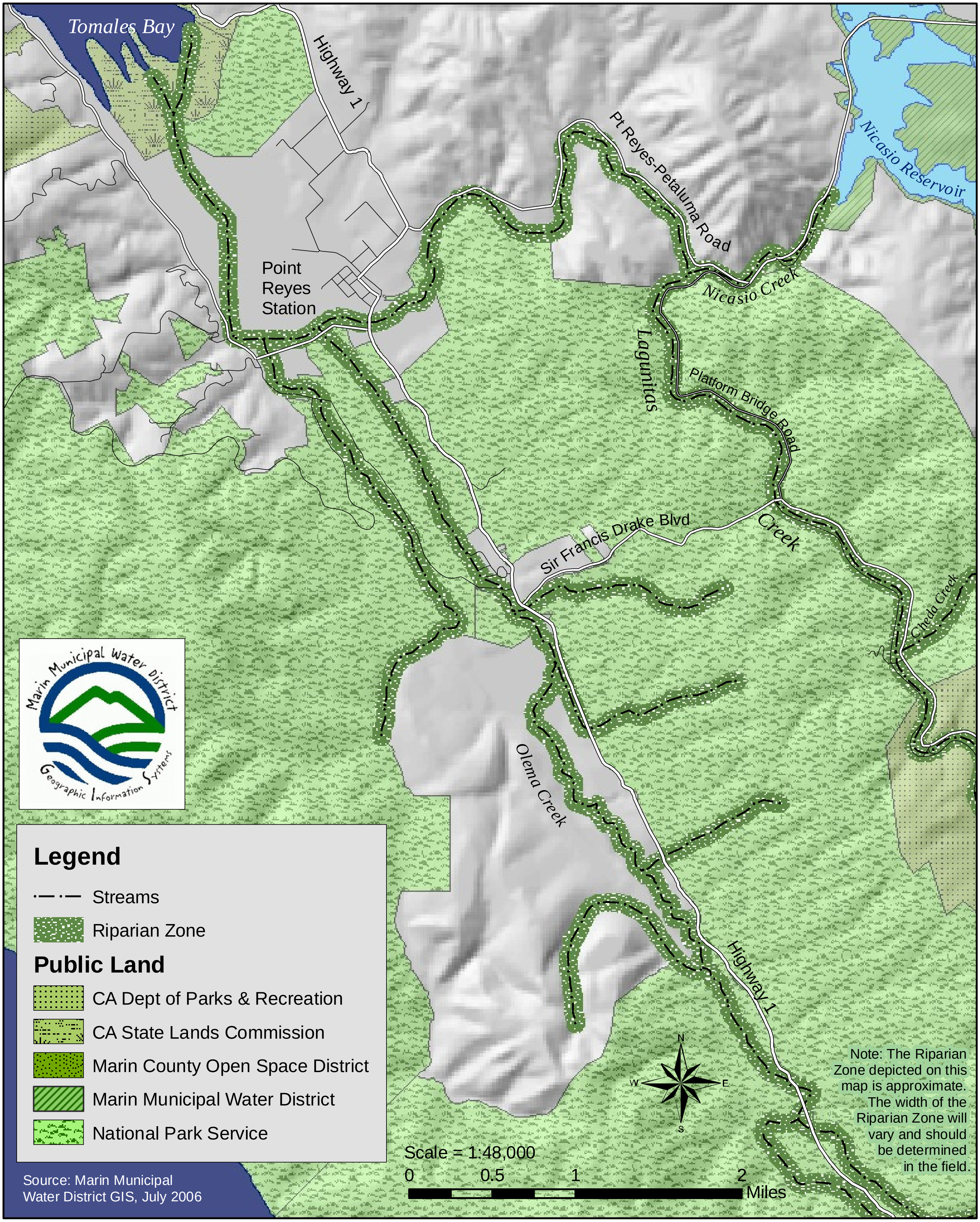
ATTACHMENT A

Maps of the Lagunitas Creek Watershed

Kent Lake Zone and Riparian Zone of Coho Bearing Streams
- Lagunitas Creek Woody Debris MOU -



Riparian Zone of Coho Bearing Streams
- Lagunitas Creek Woody Debris MOU -



ATTACHMENT B

FishNet4C Guidelines for Managing Woody Debris

6.3 WOODY DEBRIS

DESCRIPTION

A healthy salmon stream is chock full of large wood- big logs and rootwads, that dig into the banks and help form the channel's complexity.- making pools and providing food and shelter. Wood is a key link in the ecosystem of salmon. Restorationists and public agencies have taken on the task of placing large woody debris structures into creeks to benefit salmon. While restoration certainly helps***, our goal in this section is to provide guidelines on how to keep wood in the creek in the first place.***

Large Woody Debris (LWD), is defined as stumps, rootwads and logs having an average diameter greater than 6 inches and a length greater than 10 feet. When we refer to woody debris management it is best to think about ***modification***, rather than removal, whenever feasible. Removal of wood from creeks has such a negative impact on salmon, that as a general practice, it should not be done unless there is a very real threat to county property or public safety. Best Management practices outlined below will help guide crews in avoiding or minimizing this impact.

One of the very best ways to allow wood to stay in the creek is to maintain culverts and bridges that pass the 100-year flood flows. This ensures that large debris flows will also pass, creating more natural channel conditions overall. See *6.2 Culvert Cleaning, Repair and Replacement*.

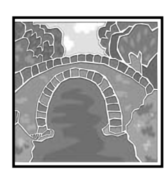
Note*:* The maintenance practices covered in this section *do not* include traditional channel maintenance or flood control activities. For information on flood control or channel maintenance BMPs, please refer to <u>Flood Control Facility Maintenance Manual</u> developed by the Bay Area Stormwater Management Agencies Association (BASMAA, June 2000).

ENVIRONMENTAL CONCERNS

- ✓ Loss of instream habitat due to wood removal.
- ✓ Harm to instream aquatic habitat or aquatic species.
- ✓ Harm to riparian areas and riparian species.
- ✓ Alteration of natural channel function or shape or destabilization of stream banks.
- ✓ Water pollution from equipment operation.
- ✓ Alteration of stream hydraulics and diversion of stream energies that may cause downstream erosion or structural damage.

BMP OBJECTIVES

- ✓ Preserve and protect important woody debris in creeks to the extent possible.
- ✓ Prevent potential water pollution from equipment operations.



BEST MANAGEMENT PRACTICES

1) Only remove (as opposed to modify) logs and debris from streams as a “last resort” when accumulation of debris poses a threat to road stability and bridges, culverts or other instream structures.

2) Have both a biologist and an engineer conduct a full review of the situation. The biologist should be familiar with the life histories and habitat needs of federally listed plants and animals in the area and be able to identify any of the life stages of these species. If in doubt as to the best way to handle large woody debris in a stream, consult with DFG personnel.

3) If log jams immediately threaten, or are damaging the integrity of roads, bridges, other public facilities during high flows, consider opportunities to ***modify*** the debris jam to halt damage and direct flow toward a more desirable path.

4) Take precautions to ensure that modifications of logs or debris jams will not cause damage downstream to culverts and other structures.

5) Limit modifications and/or removal to materials that extend higher than approximately two feet above the streambed (i.e. above knee height) to preserve some instream habitat features, *unless* the log or debris jam is immediately upstream and threatening a culvert or bridge, or if permit conditions require otherwise.

6) When modifying log jams, leave trees, logs and/or stumps in the longest lengths and diameters practicable for removal and hauling. If logs must be cut from fallen trees, leave as much as possible of the main trunk (12 feet plus is desirable) attached to the rootball and only cut branches obstructing flow. Log jams create suitable habitat for California red-legged frogs and San Francisco garter snakes and so where applicable this should be considered before removing or modifying any logjams.

7) Whenever feasible, incorporate LWD removed from water bodies into streambank repairs or cribbing at a nearby location, and/or transport any removed LWD to an approved storage site and make available for later use (e.g. in stream restoration activities).

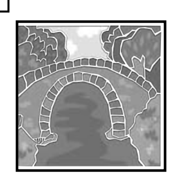
BMP TOOLBOX

Planning and Prevention BMPs

- ✓ Seasonal Planning

PERMITS

6.3 WOODY DEBRIS	
Activity or Condition	**Required permit or limitation**
Removing or modifying large woody debris	Consult with DFG biologists



ATTACHMENT C

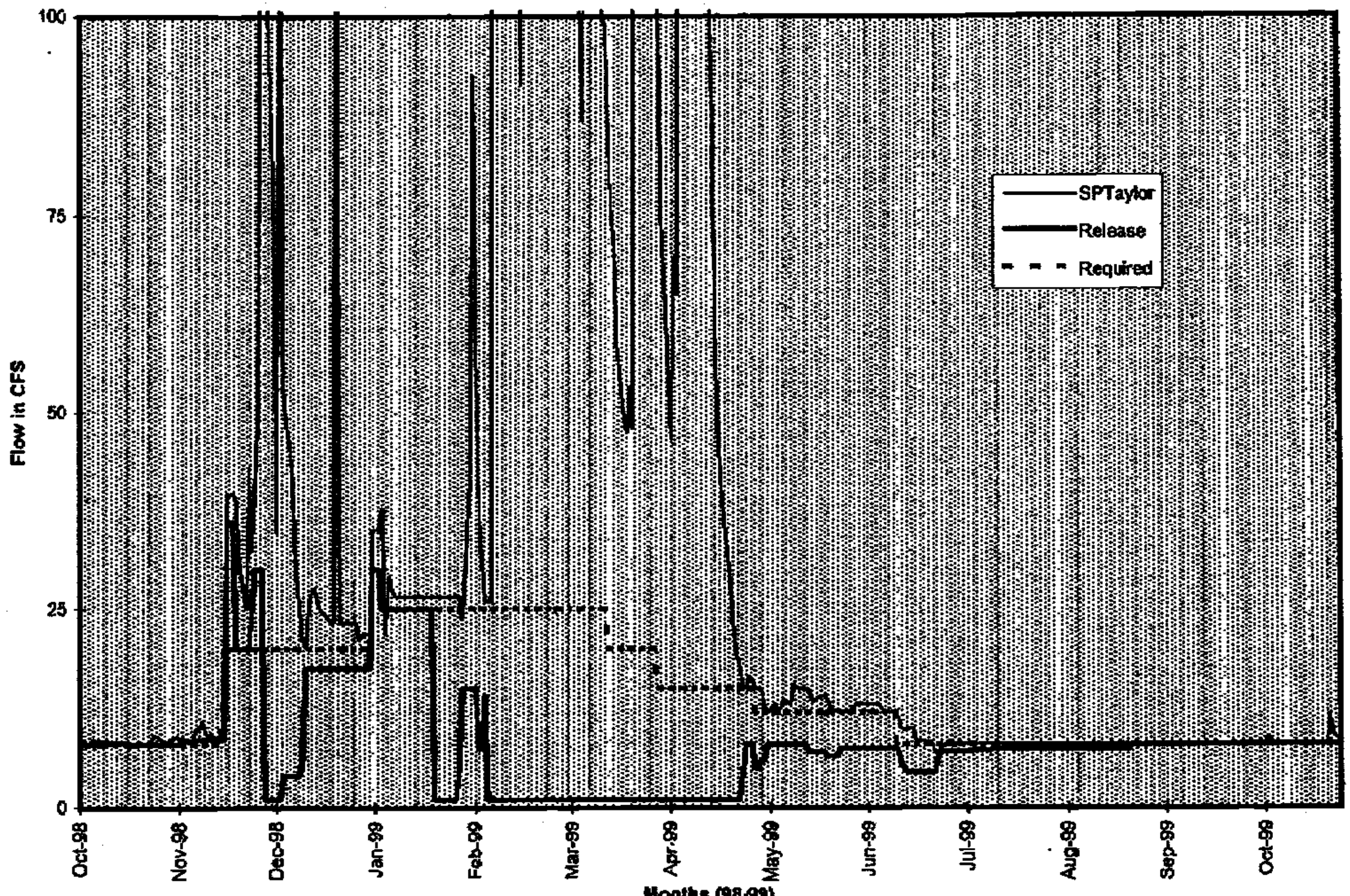
Professional Resource Contacts

Marin Municipal Water District	
Eric Ettlinger, Aquatic Ecologist	(415) 945-1193
Gregory Andrew, Fishery Program Manager	(415) 945-1191
Michael Swezy, Resource Specialist	(415) 945-1190
County of Marin	
Liz Lewis, Stormwater Program Administrator	(415) 499-7226
Kallie Kull, Senior Planner	(415) 499-6532
California Department of Parks and Recreation	
Dave Boyd, State Park Resource Ecologist	(707) 769-5665 x223
National Park Service	
Brannon Ketcham, Hydrologist	(415) 464-5192
San Francisco Bay Regional Water Quality Control Board	
Leslie Ferguson, Civil Engineer	(510) 622-2344
California Department of Fish and Game	
Bill Cox, Fisheries Biologist	(707) 823-1001

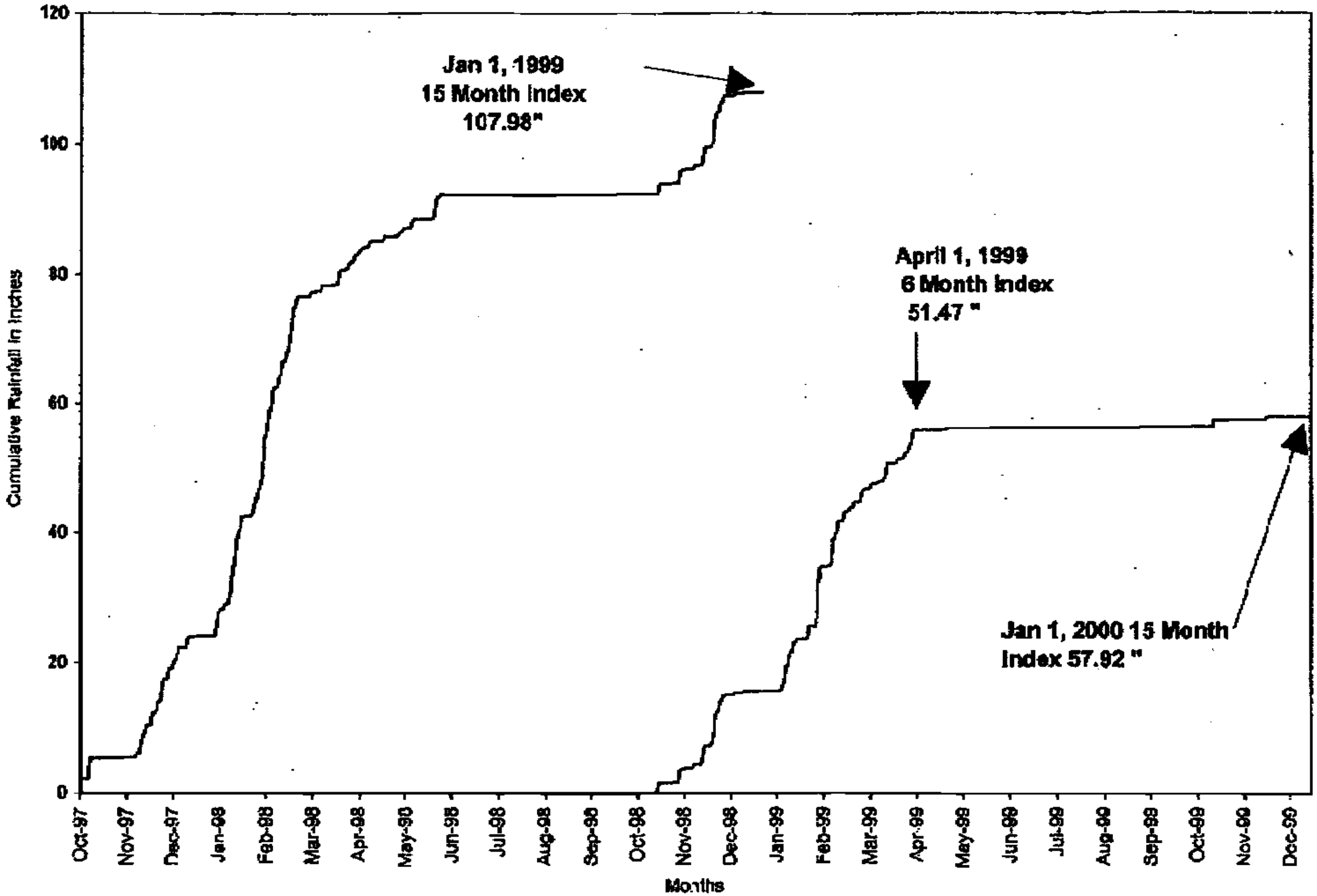
APPENDIX E

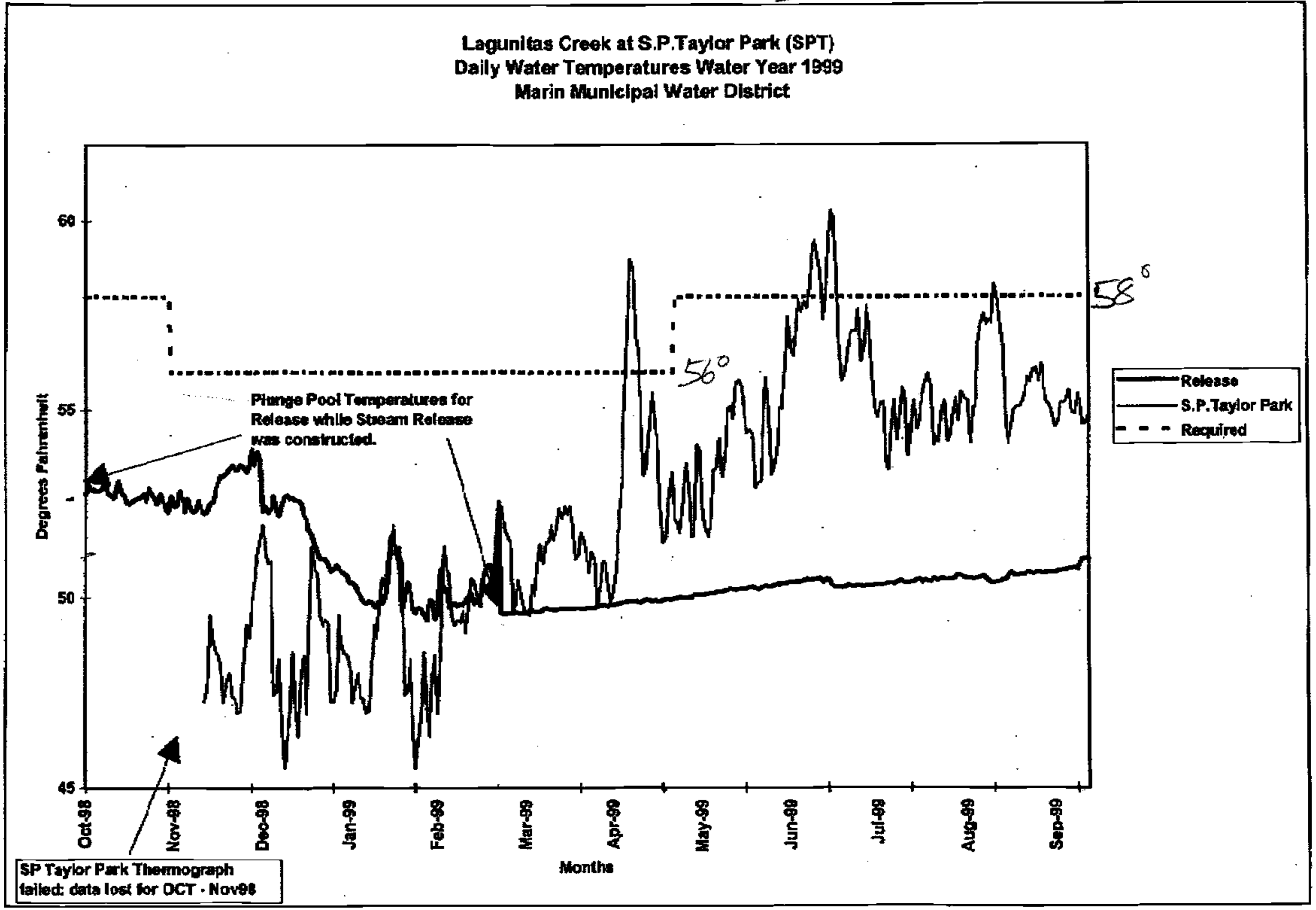
Stream Flow, Water Year Classification, and Water Temperature Summary Graphs, in Compliance with SWRCB Order WR95-17 Water Years 1999 – 2009

Lagunitas Creek at S.P. Taylor Park
Flow Requirements Water Year 1999
Marin Municipal Water District

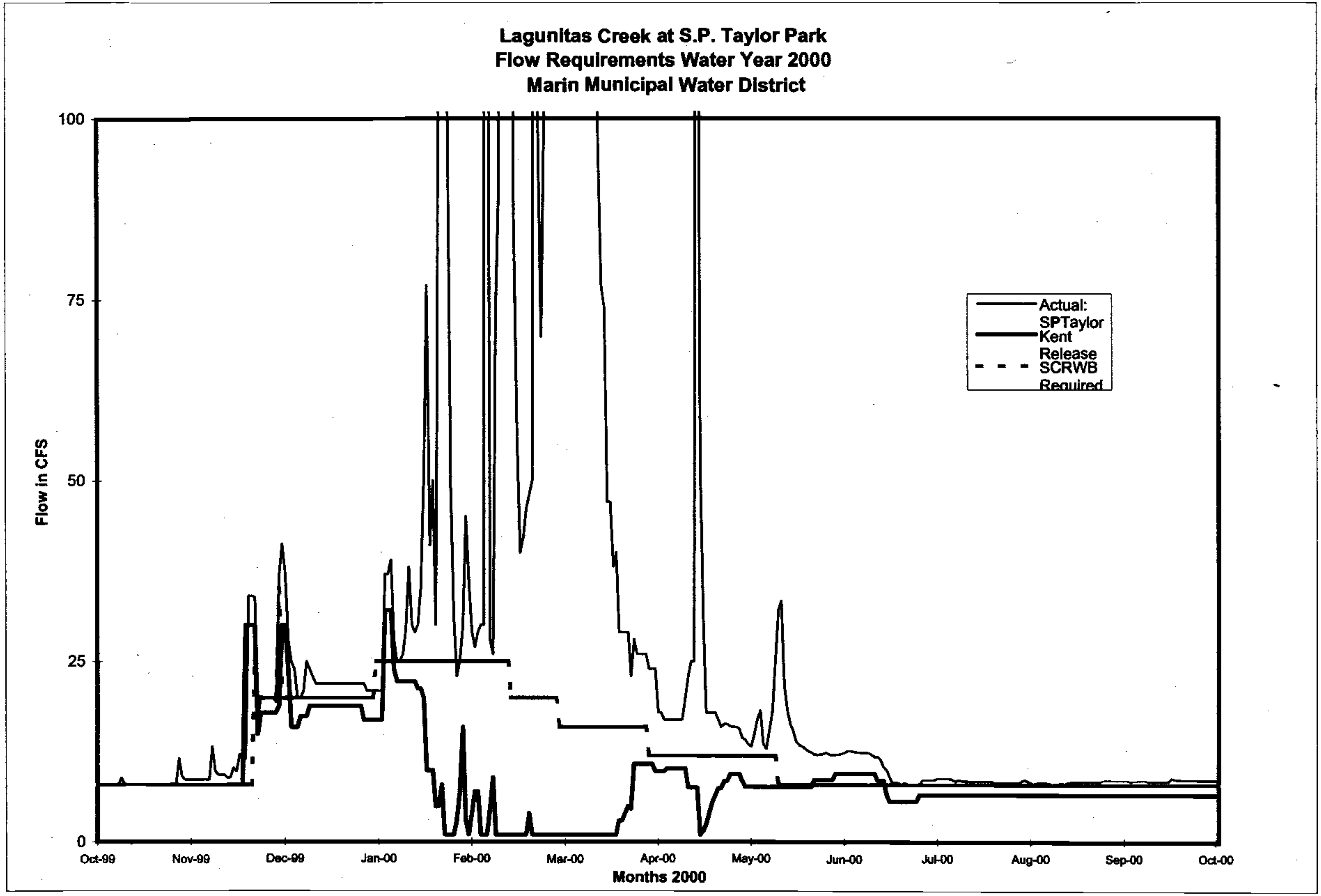


Cumulative Kent Lake Rainfall
Marin Municipal Water District
1999

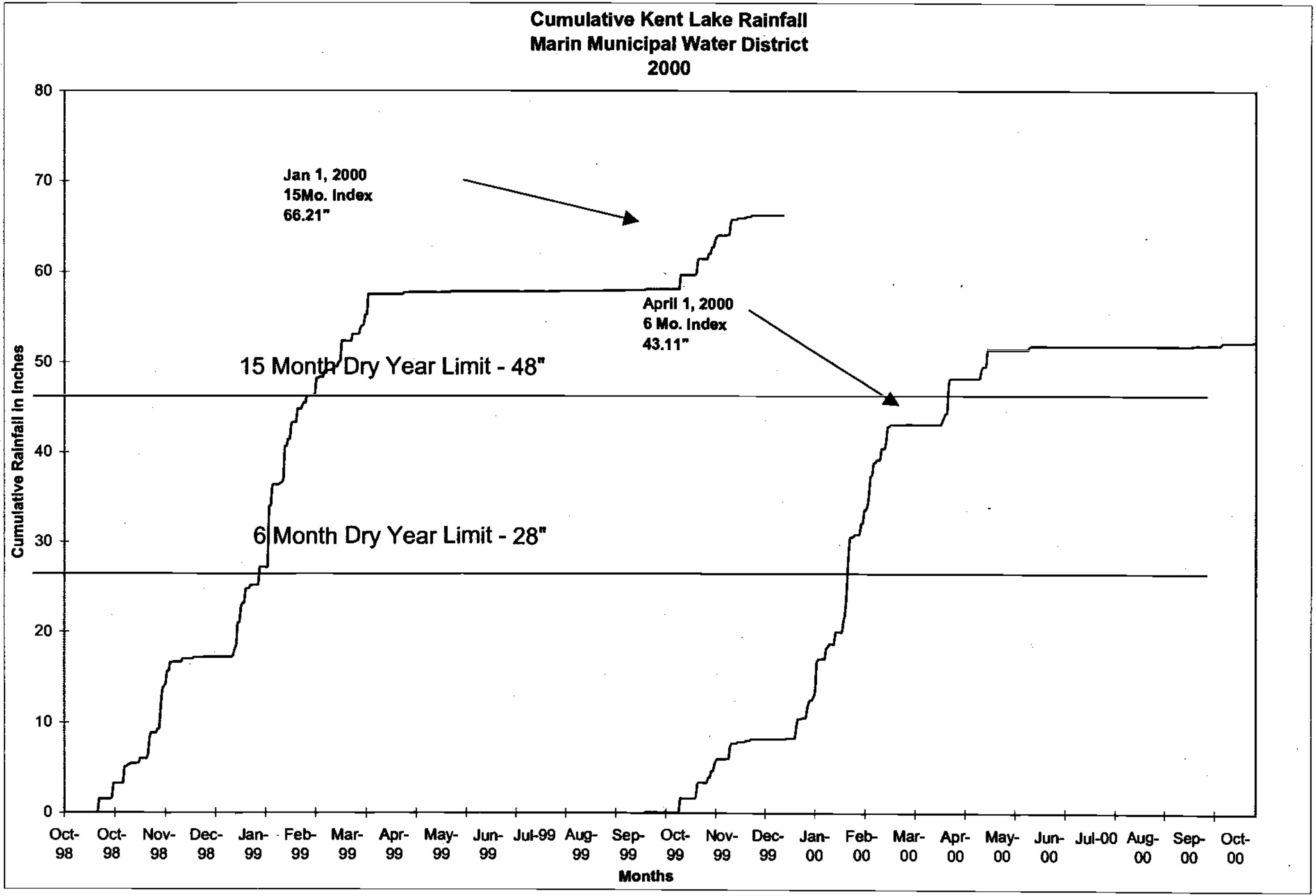


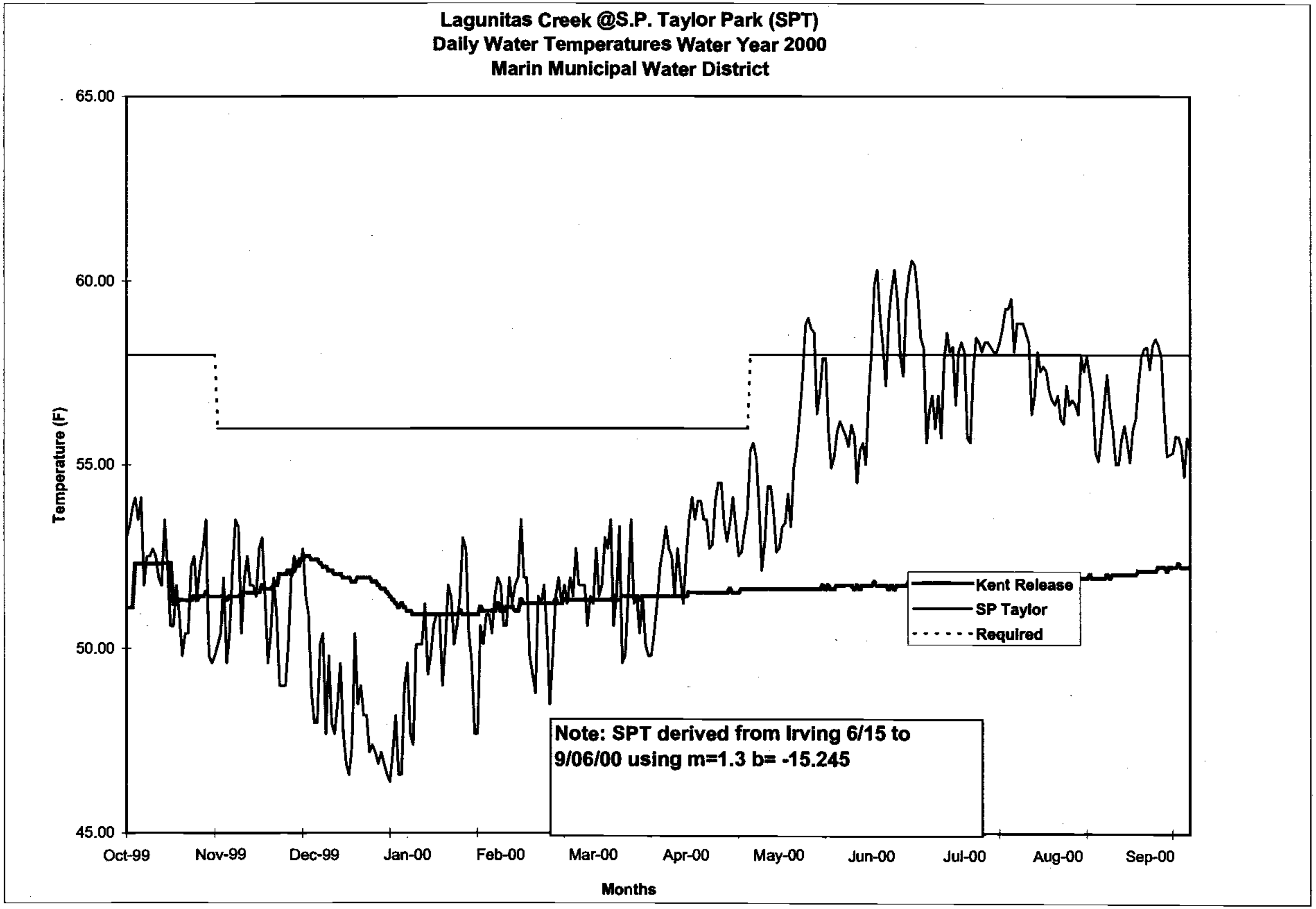


Lagunitas Creek at S.P.Taylor Park (SPT)
Daily Water Temperatures Water Year 1999
Marin Municipal Water District
60
55
50
45
Degrees Fahrenheit
58°
56°
Plunge Pool Temperatures for Release while Steam Release was constructed.
Release
S.P.Taylor Park
Required
Oct-98
Nov-98
Dec-98
Jan-99
Feb-99
Mar-99
Apr-99
May-99
Jun-99
Jul-99
Aug-99
Sep-99
Months
SP Taylor Park Thermograph failed: data lost for OCT - Nov98

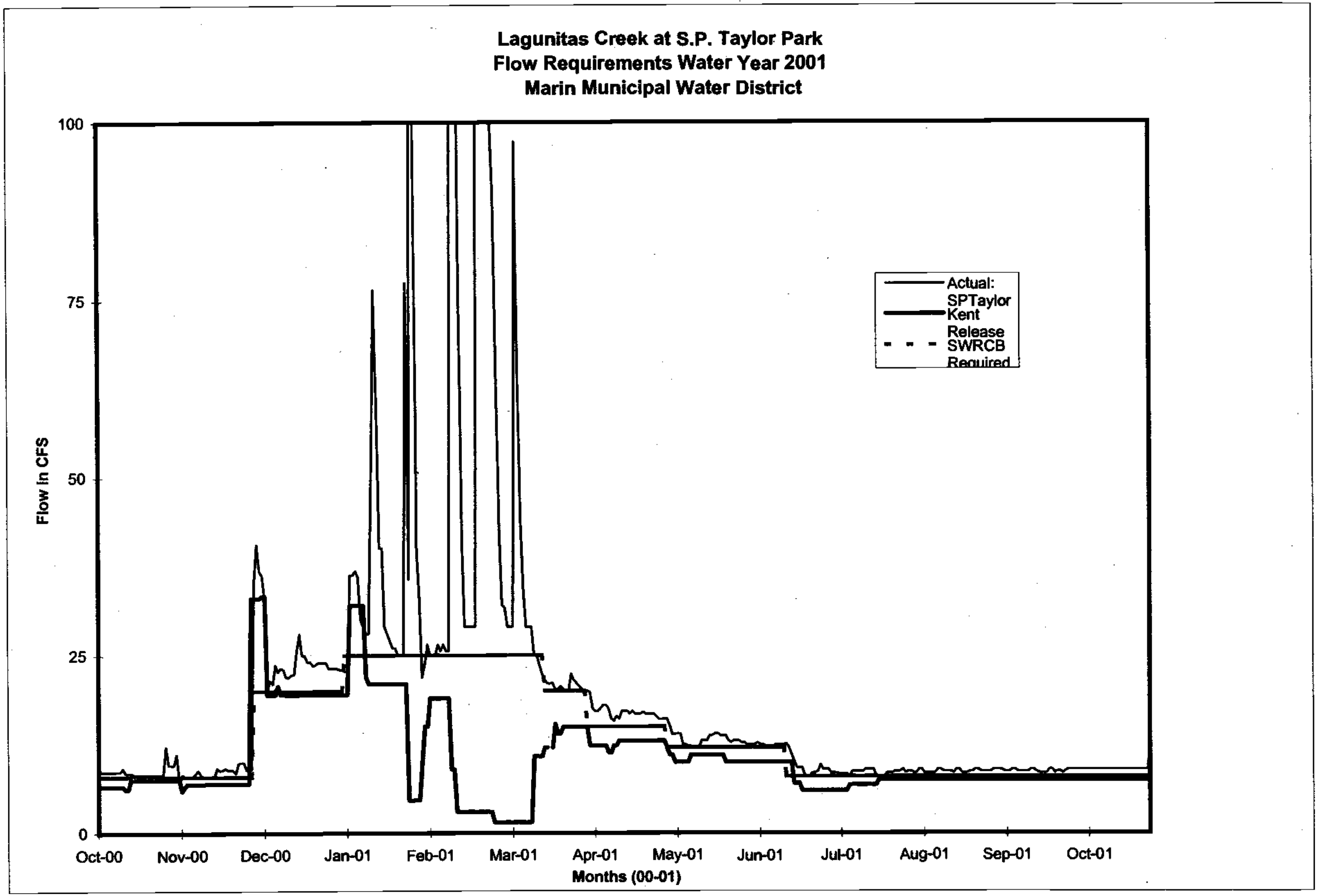


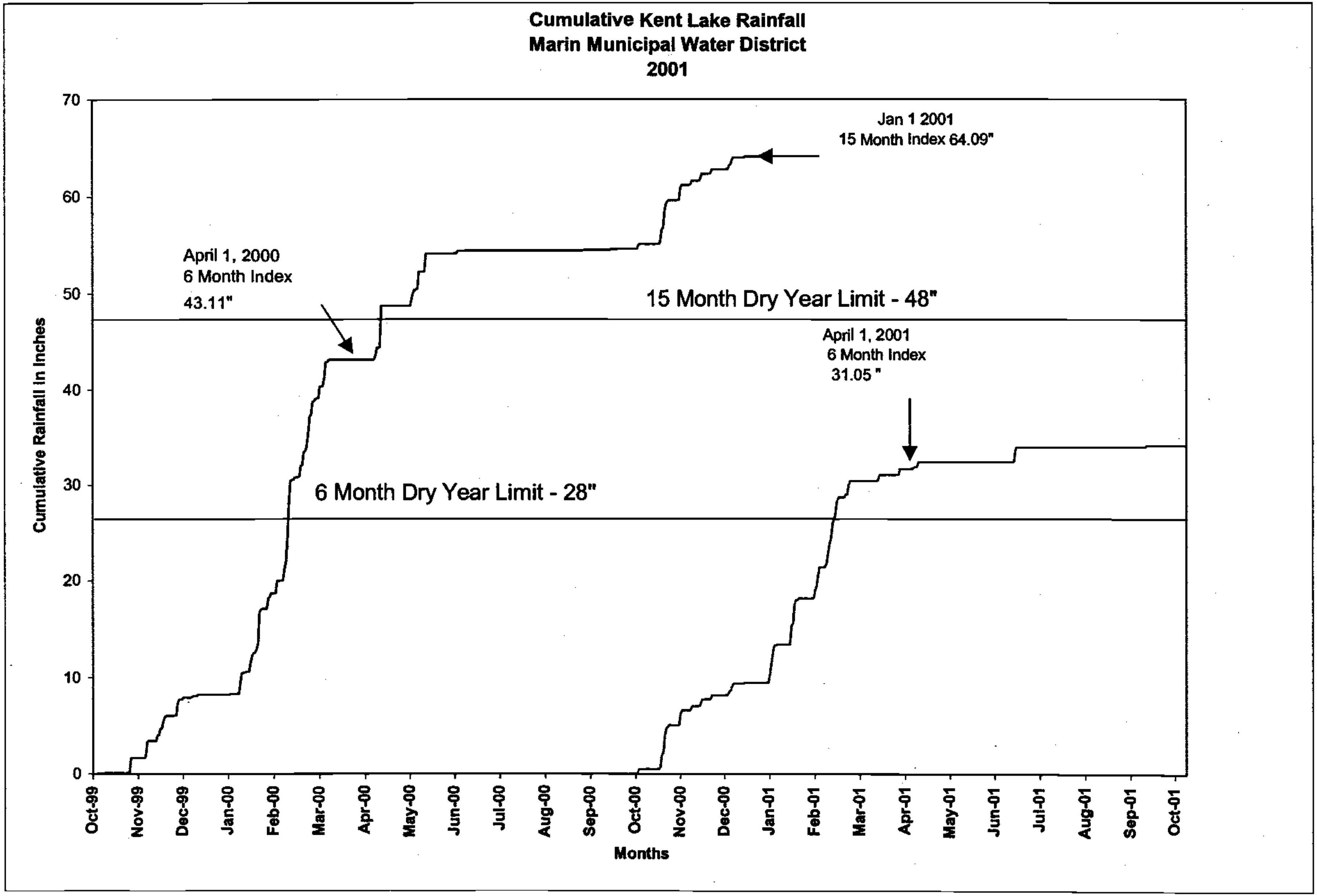
Lagunitas Creek at S.P. Taylor Park
Flow Requirements Water Year 2000
Marin Municipal Water District
Flow in CFS
100
75
50
25
0
Oct-99
Nov-99
Dec-99
Jan-00
Feb-00
Mar-00
Apr-00
May-00
Jun-00
Jul-00
Aug-00
Sep-00
Oct-00
Months 2000
Actual: SPTaylor
Kent Release
SCRWB Required


Cumulative Kent Lake Rainfall
Marin Municipal Water District
2000
Jan 1, 2000
15Mo. Index
66.21"
April 1, 2000
6 Mo. Index
43.11"
15 Month Dry Year Limit - 48"
6 Month Dry Year Limit - 28"
Cumulative Rainfall in Inches
0
10
20
30
40
50
60
70
80
Oct-98
Oct-98
Nov-98
Dec-98
Jan-99
Feb-99
Mar-99
Apr-99
May-99
Jun-99
Jul-99
Aug-99
Sep-99
Oct-99
Nov-99
Dec-99
Jan-00
Feb-00
Mar-00
Apr-00
May-00
Jun-00
Jul-00
Aug-00
Sep-00
Oct-00
Months



Lagunitas Creek @S.P. Taylor Park (SPT)
Daily Water Temperatures Water Year 2000
Marin Municipal Water District
65.00
60.00
55.00
50.00
45.00
Temperature (F)
Oct-99
Nov-99
Dec-99
Jan-00
Feb-00
Mar-00
Apr-00
May-00
Jun-00
Jul-00
Aug-00
Sep-00
Months
Kent Release
SP Taylor
Required
Note: SPT derived from Irving 6/15 to 9/06/00 using m=1.3 b= -15.245


Lagunitas Creek at S.P. Taylor Park
Flow Requirements Water Year 2001
Marin Municipal Water District
Actual: SPTaylor
Kent Release
SWRCB Required
100
75
50
25
0
Flow in CFS
Oct-00
Nov-00
Dec-00
Jan-01
Feb-01
Mar-01
Apr-01
May-01
Jun-01
Jul-01
Aug-01
Sep-01
Oct-01
Months (00-01)


Cumulative Kent Lake Rainfall
Marin Municipal Water District
2001
Jan 1 2001
15 Month Index 64.09"
April 1, 2000
6 Month Index
43.11"
15 Month Dry Year Limit - 48"
April 1, 2001
6 Month Index
31.05 "
6 Month Dry Year Limit - 28"
Cumulative Rainfall in Inches
0
10
20
30
40
50
60
70
Oct-99
Nov-99
Dec-99
Jan-00
Feb-00
Mar-00
Apr-00
May-00
Jun-00
Jul-00
Aug-00
Sep-00
Oct-00
Nov-00
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Mar-01
Apr-01
May-01
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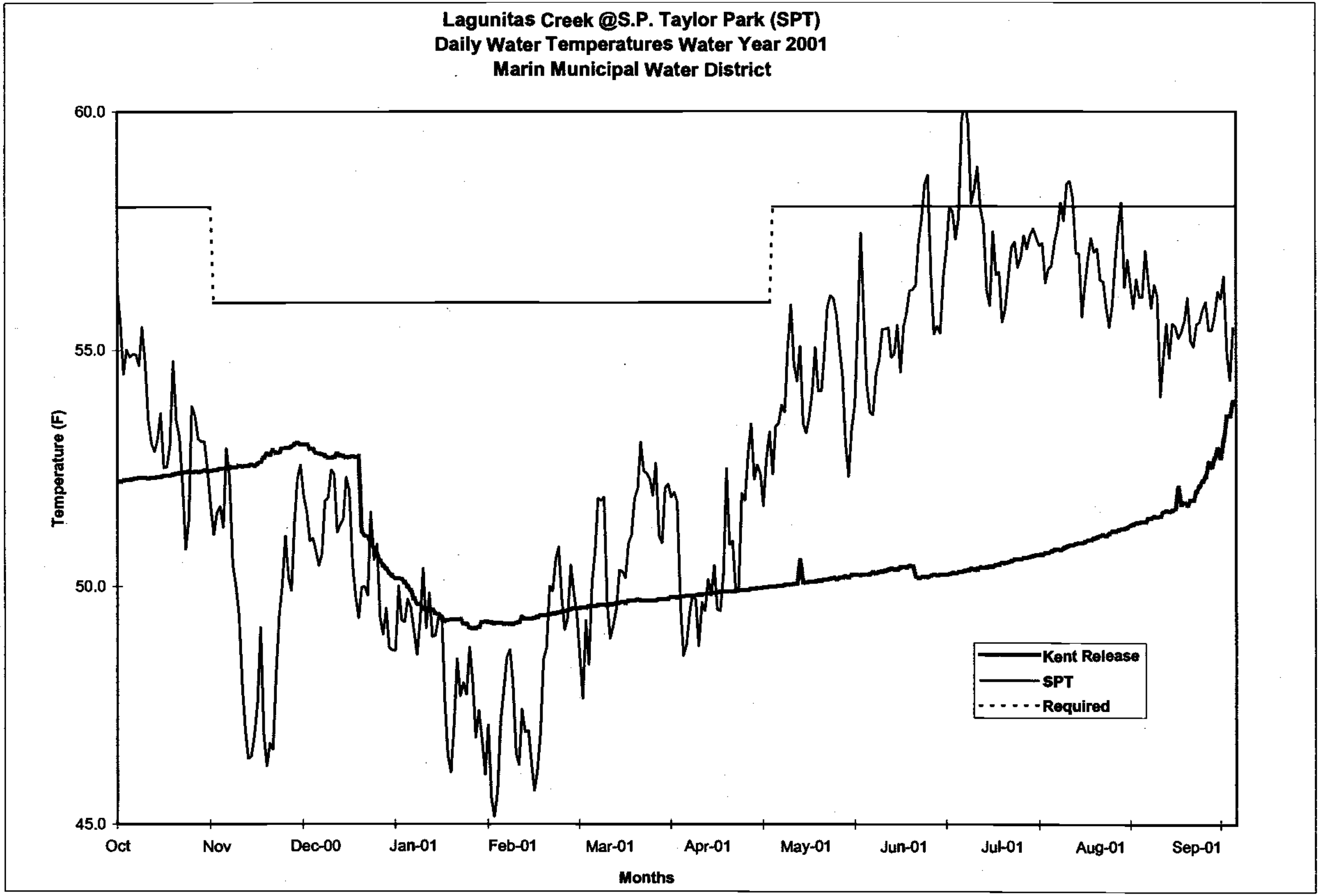
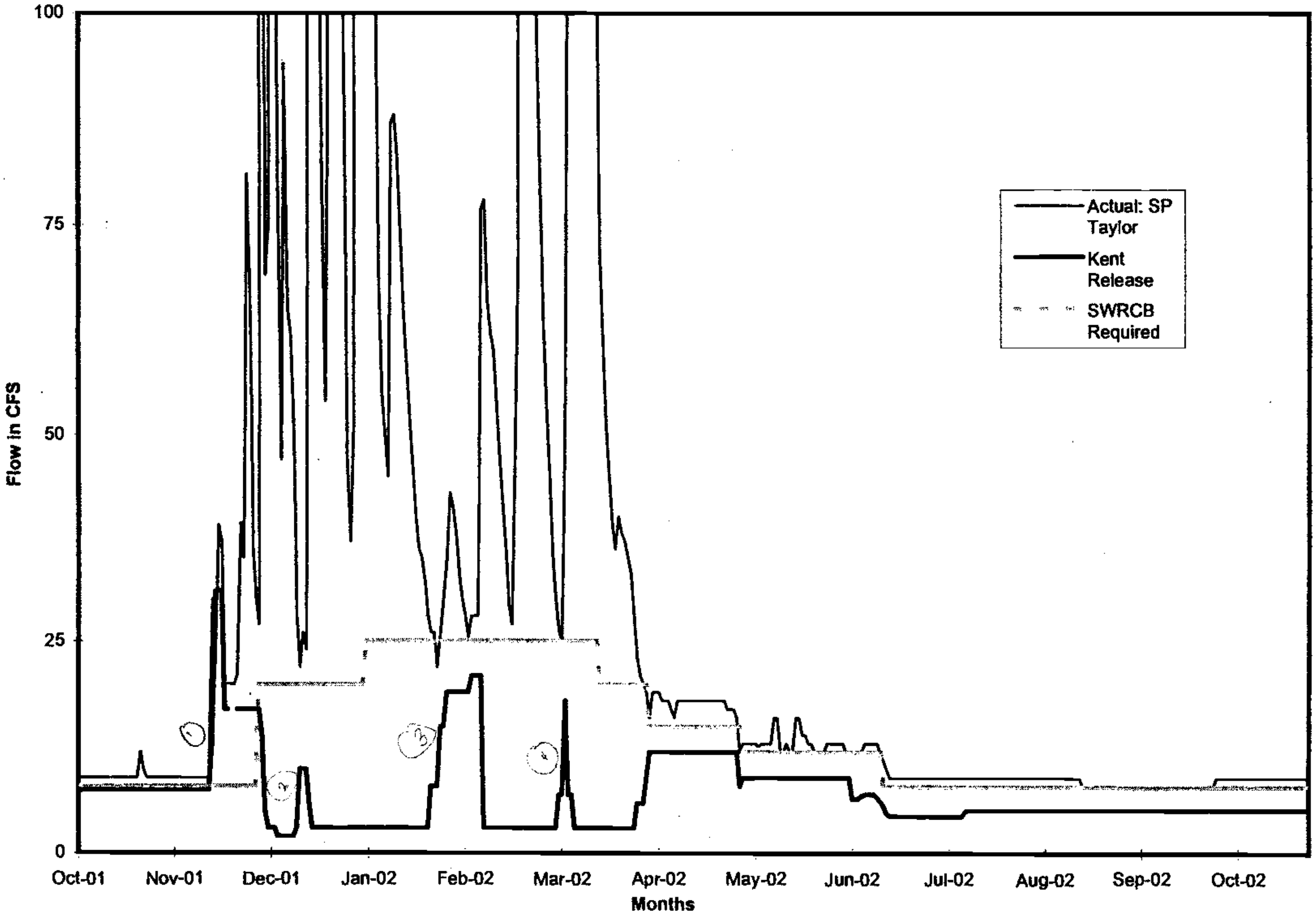
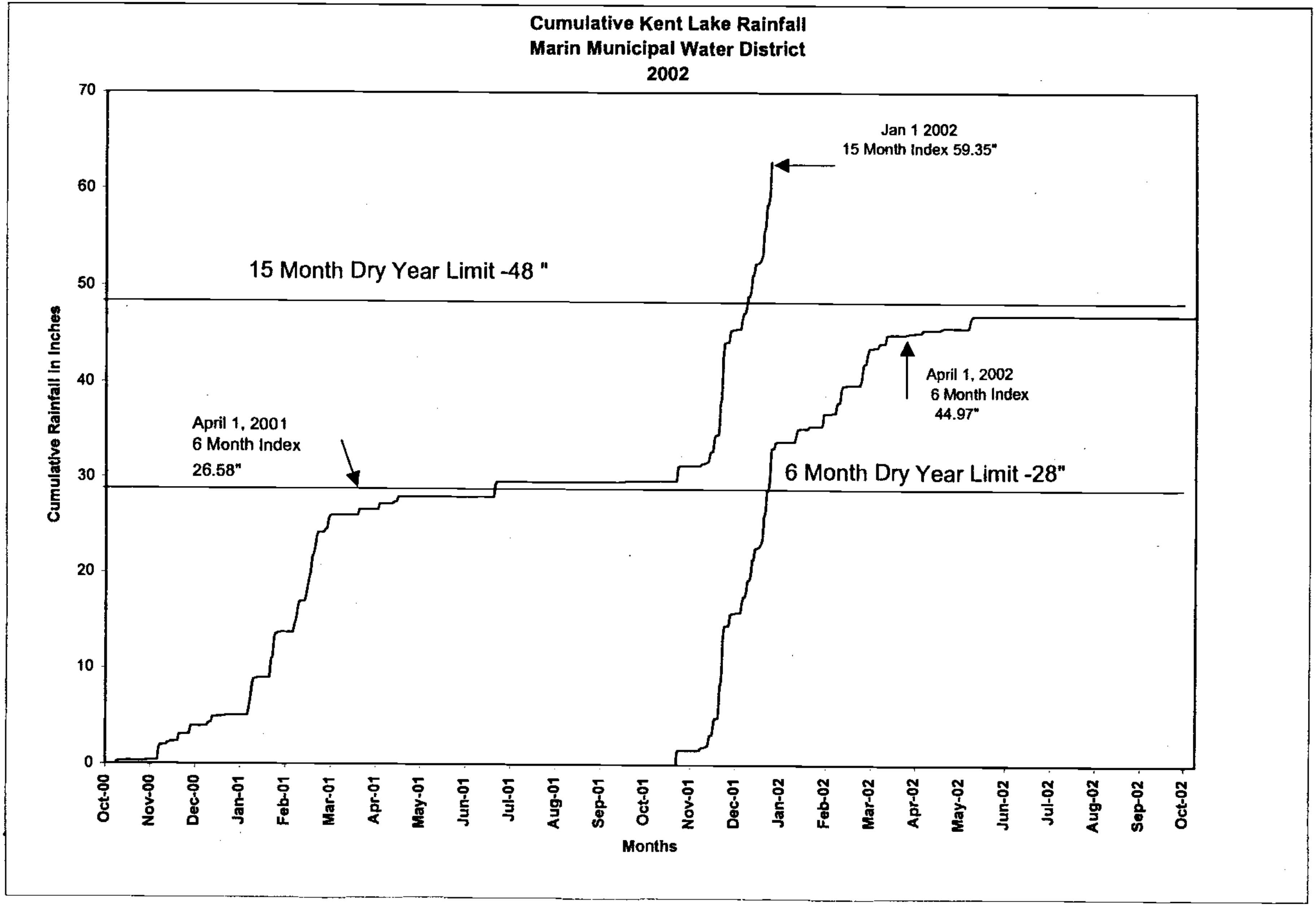
Aug-01
Sep-01
Oct-01
Months



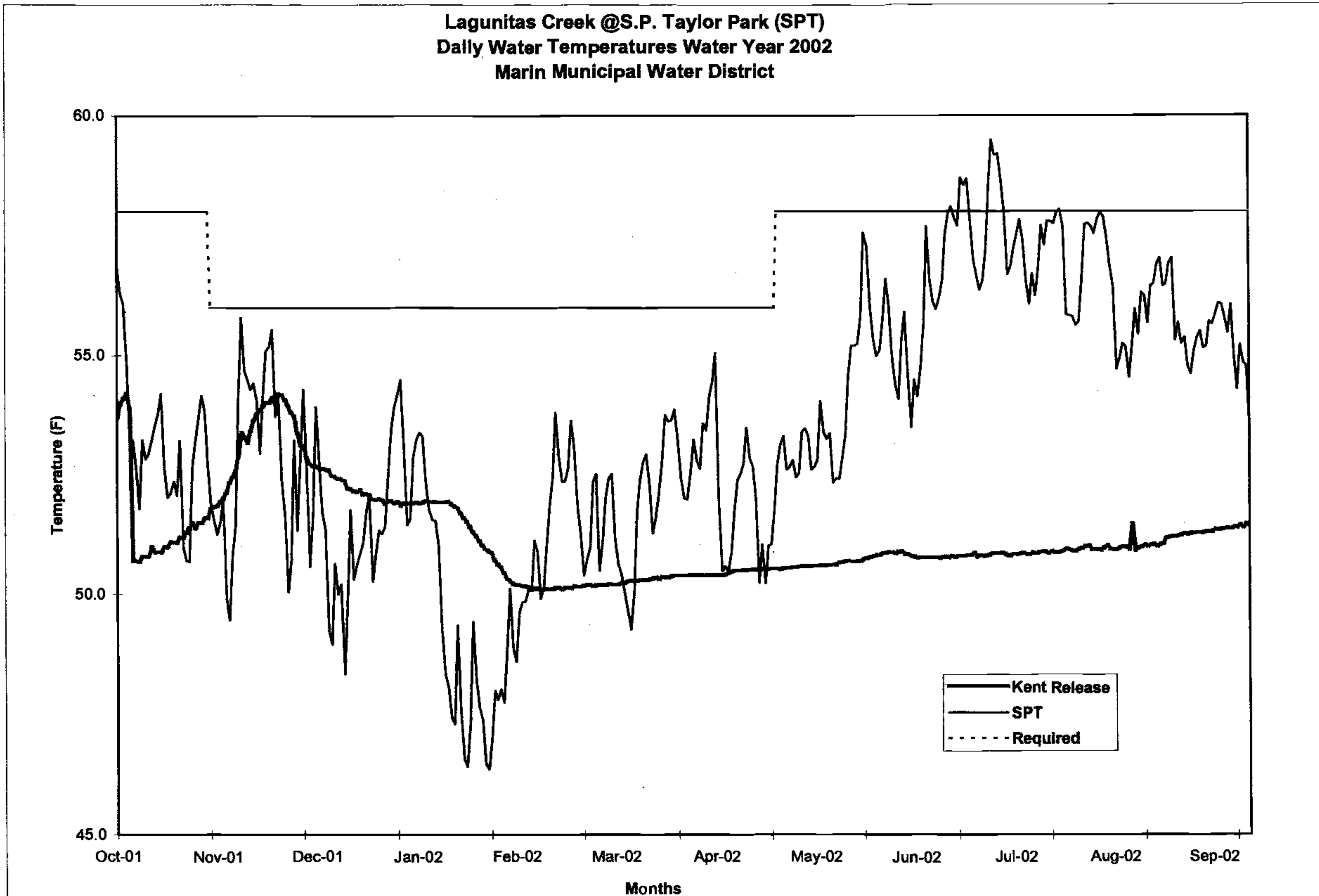
Lagunitas Creek @S.P. Taylor Park (SPT)
Daily Water Temperatures Water Year 2001
Marin Municipal Water District
60.0
55.0
50.0
45.0
Temperature (F)
Oct
Nov
Dec-00
Jan-01
Feb-01
Mar-01
Apr-01
May-01
Jun-01
Jul-01
Aug-01
Sep-01
Months
Kent Release
SPT
Required

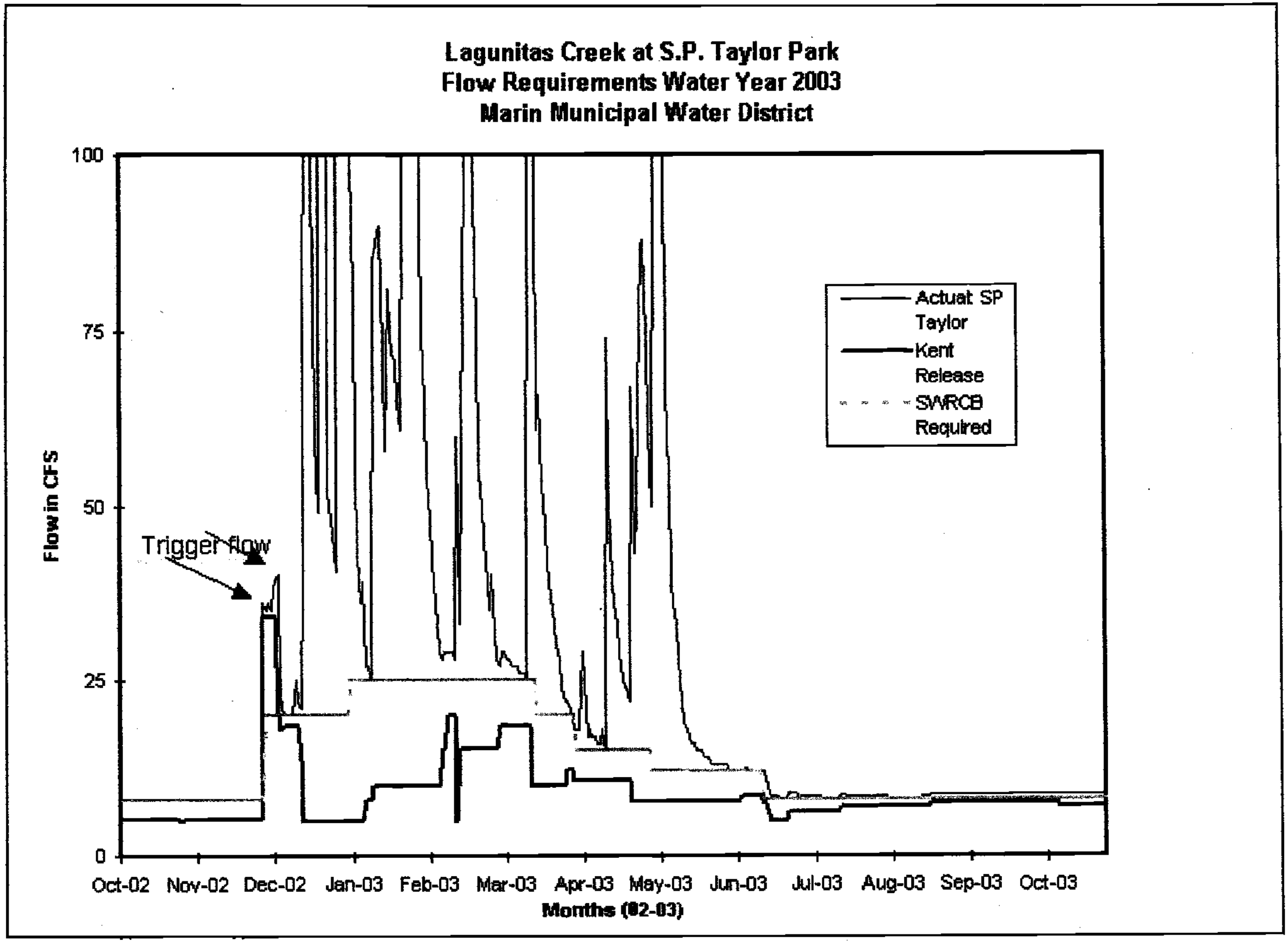
Lagunitas Creek at S.P. Taylor Park
Flow Requirements Water Year 2002
Marin Municipal Water District



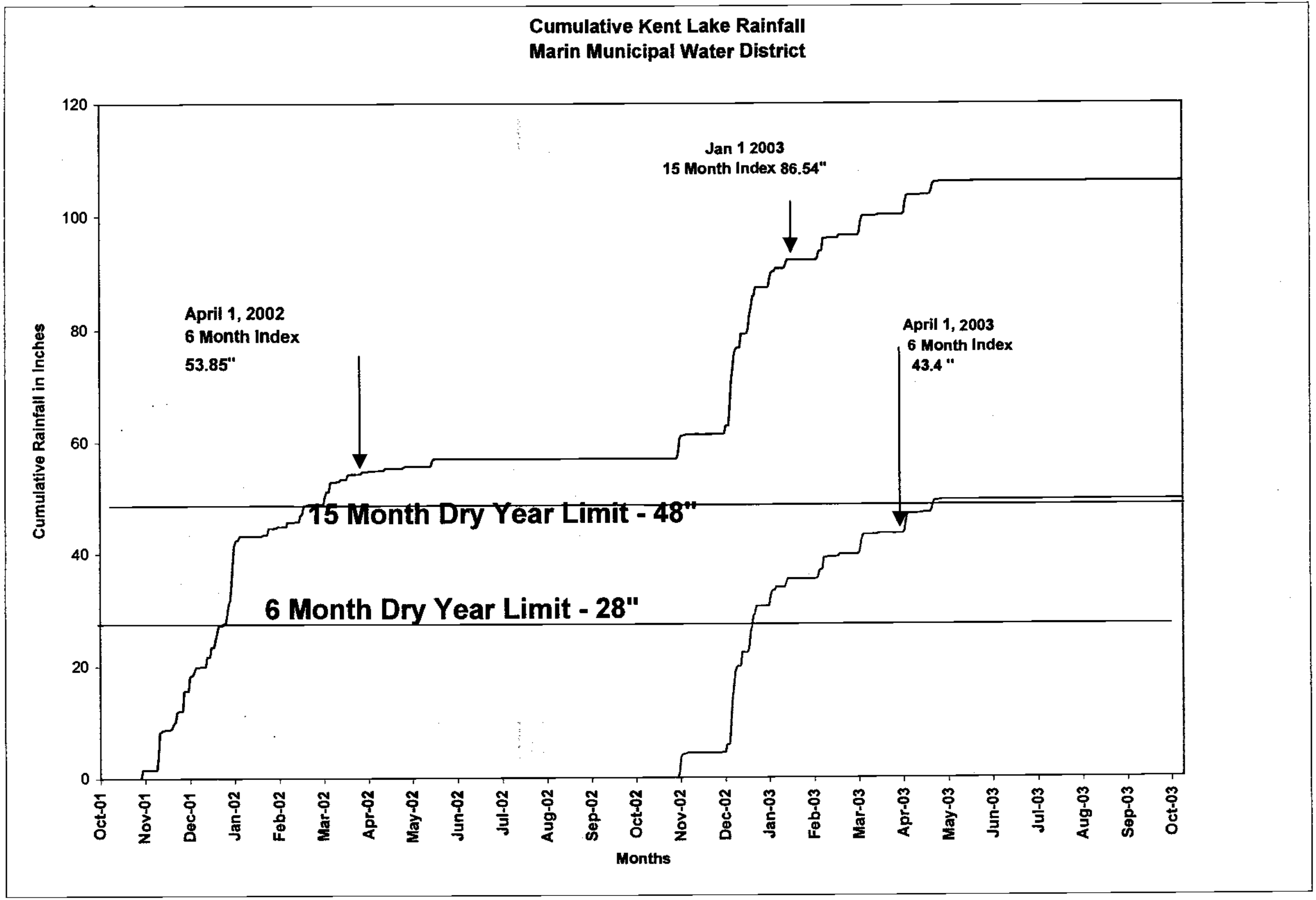


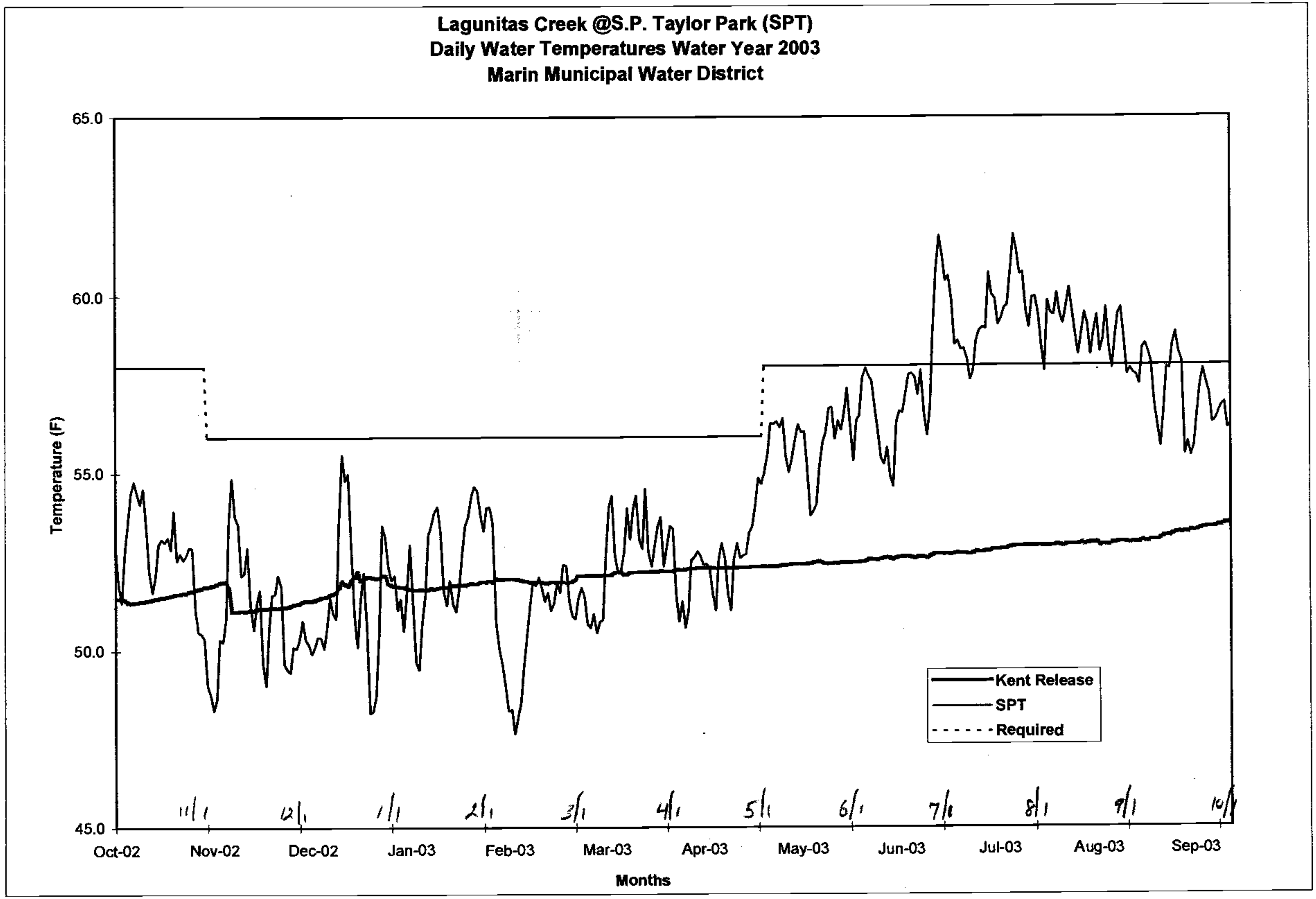
Cumulative Kent Lake Rainfall
Marin Municipal Water District
2002
Jan 1 2002
15 Month Index 59.35"
15 Month Dry Year Limit -48 "
April 1, 2002
6 Month Index
44.97"
April 1, 2001
6 Month Index
26.58"
6 Month Dry Year Limit -28"
Cumulative Rainfall in Inches
Months
0
10
20
30
40
50
60
70
Oct-00
Nov-00
Dec-00
Jan-01
Feb-01
Mar-01
Apr-01
May-01
Jun-01
Jul-01
Aug-01
Sep-01
Oct-01
Nov-01
Dec-01
Jan-02
Feb-02
Mar-02
Apr-02
May-02
Jun-02
Jul-02
Aug-02
Sep-02
Oct-02


Lagunitas Creek @S.P. Taylor Park (SPT)
Daily Water Temperatures Water Year 2002
Marin Municipal Water District
60.0
55.0
50.0
45.0
Temperature (F)
Oct-01
Nov-01
Dec-01
Jan-02
Feb-02
Mar-02
Apr-02
May-02
Jun-02
Jul-02
Aug-02
Sep-02
Months
Kent Release
SPT
Required

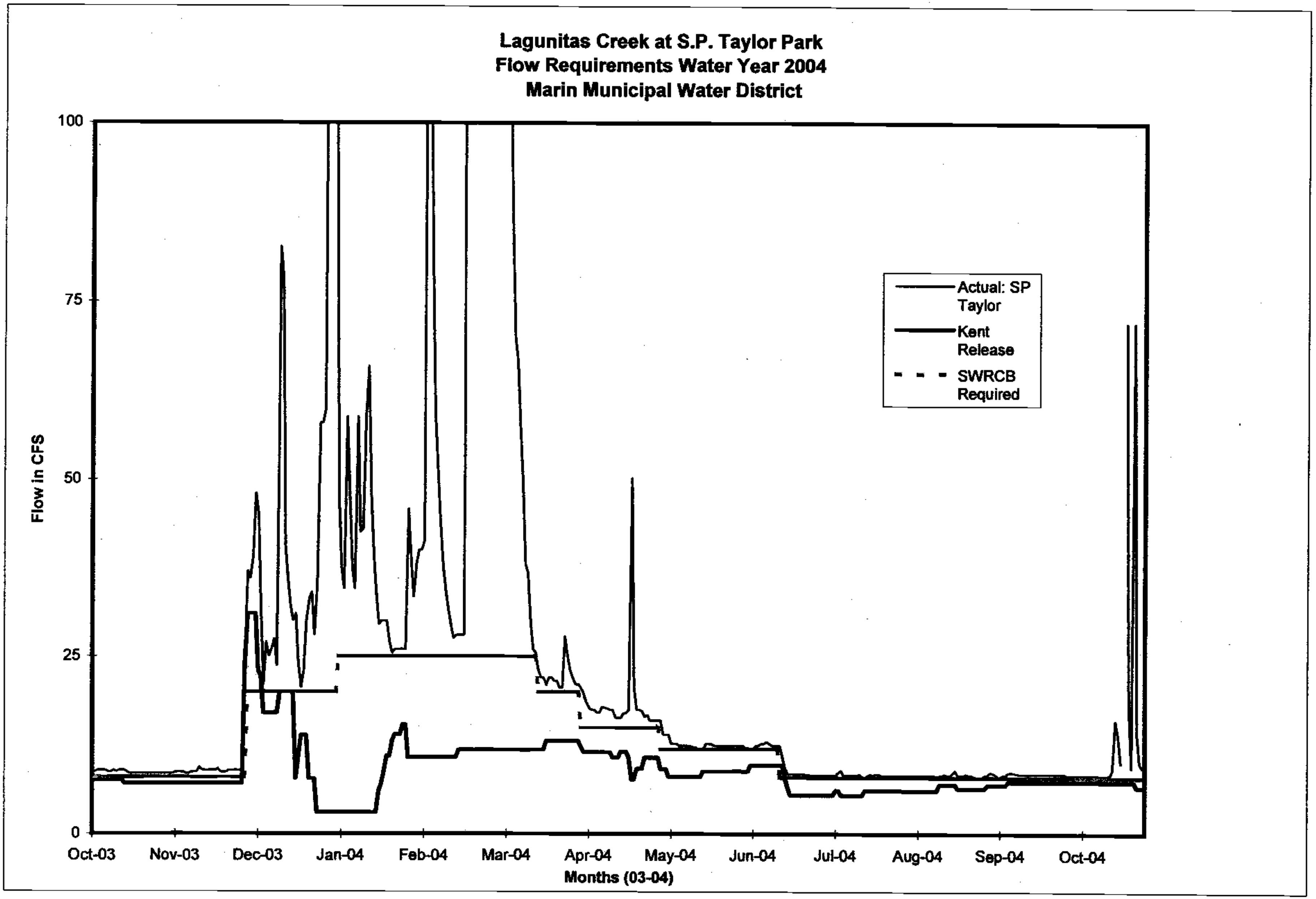


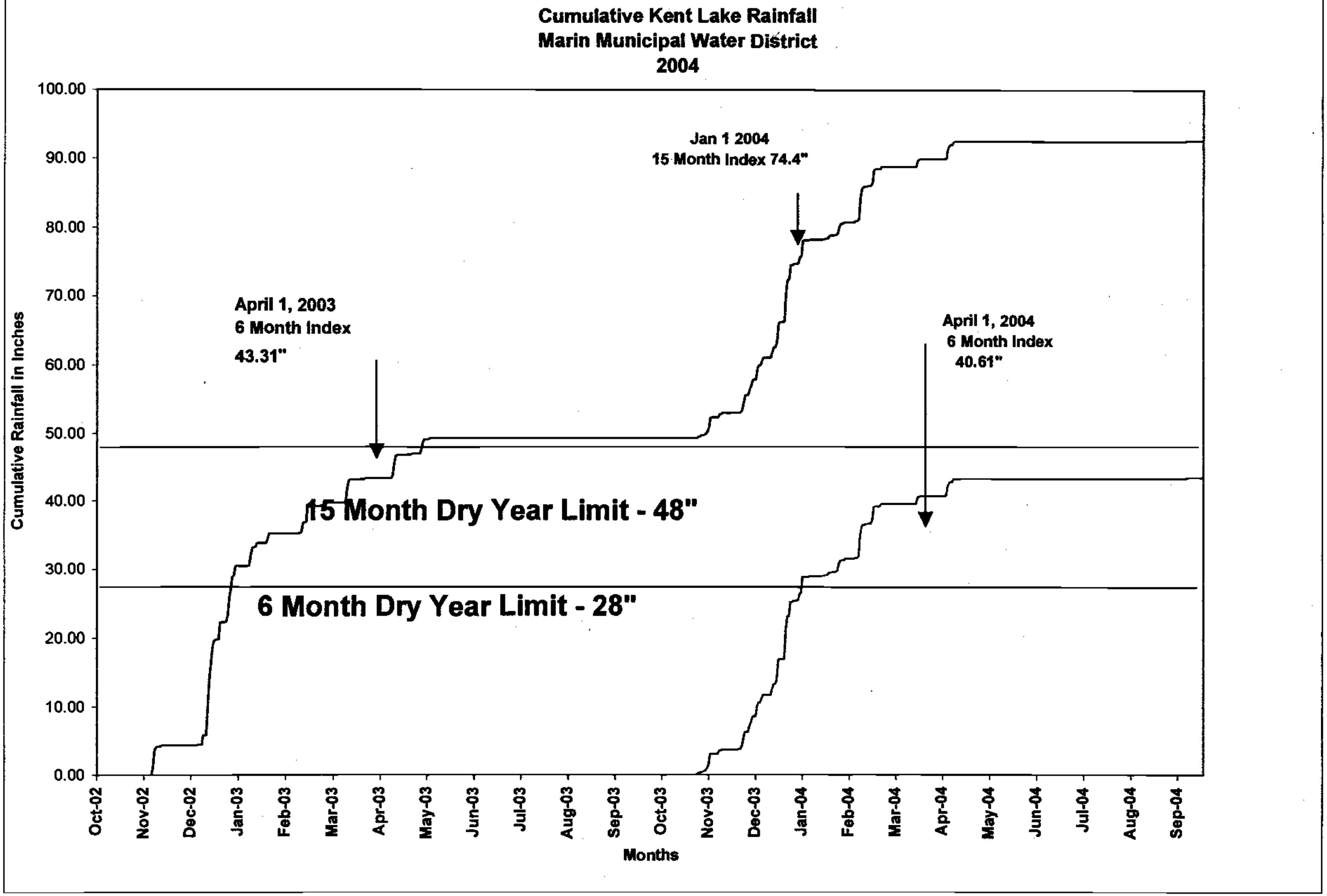
Lagunitas Creek at S.P. Taylor Park
Flow Requirements Water Year 2003
Marin Municipal Water District
100
75
50
25
0
Flow in CFS
Trigger flow
Actual SP Taylor
Kent Release
SWRCB Required
Oct-02
Nov-02
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Jun-03
Jul-03
Aug-03
Sep-03
Oct-03
Months (02-03)


Cumulative Kent Lake Rainfall
Marin Municipal Water District
Cumulative Rainfall in Inches
Months
120
100
80
60
40
20
0
Oct-01
Nov-01
Dec-01
Jan-02
Feb-02
Mar-02
Apr-02
May-02
Jun-02
Jul-02
Aug-02
Sep-02
Oct-02
Nov-02
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Jun-03
Jul-03
Aug-03
Sep-03
Oct-03
April 1, 2002
6 Month Index
53.85"
Jan 1 2003
15 Month Index 86.54"
April 1, 2003
6 Month Index
43.4 "
15 Month Dry Year Limit - 48"
6 Month Dry Year Limit - 28"



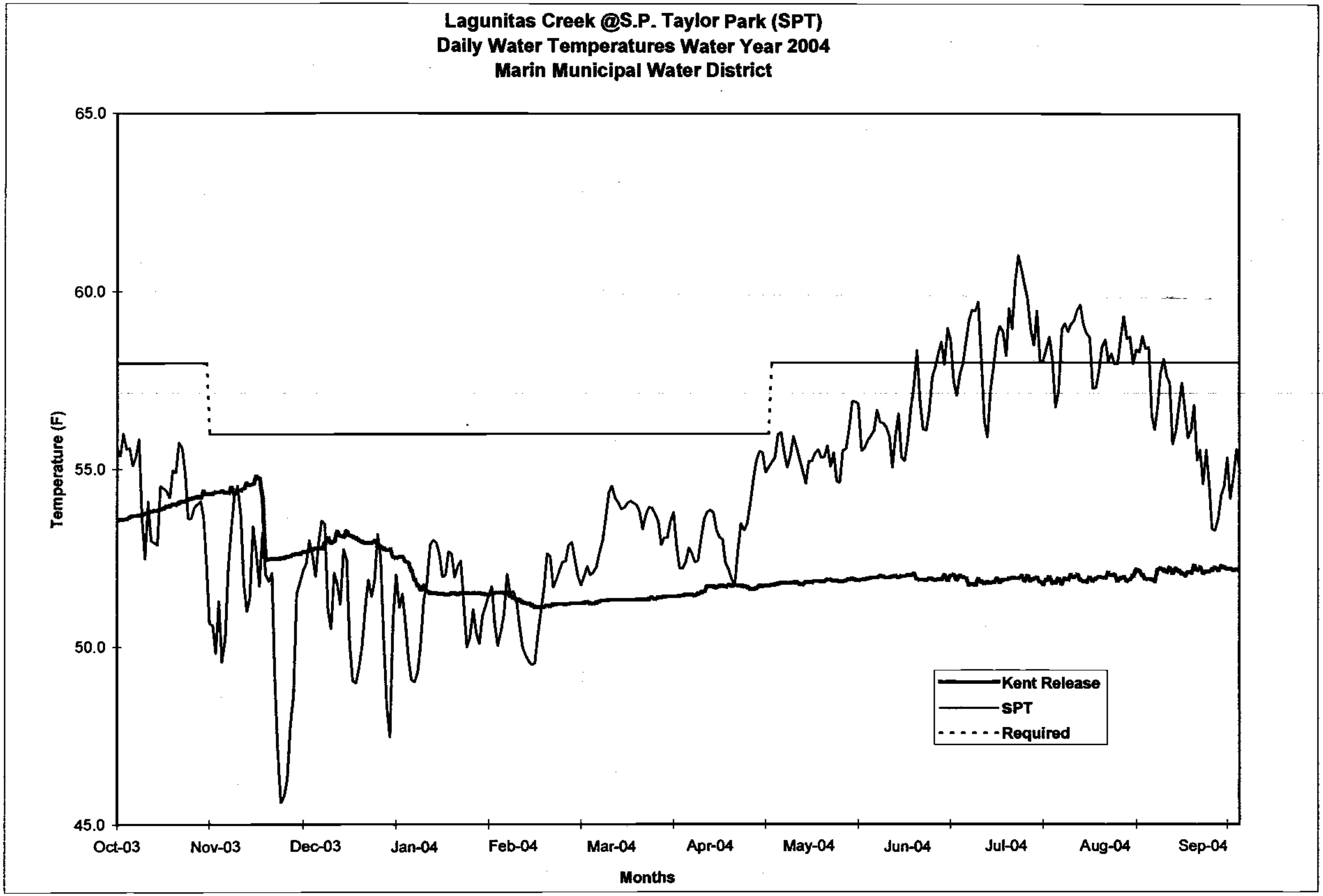
Lagunitas Creek @S.P. Taylor Park (SPT)
Daily Water Temperatures Water Year 2003
Marin Municipal Water District
65.0
60.0
55.0
50.0
45.0
Temperature (F)
Kent Release
SPT
Required
11/1
12/1
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
Oct-02
Nov-02
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Jun-03
Jul-03
Aug-03
Sep-03
Months


Lagunitas Creek at S.P. Taylor Park
Flow Requirements Water Year 2004
Marin Municipal Water District
100
75
50
25
0
Flow in CFS
Actual: SP Taylor
Kent Release
SWRCB Required
Oct-03
Nov-03
Dec-03
Jan-04
Feb-04
Mar-04
Apr-04
May-04
Jun-04
Jul-04
Aug-04
Sep-04
Oct-04
Months (03-04)



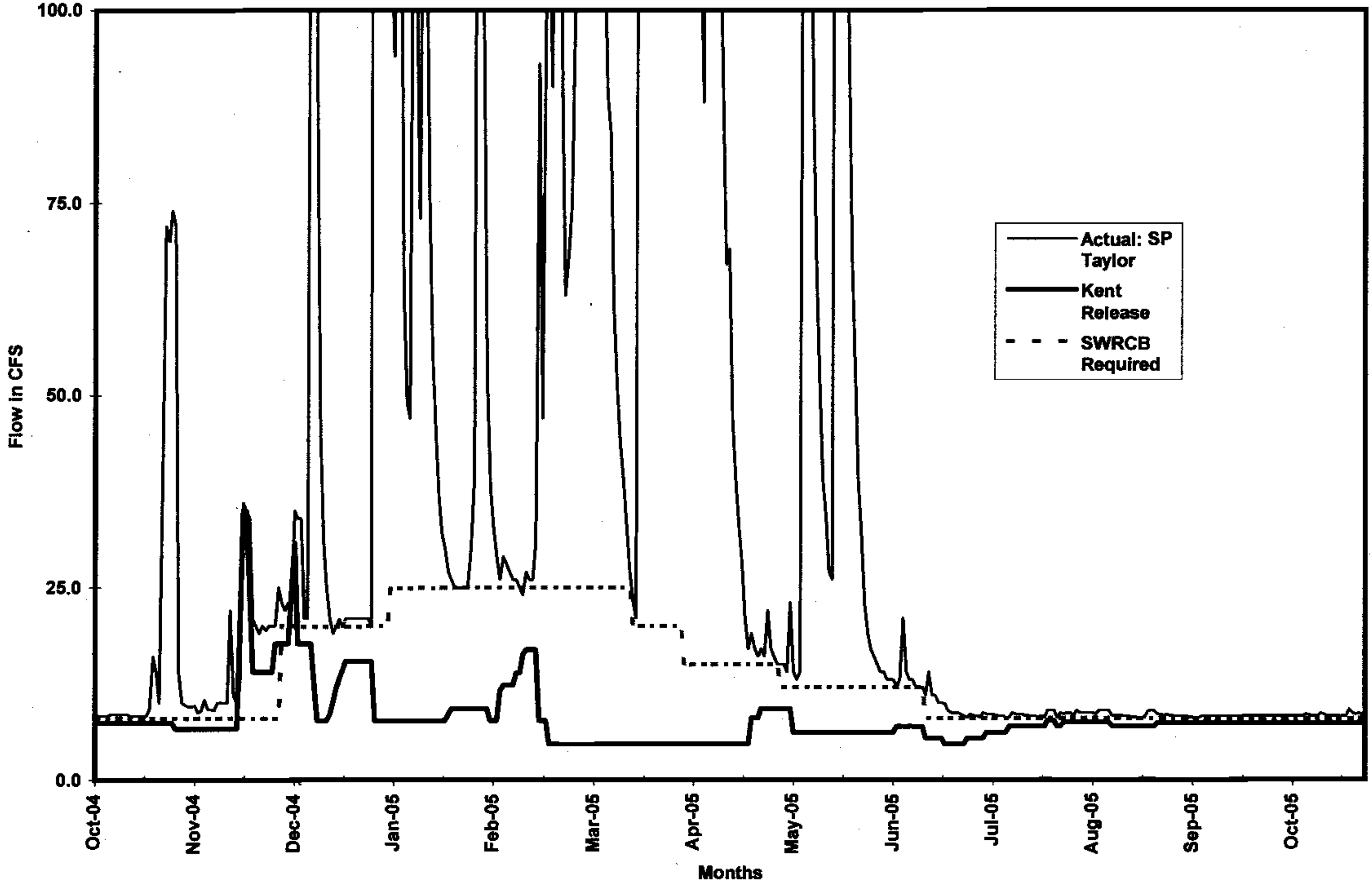
Cumulative Kent Lake Rainfall
Marin Municipal Water District
2004
Cumulative Rainfall in Inches
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Jan 1 2004
15 Month Index 74.4"
April 1, 2003
6 Month Index
43.31"
April 1, 2004
6 Month Index
40.61"
15 Month Dry Year Limit - 48"
6 Month Dry Year Limit - 28"
Oct-02
Nov-02
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Jun-03
Jul-03
Aug-03
Sep-03
Oct-03
Nov-03
Dec-03
Jan-04
Feb-04
Mar-04
Apr-04
May-04
Jun-04
Jul-04
Aug-04
Sep-04
Months

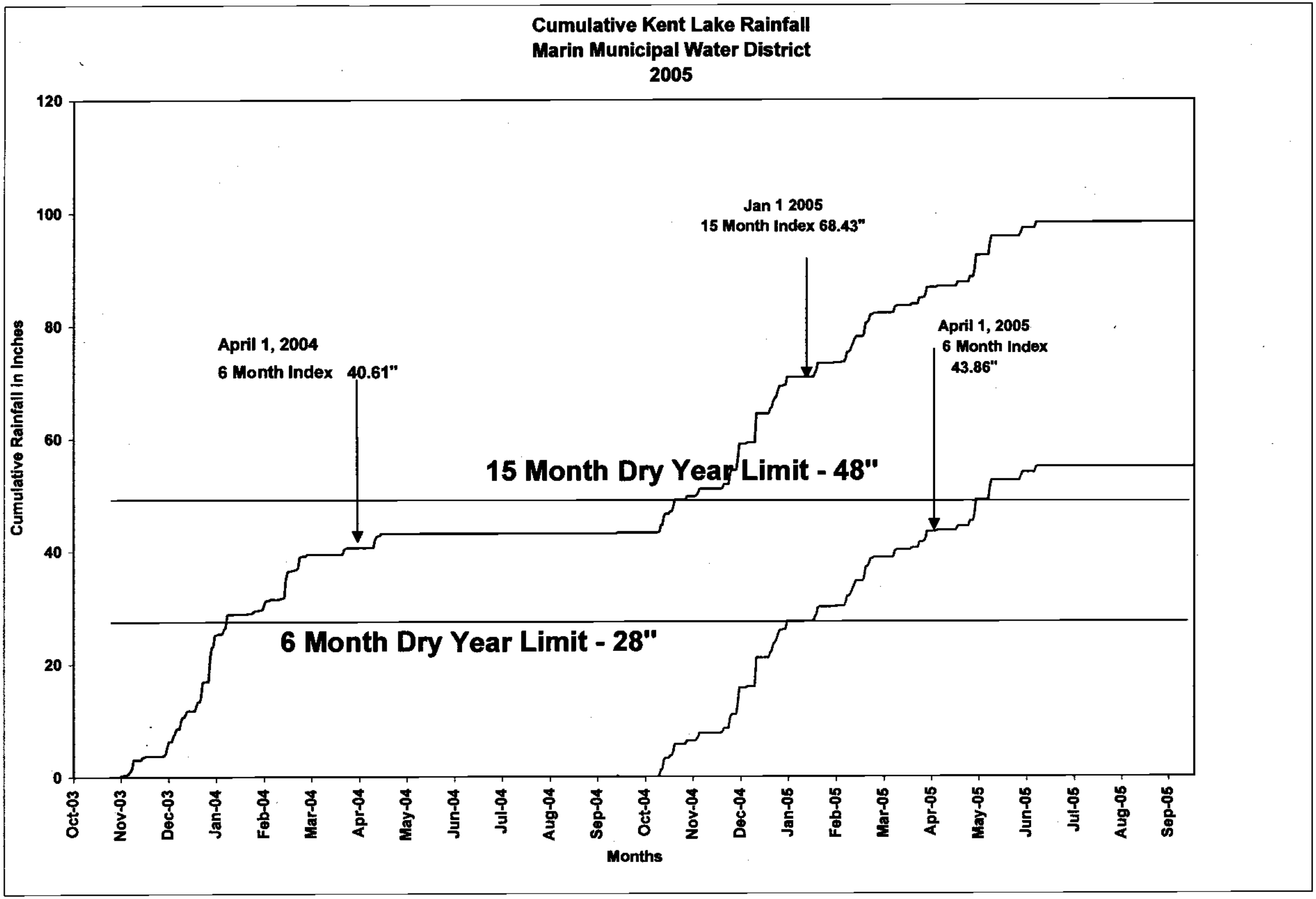
FIG. 3



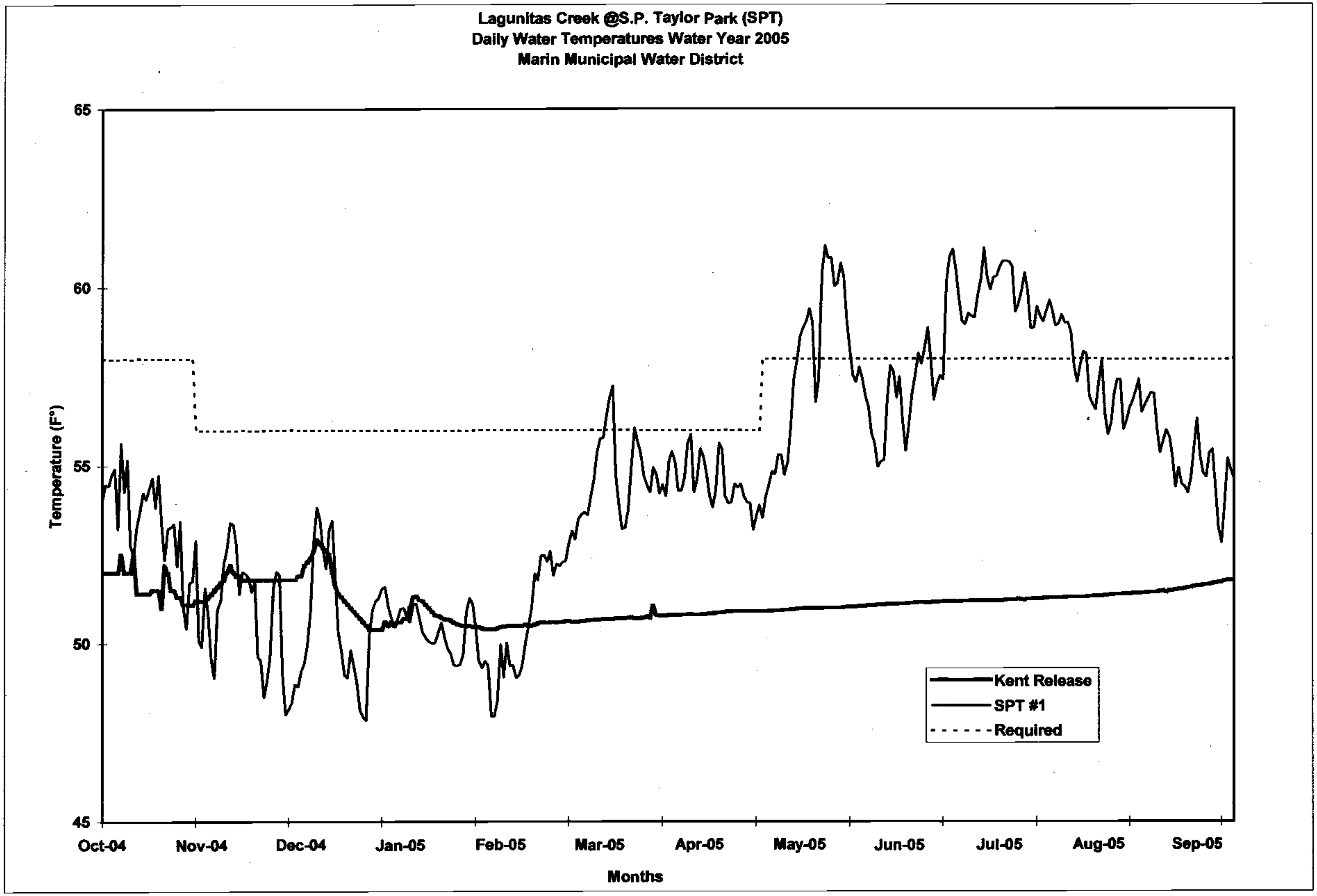
Lagunitas Creek @S.P. Taylor Park (SPT)
Daily Water Temperatures Water Year 2004
Marin Municipal Water District
Temperature (F)
65.0
60.0
55.0
50.0
45.0
Oct-03
Nov-03
Dec-03
Jan-04
Feb-04
Mar-04
Apr-04
May-04
Jun-04
Jul-04
Aug-04
Sep-04
Months
Kent Release
SPT
Required

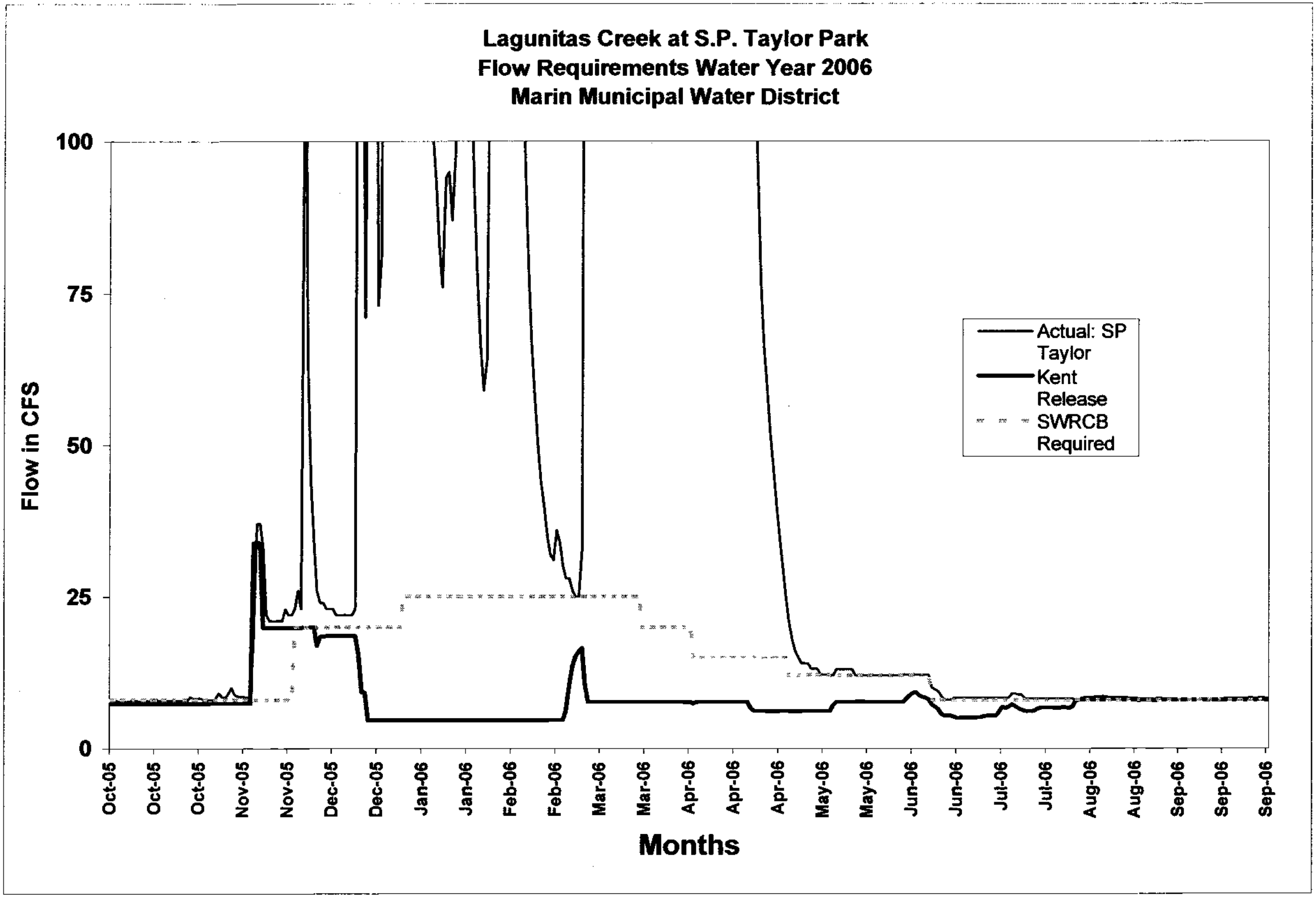
Lagunitas Creek at S.P. Taylor Park
Flow Requirements Water Year 2005
Marin Municipal Water District



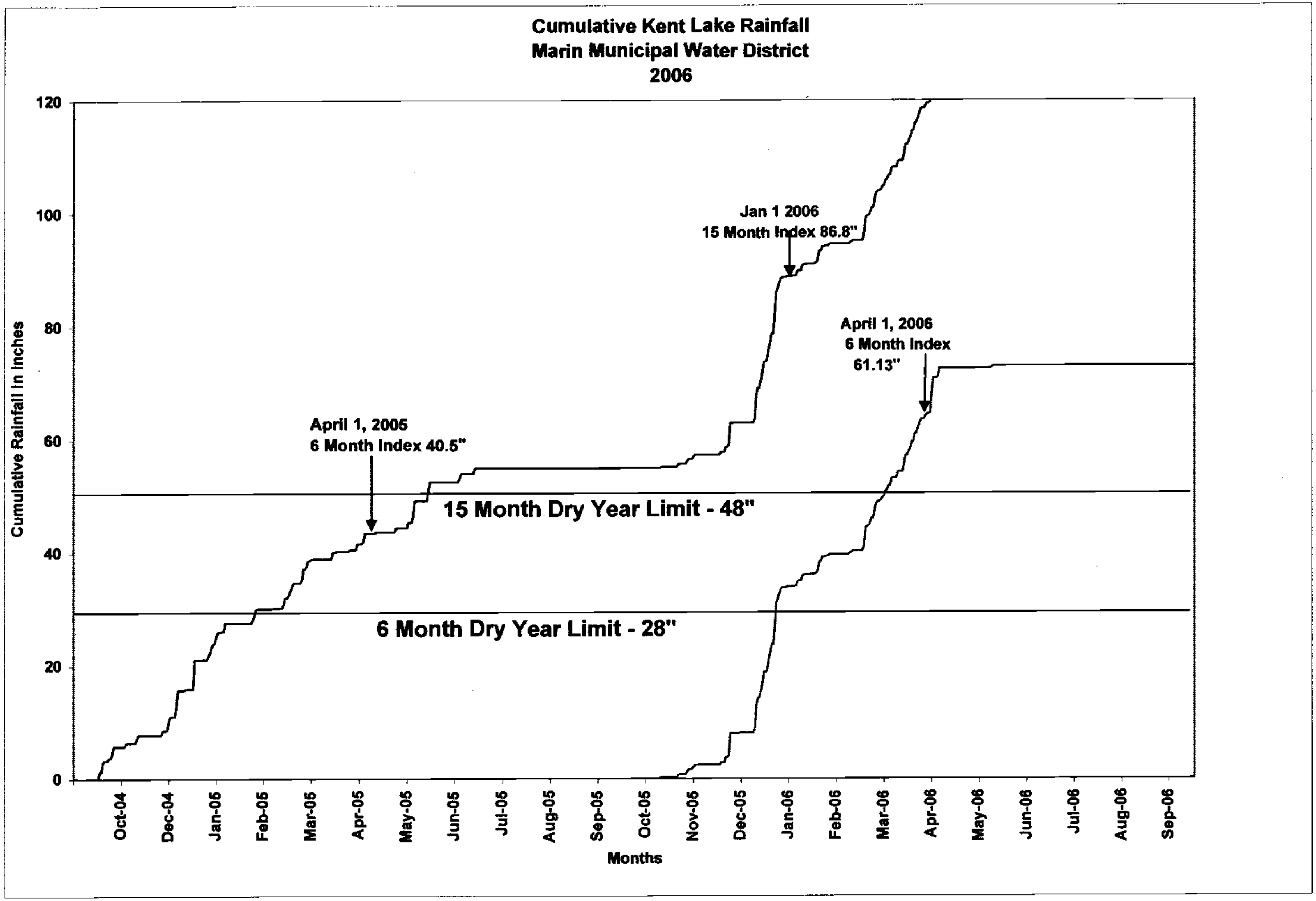


Cumulative Kent Lake Rainfall
Marin Municipal Water District
2005
Cumulative Rainfall in Inches
0
20
40
60
80
100
120
Jan 1 2005
15 Month Index 68.43"
April 1, 2004
6 Month Index 40.61"
April 1, 2005
6 Month Index
43.86"
15 Month Dry Year Limit - 48"
6 Month Dry Year Limit - 28"
Oct-03
Nov-03
Dec-03
Jan-04
Feb-04
Mar-04
Apr-04
May-04
Jun-04
Jul-04
Aug-04
Sep-04
Oct-04
Nov-04
Dec-04
Jan-05
Feb-05
Mar-05
Apr-05
May-05
Jun-05
Jul-05
Aug-05
Sep-05
Months

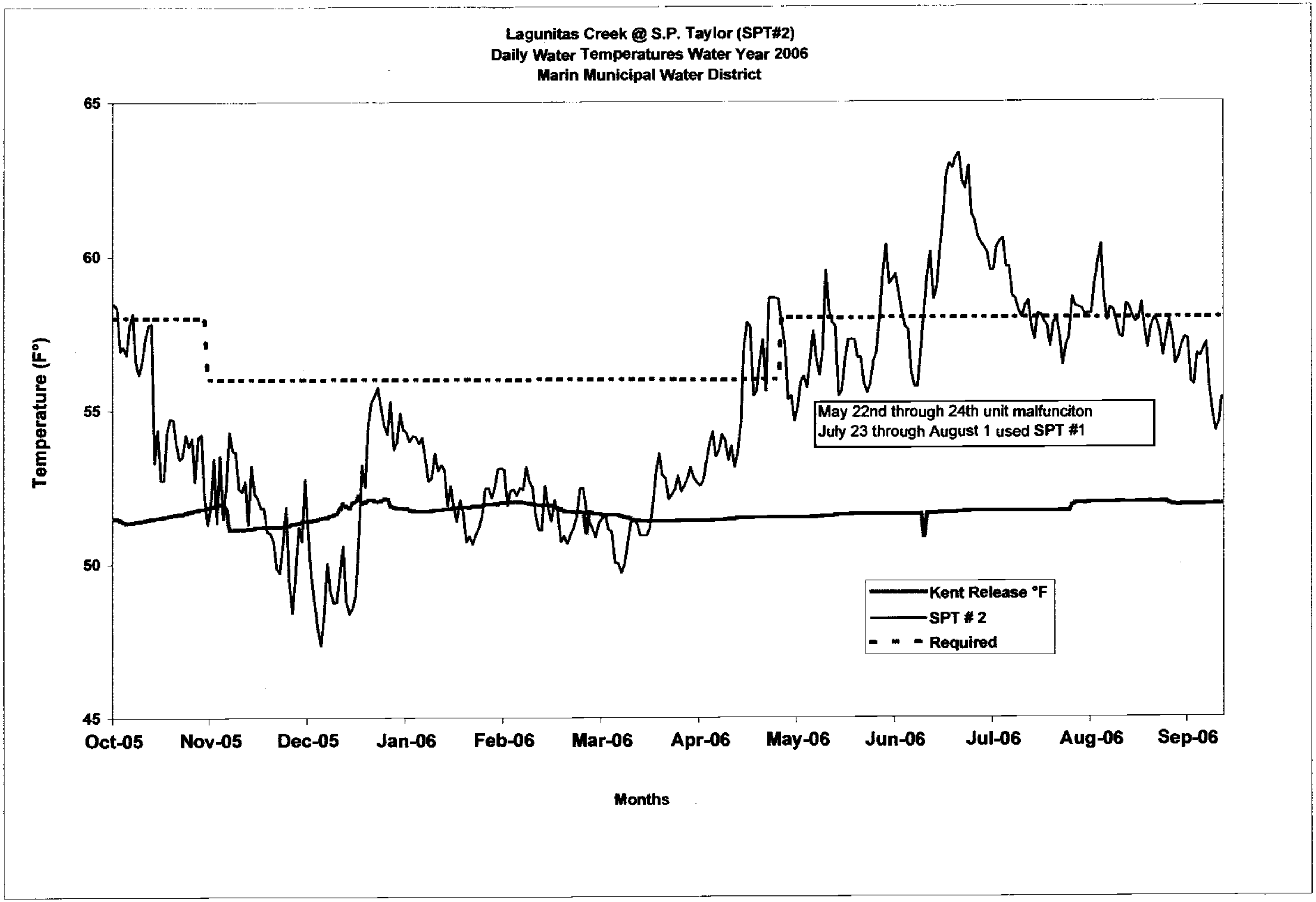

Lagunitas Creek @S.P. Taylor Park (SPT)
Daily Water Temperatures Water Year 2005
Marin Municipal Water District
65
60
55
50
45
Temperature (F°)
Oct-04
Nov-04
Dec-04
Jan-05
Feb-05
Mar-05
Apr-05
May-05
Jun-05
Jul-05
Aug-05
Sep-05
Months
Kent Release
SPT #1
Required

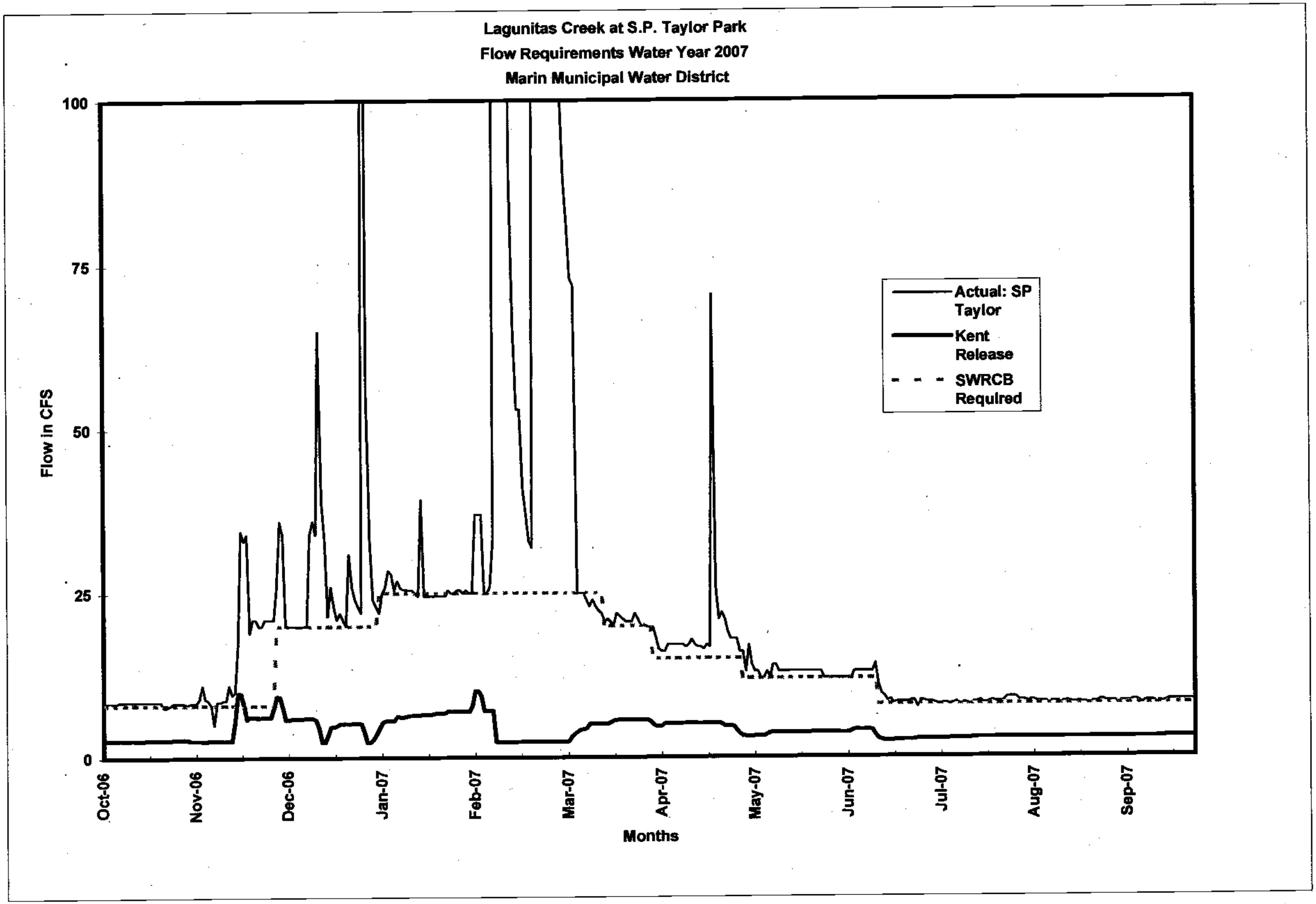


Lagunitas Creek at S.P. Taylor Park
Flow Requirements Water Year 2006
Marin Municipal Water District
Flow in CFS
100
75
50
25
0
Actual: SP Taylor
Kent Release
SWRCB Required
Oct-05
Oct-05
Oct-05
Nov-05
Nov-05
Dec-05
Dec-05
Jan-06
Jan-06
Feb-06
Feb-06
Mar-06
Mar-06
Apr-06
Apr-06
Apr-06
May-06
May-06
Jun-06
Jun-06
Jul-06
Jul-06
Aug-06
Aug-06
Sep-06
Sep-06
Sep-06
Months

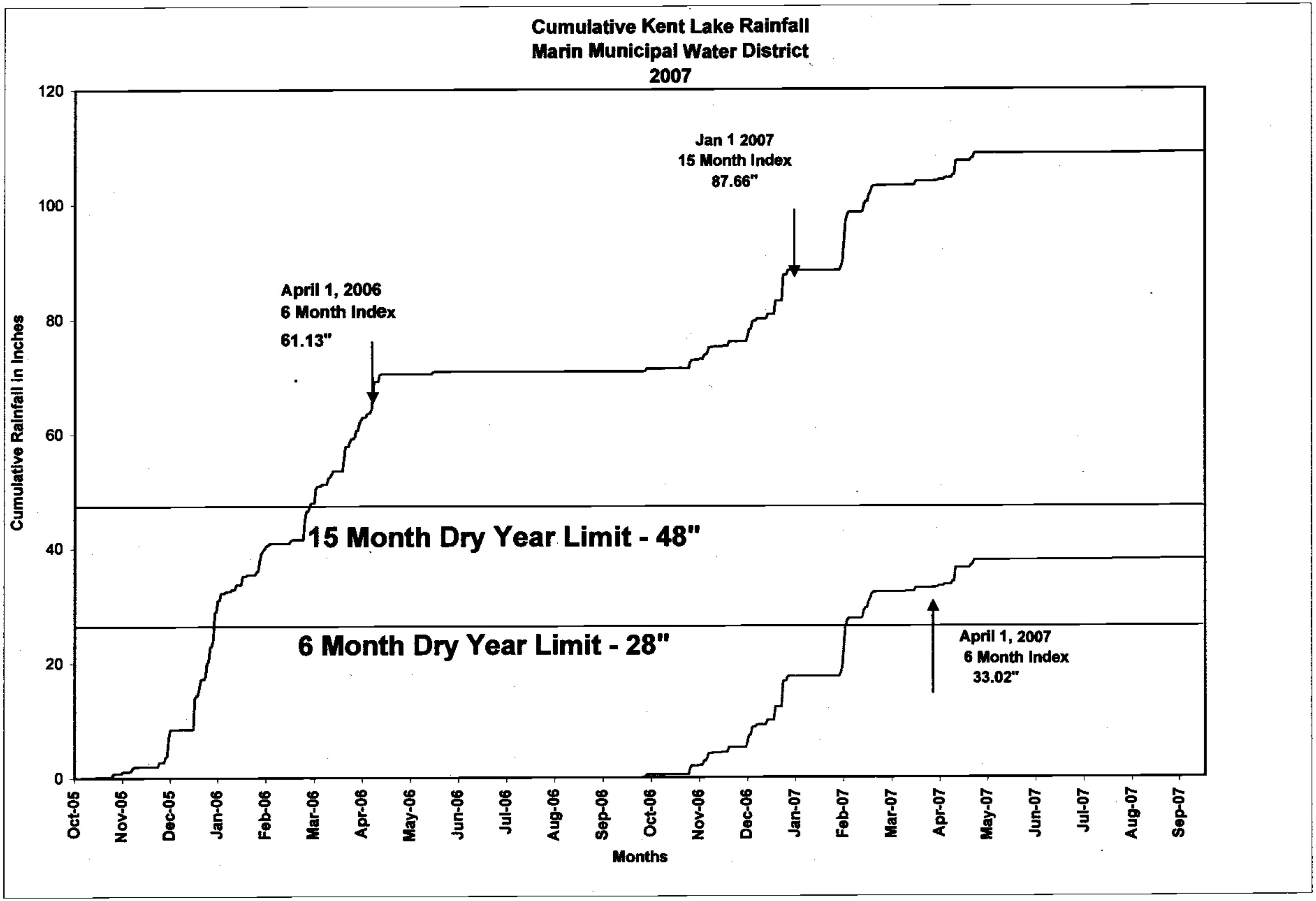


Cumulative Kent Lake Rainfall
Marin Municipal Water District
2006
Cumulative Rainfall in Inches
120
100
80
60
40
20
0
Jan 1 2006
15 Month Index 86.8"
April 1, 2006
6 Month Index
61.13"
April 1, 2005
6 Month Index 40.5"
15 Month Dry Year Limit - 48"
6 Month Dry Year Limit - 28"
Oct-04
Dec-04
Jan-05
Feb-05
Mar-05
Apr-05
May-05
Jun-05
Jul-05
Aug-05
Sep-05
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Months

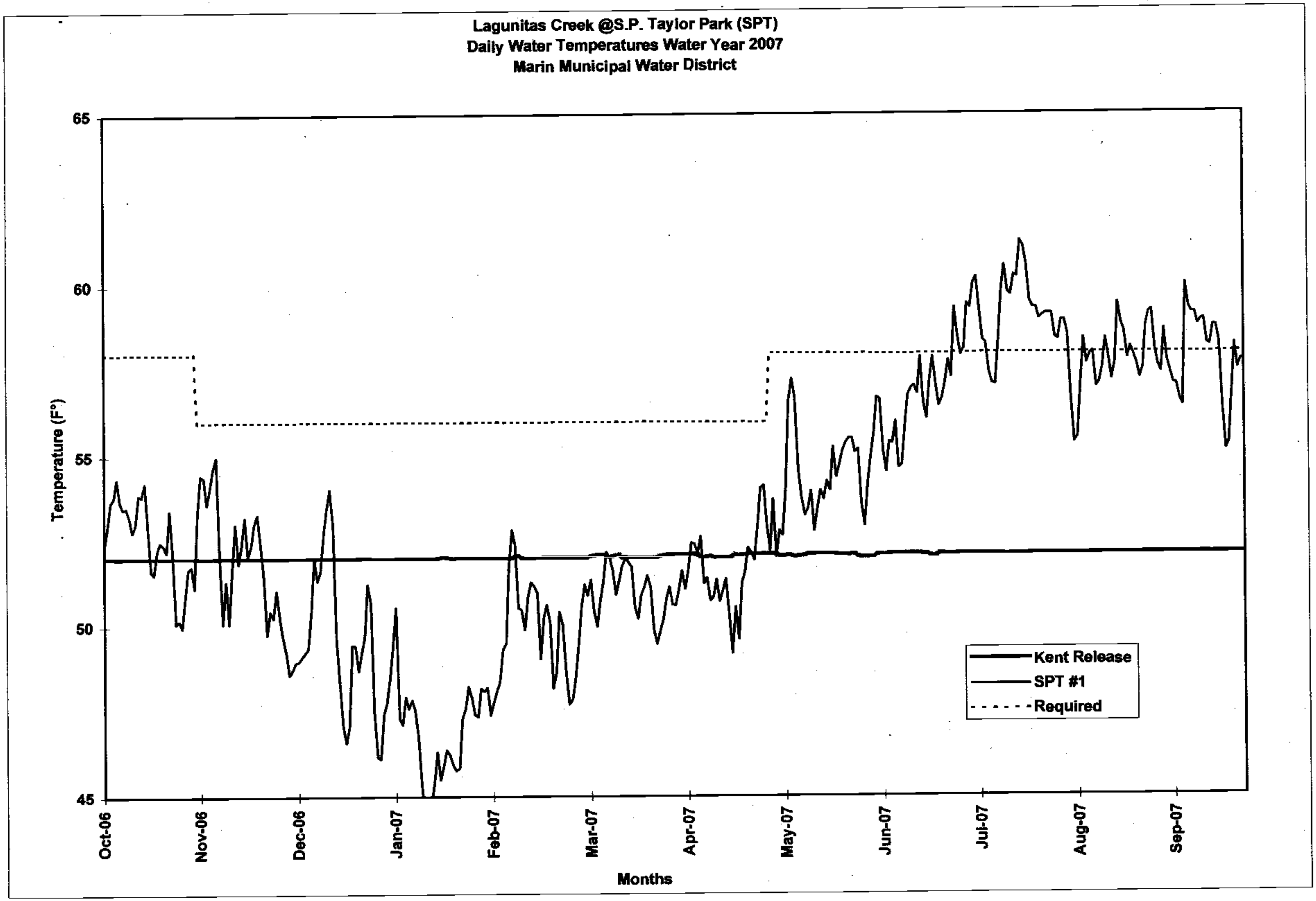

Lagunitas Creek @ S.P. Taylor (SPT#2)
Daily Water Temperatures Water Year 2006
Marin Municipal Water District
Temperature (F°)
65
60
55
50
45
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Months
May 22nd through 24th unit malfunciton
July 23 through August 1 used SPT #1
Kent Release °F
SPT # 2
Required

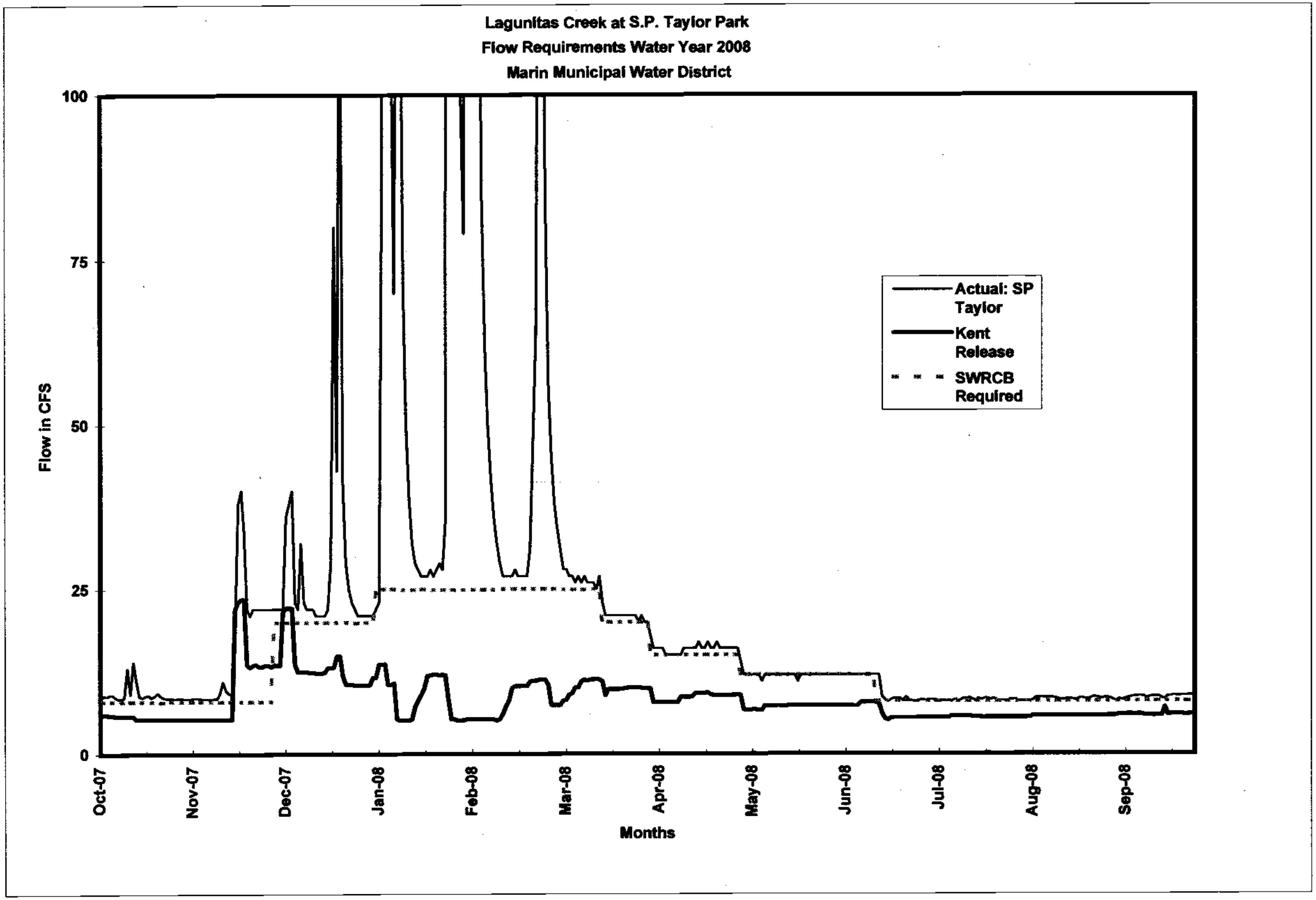


Lagunitas Creek at S.P. Taylor Park
Flow Requirements Water Year 2007
Marin Municipal Water District
Flow in CFS
100
75
50
25
0
Actual: SP Taylor
Kent Release
SWRCB Required
Oct-06
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Months

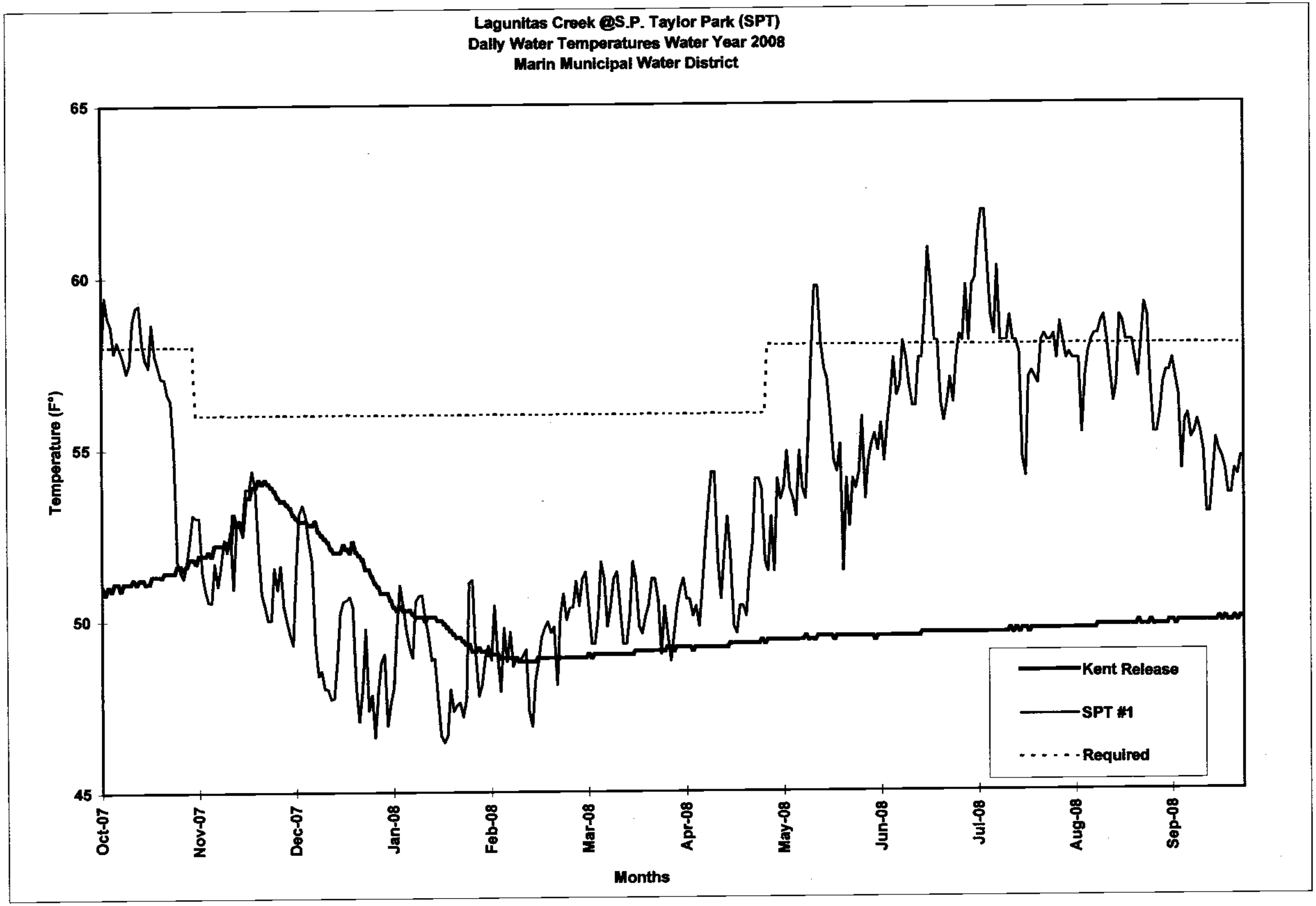


Cumulative Kent Lake Rainfall
Marin Municipal Water District
2007
Cumulative Rainfall in Inches
0
20
40
60
80
100
120
Jan 1 2007
15 Month Index
87.66"
April 1, 2006
6 Month Index
61.13"
15 Month Dry Year Limit - 48"
6 Month Dry Year Limit - 28"
April 1, 2007
6 Month Index
33.02"
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Months

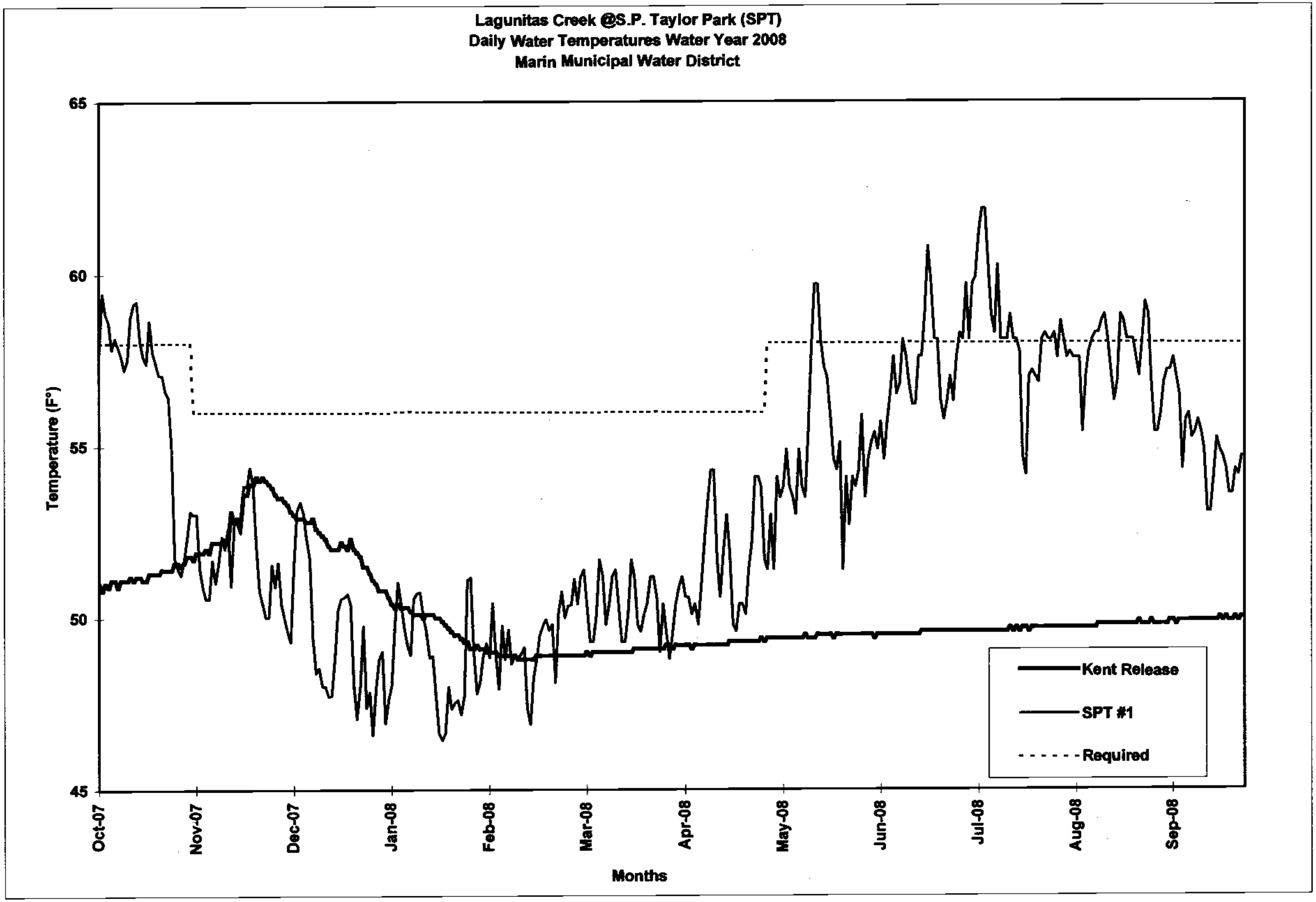

Lagunitas Creek @S.P. Taylor Park (SPT)
Daily Water Temperatures Water Year 2007
Marin Municipal Water District
65
60
55
50
45
Temperature (F°)
Oct-06
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Months
Kent Release
SPT #1
Required



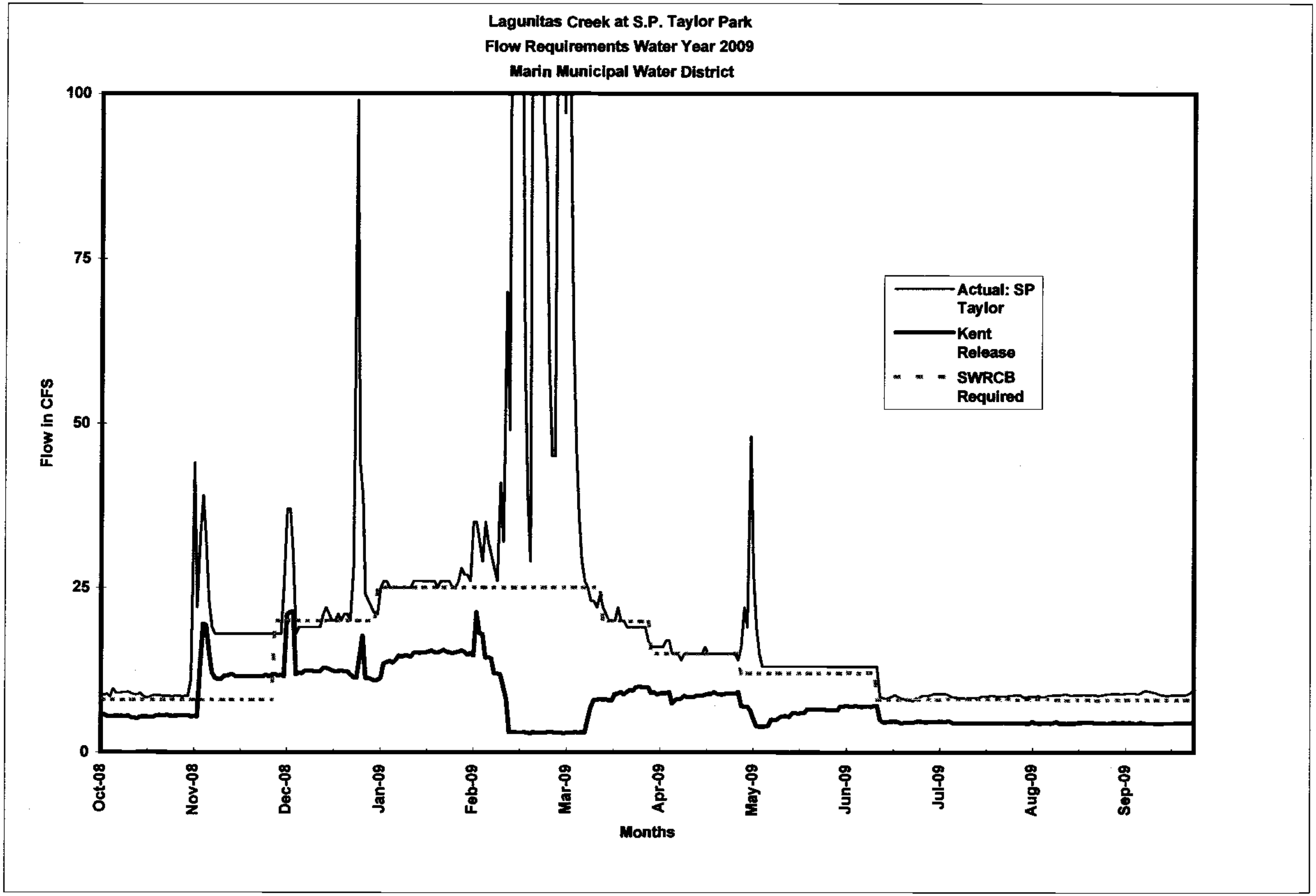
Lagunitas Creek at S.P. Taylor Park
Flow Requirements Water Year 2008
Marin Municipal Water District
100
75
50
25
0
Flow in CFS
Actual: SP Taylor
Kent Release
SWRCB Required
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Months



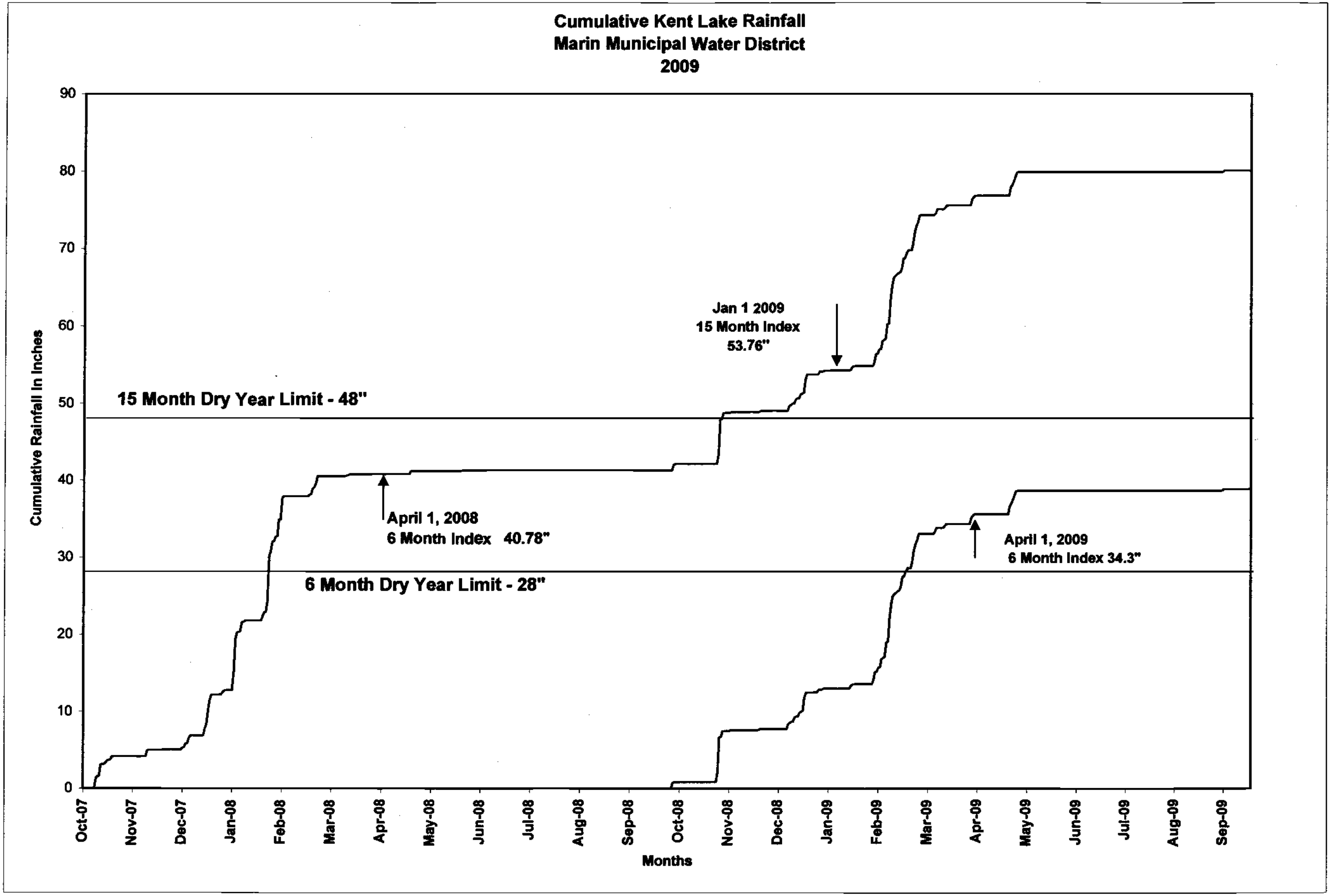
Lagunitas Creek @S.P. Taylor Park (SPT)
Daily Water Temperatures Water Year 2008
Marin Municipal Water District
Temperature (F°)
65
60
55
50
45
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Months
Kent Release
SPT #1
Required

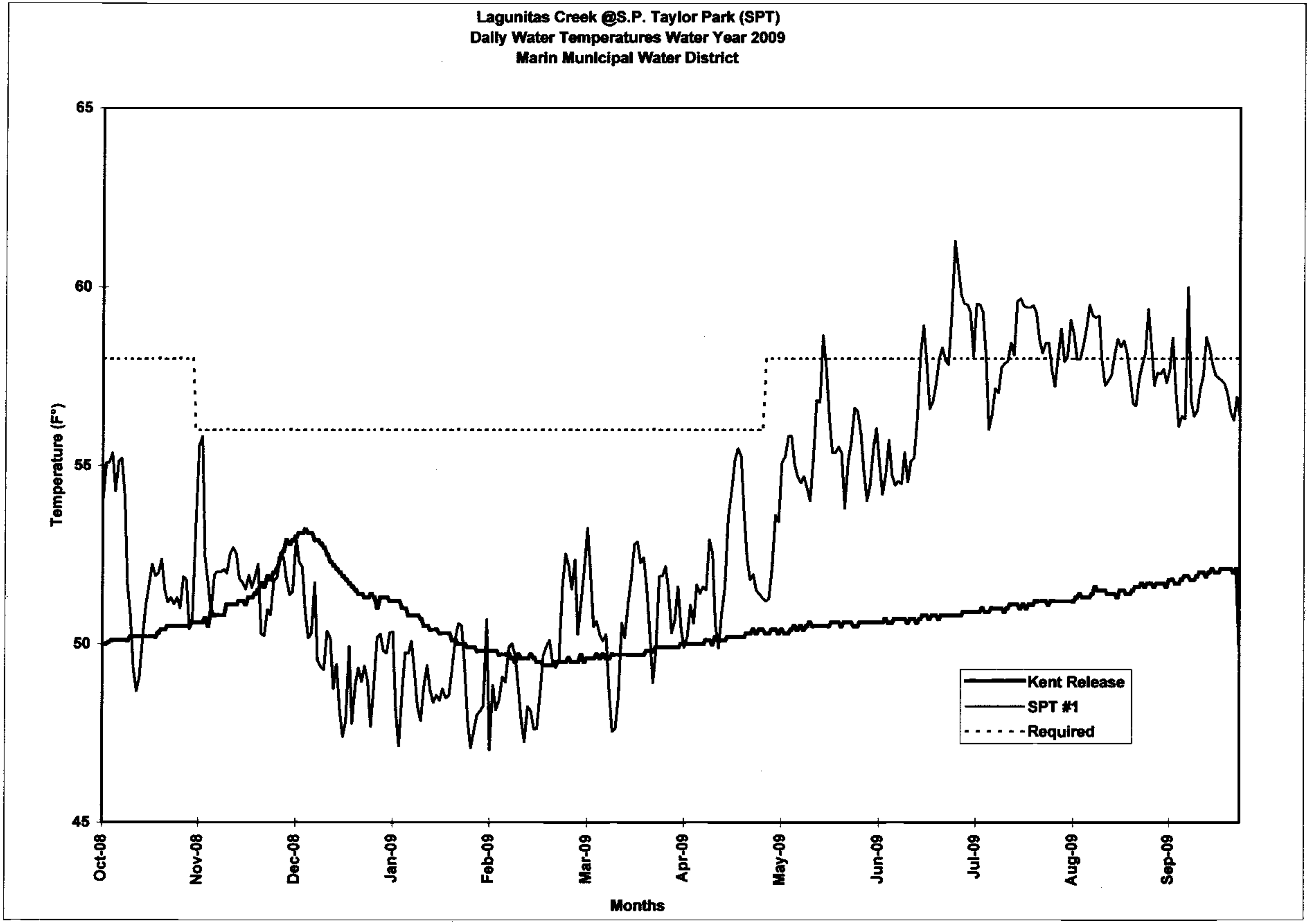


Lagunitas Creek @S.P. Taylor Park (SPT)
Daily Water Temperatures Water Year 2008
Marin Municipal Water District
65
60
55
50
45
Temperature (F°)
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Months
Kent Release
SPT #1
Required



Lagunitas Creek at S.P. Taylor Park
Flow Requirements Water Year 2009
Marin Municipal Water District
Flow in CFS
100
75
50
25
0
Actual: SP Taylor
Kent Release
SWRCB Required
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Jul-09
Aug-09
Sep-09
Months


Cumulative Kent Lake Rainfall
Marin Municipal Water District
2009
Cumulative Rainfall In Inches
90
80
70
60
50
40
30
20
10
0
Jan 1 2009
15 Month Index
53.76"
15 Month Dry Year Limit - 48"
April 1, 2008
6 Month Index 40.78"
April 1, 2009
6 Month Index 34.3"
6 Month Dry Year Limit - 28"
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Jul-09
Aug-09
Sep-09
Months


Lagunitas Creek @S.P. Taylor Park (SPT)
Daily Water Temperatures Water Year 2009
Marin Municipal Water District
65
60
55
50
45
Temperature (F°)
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Jul-09
Aug-09
Sep-09
Months
Kent Release
SPT #1
Required

APPENDIX F

Summary of MMWD Water Quality Monitoring Data For the Lagunitas Creek Watershed
1995 – 2006

Summary of Water Quality Monitoring Data
For the Lagunitas Creek Watershed (1995-2006)

Marisa Piovarcsik, Fisheries Watershed Aide
Gregory Andrew, Fishery Program Manager
Marin Municipal Water District
August 25, 2008

The Marin Municipal Water District's (MMWD) water quality monitoring program of the Lagunitas Creek watershed began in January of 1995, under an agreement with the Regional Water Quality Control Board. Water quality sampling has been conducted at 4 sample sites (Figure 1):

- Lagunitas Creek at Kent (between Peters Dam/Kent Lake and Shafter Bridge);
- Lagunitas Creek at Nicasio Creek (downstream of the Nicasio Creek confluence);
- Nicasio Creek (downstream of Seeger Dam/Nicasio Reservoir); and
- San Geronimo Creek (upstream of the mouth, at the Inkwells)

There is also a sample site located on Walker Creek, at Arroyo Sausal, just downstream from MMWD's Soulajule Reservoir. The results from that sample site are not presented in this report, which is intended to focus on Lagunitas Creek.

Water samples have been collected monthly at each site and analyzed at MMWD's water quality lab for the following eight parameters:

- Temperature;
- pH;
- Turbidity;
- Alkalinity;
- Hardness;
- Copper;
- Total Suspended Solids; and
- Settleable Solids

The results of this monitoring effort are summarized in Table 1. Trends in ph, alkalinity, hardness, and turbidity are displayed in Figures 2-9. A brief review of each parameter is discussed below, with the exception of temperature, which will be discussed separately in a later report. The complete results for all water quality monitoring are shown in Appendix A.

pH

The permissible range of pH for fish is dependent on factors such as temperature, dissolved oxygen, buffering capacity, and concentrations of dissolved materials in the water. While no single pH value can be given as a threshold for anticipating population responses, data suggests that fish are adversely affected by pH levels below 5.6 (Spence 1996). According to the Regional Water Quality Control Board, Region 2, for the San Francisco Bay Basin (which includes the Lagunitas Creek watershed), “pH shall not be depressed below 6.5 nor raised above 8.5” (Cal. EPA 2006).

Mean pH values at the four sites ranged from 7.70 to 8.0, well above the adverse level of 5.6. Only at the Nicasio Creek site did pH exceed the upper limit of 8.5; this occurred eight times in the 12 years of monitoring.

Table 1:
Range and Mean of Water Quality Parameters for the Lagunitas Creek Watershed (1995-2006)

Site		pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)	Copper (mg/L) ^ †	Total suspended solids (mg/L)** †	Settleable solids (mg/L)
Lagunitas Creek @ Kent (Shafter Bridge)	max	8.24	30.0	166.0	146.0	0.024	37	< 0.5
	min	7.10	0.3	48.5	50.0	< 0.001	<2	< 0.5
	mean	7.70	2.4	64.3	67.0	0.006-0.007	3.1-3.5	< 0.5
Lagunitas Creek @ Nicasio Creek (Gallagher Ranch) *	max	8.10	154.0	142.0	154.0	0.037	77	< 0.5
	min	6.90	0.4	49.0	50.0	0.001	< 2	< 0.5
	mean	7.70	10.0	81.4	87.7	0.007-0.008	8.6-8.9	< 0.5
San Geronimo Creek (at the Inkwells)	max	8.33	88.0	179.0	205.0	0.019	216	< 0.5
	min	7.40	0.2	56.0	65.0	< 0.001	< 2	< 0.5
	mean	8.00	4.0	137.3	150.2	0.005-0.007	4.6-5.1	< 0.5
Nicasio Creek (below Seeger Dam)	max	9.95	192.0	167.0	168.0	0.101	121	< 0.5
	min	6.95	0.6	28.0	38.0	< 0.001	<2	< 0.5
	mean	7.80	14.4	100.1	103.6	0.008-0.009	6.8-6.9	< 0.5

* Water quality sampling at this site discontinued in July of 2002, when access by the property owner was denied.

^ Copper was measured in mg/L. The EPA sets the standard for copper in ug/L. 1 ug = 0.001 mg.
Note: The detection limit for copper in water samples was 0.001mg/L. If there was no detectable limit, then the sample was said to be < 0.001 mg/L.

** The detection limit of total suspended solids is reported here as <2 but actually appears to have fluctuated over the 12 year sample period, between <0.5 to <3.

† These means fall within a range because parameters in some years fell below detectable levels, so the ranges reflect the range from a value of 0 up to a value that is the detection limit.

Alkalinity

Alkalinity, or the buffering capacity of water, may not directly affect anadromous fish; however the ability of water to neutralize acids is important. Waters with low alkalinity are more susceptible to pH fluctuations, which can lead to increased toxicity of certain pollutants. The EPA (1976) states that in order to support cold water biota in freshwater aquatic systems, a minimum alkalinity of 20 mg/L should be maintained. The alkalinity at all four Lagunitas sites was above this threshold on all sampling dates.

Hardness

The effects of hardness to aquatic life appear to be related to the ions causing the hardness rather than hardness, itself. While there are no specific criteria for fish, hardness helps to reduce toxicity of metals. Hardness, at the four Lagunitas sampling sites, ranged from 38 to 205 mg/L.

Turbidity

Turbidity of water, which is measured in nephelometric turbidity units (NTUs), is a measure of the degree to which light passing through is reduced by suspended particulates. Suspended matter may include inorganic solids such as sand, silt, or clay or may consist of zooplankton, algae, or other organic matter.

The effects of turbidity to salmon are both direct and indirect. Suspended materials can cause gill abrasions or clogging, thus reducing resistance to disease. Turbidity decreases the ability of fish to find prey, causing lower growth rates. Data suggests that turbidities greater than 20 NTU may adversely affect the ability of salmonids to capture prey (e.g., Berg and Northcote 1985, Newcombe and Jensen 1996). Also, as particulates settle, they may smother developing eggs in spawning gravels. Indirectly, turbid waters increase water temperature due to the absorption of heat by the suspended particles, which in turn reduce concentrations of dissolved oxygen. Decreased light penetration of the water column reduces primary production, thus affecting the food base for salmonids. While there are no numerical criteria for turbidity, the Regional Water Quality Control Board states, “Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses” (Cal. EPA 2006)

Turbidity naturally increases with rainfall, as high flows from stormwater runoff causes erosion of hillslopes and streambanks. The length and strength of a storm has the most influence on how turbid the water becomes and how long it remains turbid. Reservoir spilling, of Kent Lake and Nicasio Reservoir, may also have affected turbidities. While Lagunitas Creek turbidities spiked with storm events, lower turbidities were the norm. The monitoring results reveals that 84%, or more, of all water samples at all sites had turbidities lower than 20 NTU’s.

Copper

Although copper is a necessary trace element for all living organisms, studies have shown that copper in small amounts can have lethal and sub lethal effects that increase mortality rates and decrease fish survival and production. Sub lethal effects may include: the impairment of a salmon's sense of smell, which can interfere with salmon feeding, predator avoidance, and migration; impairment of the ability of salmon to fight disease; killing or harming salmon food sources; and changes in a salmon's enzyme activity, blood chemistry and metabolism, which can cause death and impair reproduction.

Copper monitoring in Lagunitas Creek has been done in response to the District's use of copper sulfate in the reservoirs to control algal blooms. The monitoring program has included analyses for copper to determine if releases and spilling from the reservoirs may have influenced copper levels in Lagunitas and Nicasio Creeks.

The US EPA water quality criteria for copper are hardness dependent. Data suggests, for some species, that acute toxicity of copper decreases as hardness increases. The EPA also states that "when the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate" (EPA, 1984). As copper toxicity is not adequately expressed by measuring total copper, the water-effects ratio more accurately determines site specific criteria for copper. Additionally, the EPA has recently released proposed copper criteria which enable the use of the Biotic Ligand Model to evaluate copper toxicity. EPA realizes that other water quality parameters besides total hardness and total or dissolved copper concentrations determine actual copper toxicity. The Biotic Ligand model evaluates 9 water quality parameters, none of which are total hardness.

The EPA's current recommendations for copper in freshwater are 13 ug/L for acute (1 hour average) toxicity and 9 ug/L for chronic (4 day average) toxicity, and they are calculated for 100 mg/L hardness as $CaCO_3$.

As the water samples were taken instantaneously and monthly, and hardness levels fluctuated, it is unclear whether copper levels exceeded the threshold levels as set out by the US EPA. With one exception, the copper levels during the 12 year sampling effort ranged up to 0.037 mg/L (37 ug/L). However, on March 29, 2000 a water sample from Nicasio Creek, recorded copper levels at 0.101 mg/L (101 ug/L) with a hardness of 57, which was clearly a result that exceeded the EPA's recommendations.

The San Geronimo Creek sample site has shown copper levels ranging up to 0.019 mg/L (19 ug/L). San Geronimo Creek does not receive any water from any reservoir, so there appears to be some "background" copper levels that are detectable in the watershed. In addition, while not presented in this report, results from the Walker Creek sample site, below Soulajule Reservoir, have shown over a dozen copper level results exceeding 0.013 mg/L (13 ug/L) and even one result of 0.122 mg/L (122 ug/L) at a hardness of 56 mg/L. Soulajule Reservoir is not treated with copper sulfate and so Walker Creek can also be considered as an example of background conditions for copper.

Copper deposits have been documented within the Lagunitas Creek watershed, particularly along Bolinas Ridge, and some of these deposits have historically been exploited (Aubrey 1908). Dogtown Copper Mine, located just off Bolinas Ridge, was developed in 1863 and re-worked around the turn of the century (National Park Service, no date). These small, scattered copper deposits could be the source of copper that are being detected in the water sampling program, and they would certainly have to be the source for sites where no copper sulfate treatments occur.

When comparing the averages of copper values from all of the creek sites MMWD has monitored, the two creek sites without copper addition (Walker Creek and San Geronimo Creek) have an average of 8 ug/L copper, and the three creek sites potentially influenced by copper addition (Lagunitas at Kent, Nicasio Creek, and Lagunitas at Nicasio) also have an average copper concentration of 8 ug/L. So there does not appear to be any clear differences between drainages with copper addition, and those without.

Suspended and Settleable Solids

According to the Regional Water Quality Control Board, “Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses,” and “waters shall not contain substances in concentrations that result in the deposition of material that cause nuisance or adversely affect beneficial uses” (Cal. EPA, 2006). It is unclear whether suspended and settleable solids adversely affected use, however, all settleable solids values were < 0.5ml/L at all sites in 12 years of monitoring.

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FIGURES

Lagunitas Creek Water Quality Trends

1995-2006

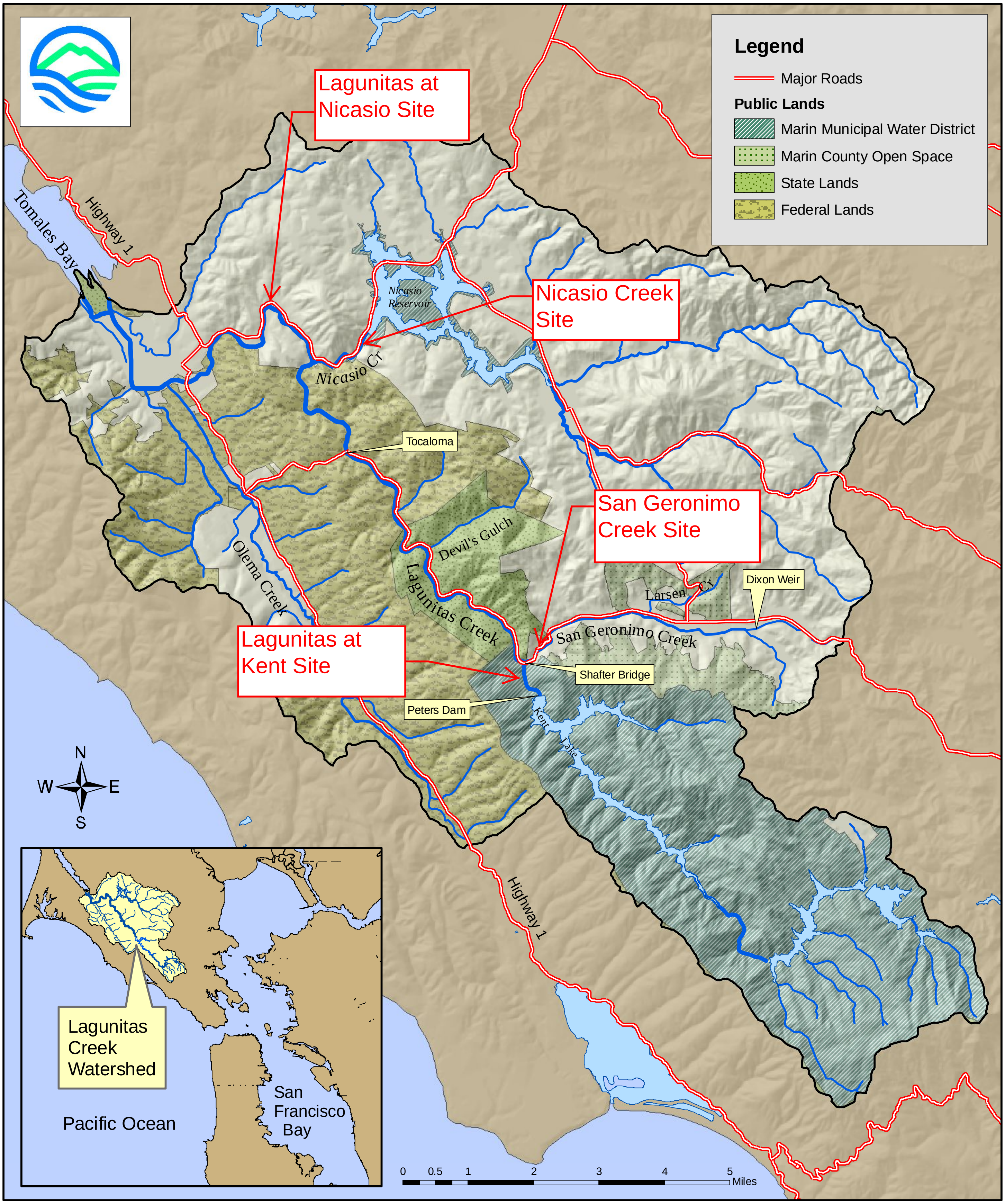


Figure 1. Water quality monitoring sample sites in the Lagunitas Creek Watershed

Figure 2. Lagunitas Creek @ Kent pH, Alkalinity, and Hardness

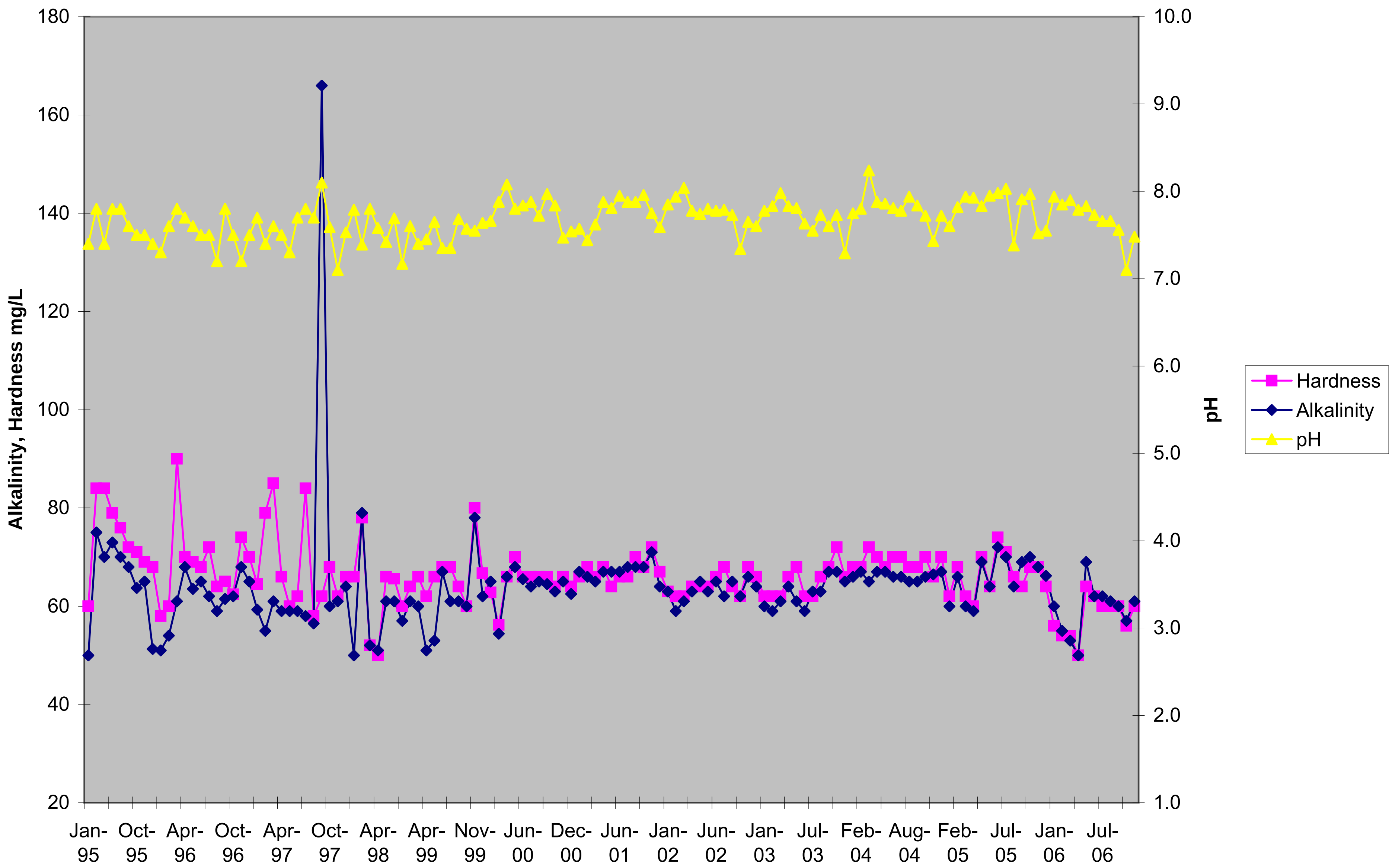


Figure 3. Lagunitas Creek @ Nicasio Creek pH, Alkalinity, and Hardness

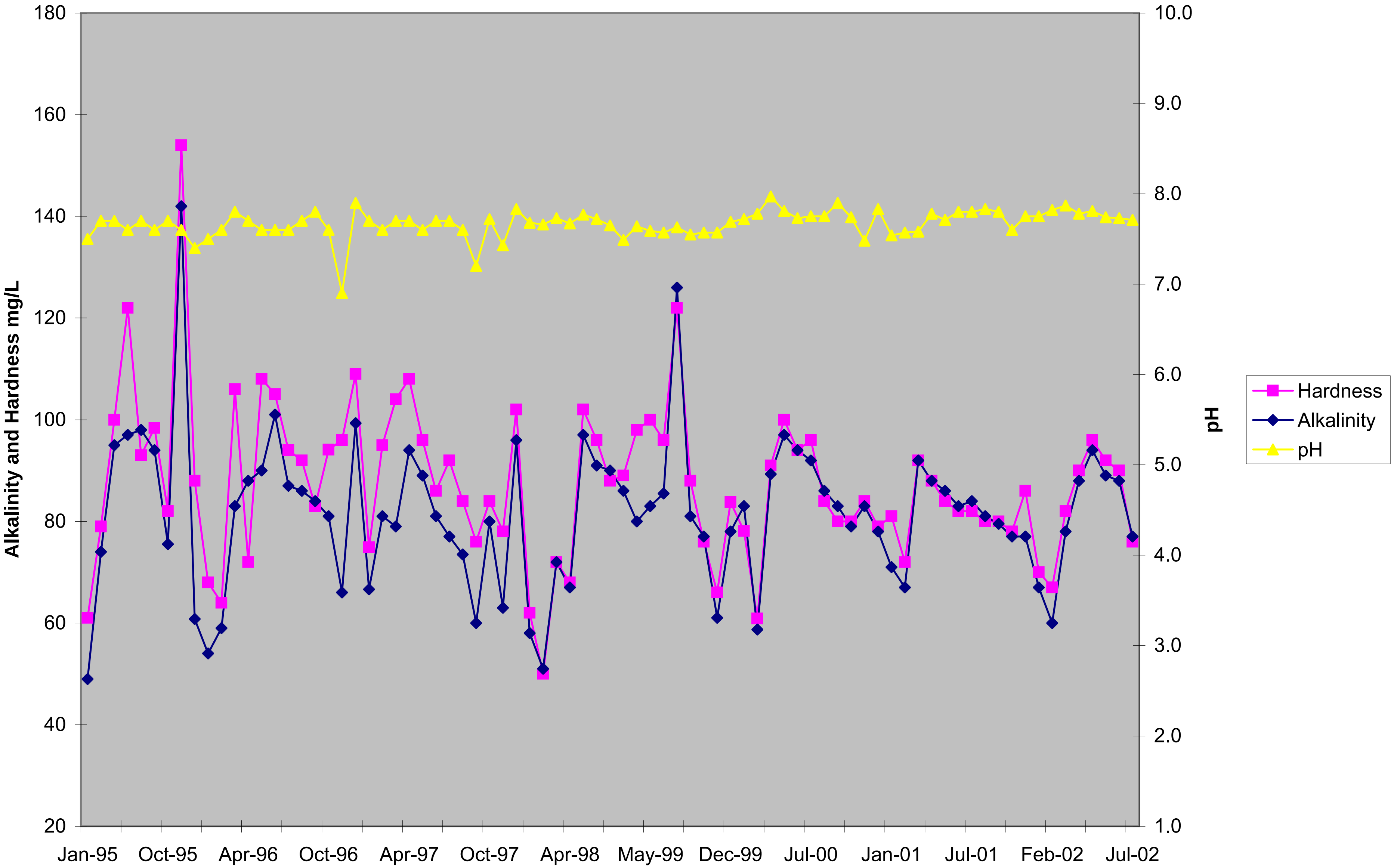


Figure 4. Nicasio Creek pH, Alkalinity, and Hardness 1995-2006

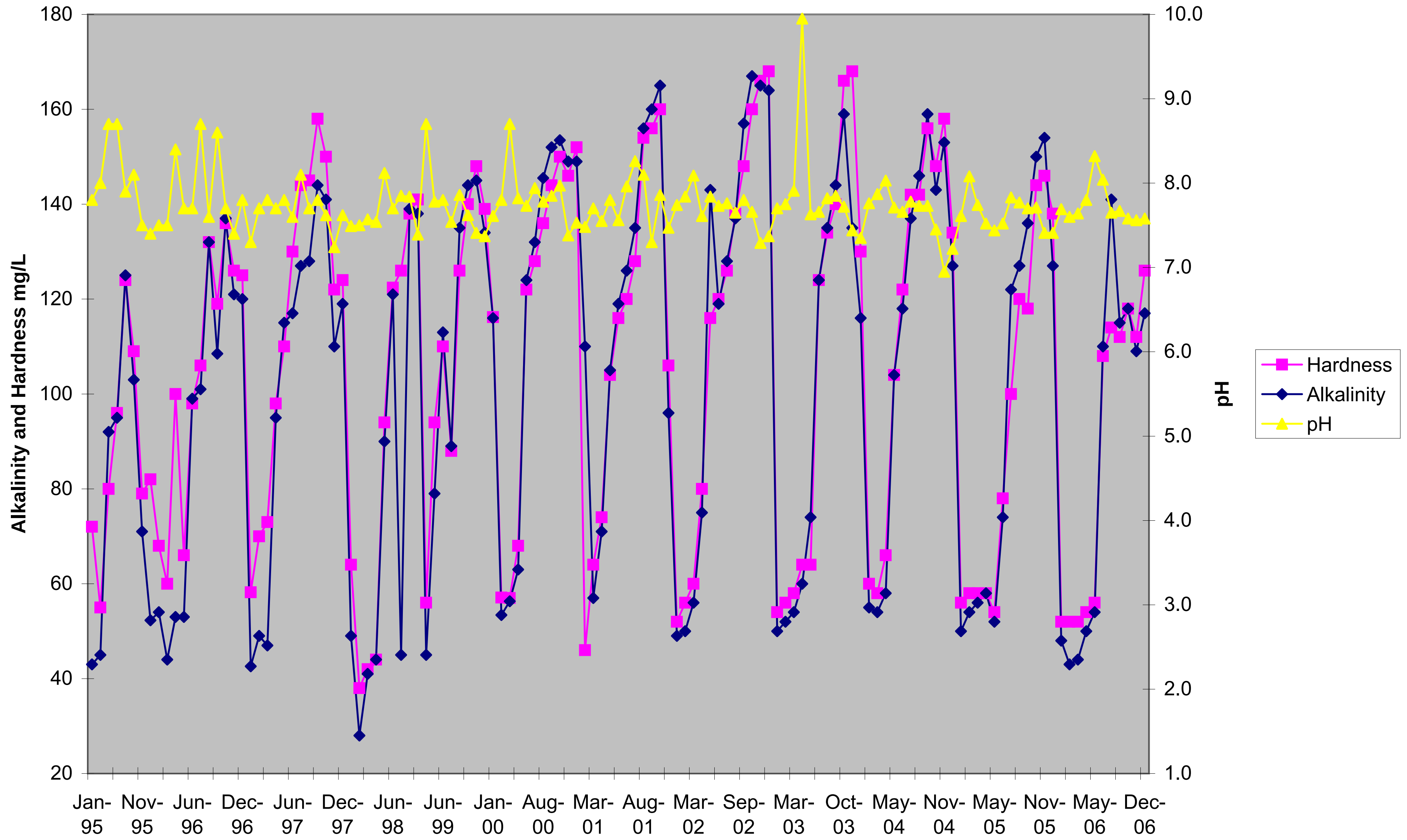


Figure 5. San Geronimo Creek pH, Allkalinity, and Hardness 1995-2006

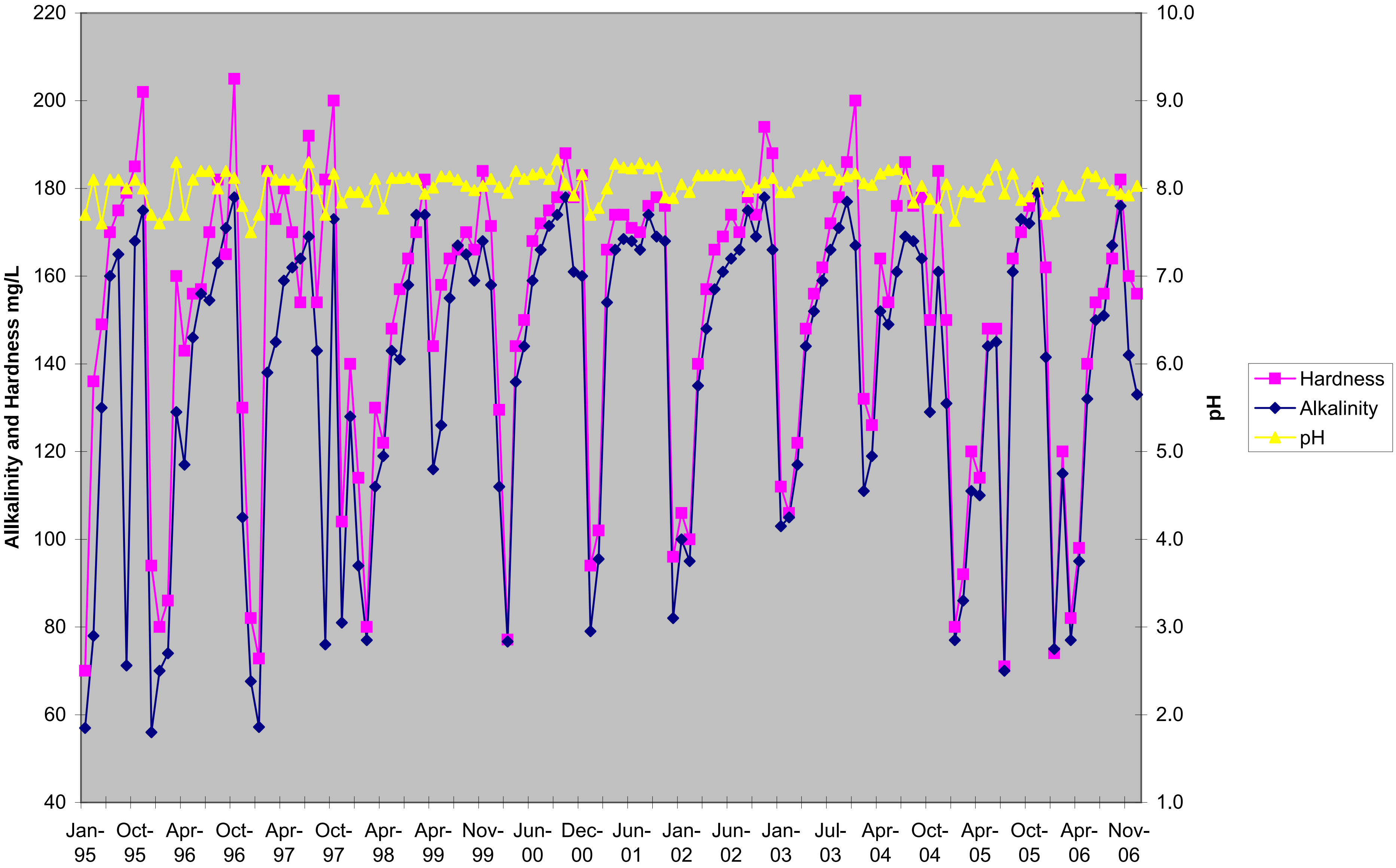


Figure 6. Lagunitas Creek @ Kent Turbidity 1995-2006

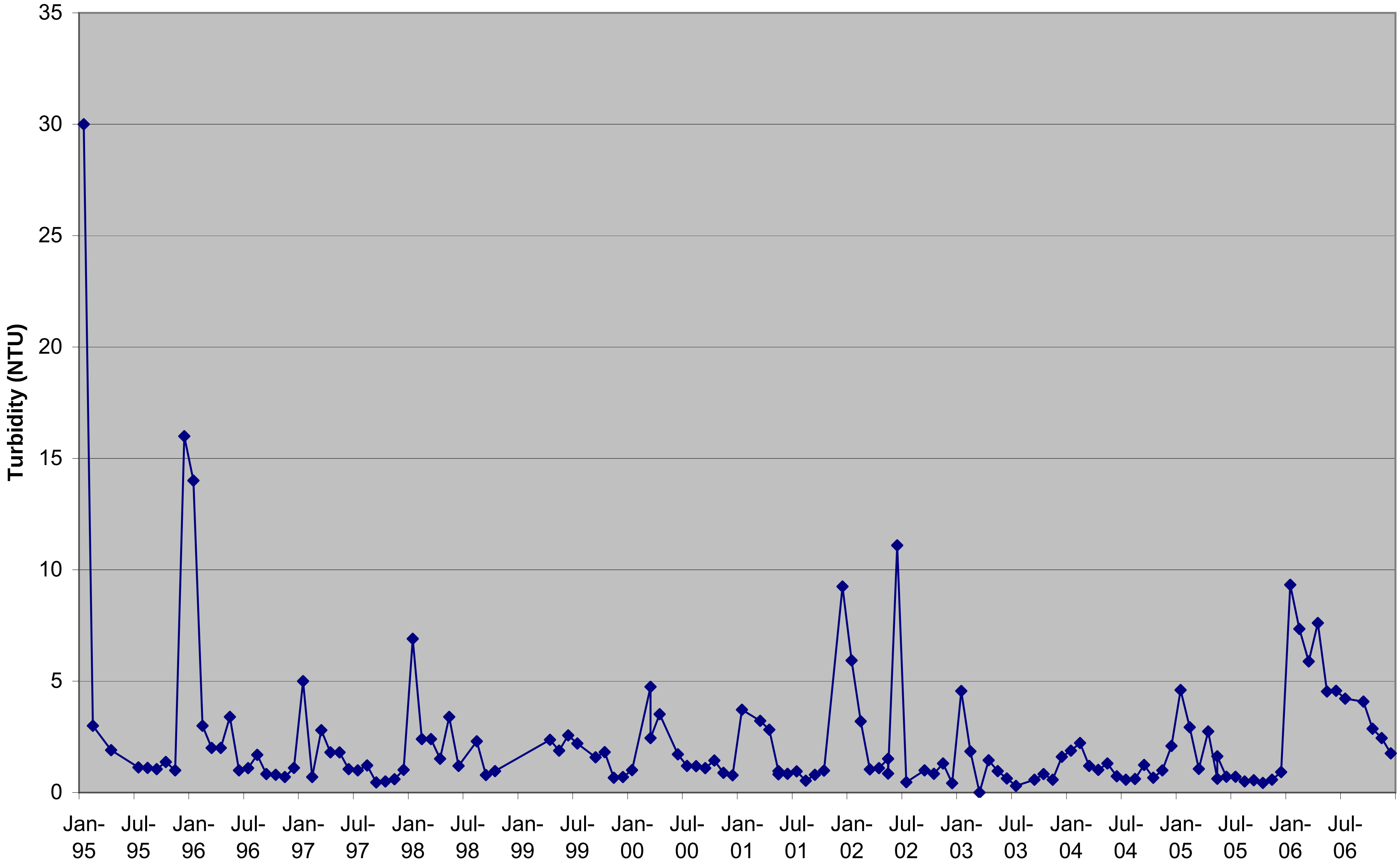


Figure 7. Lagunitas Creek @ Nicasio CreekTurbidity 1995-2002

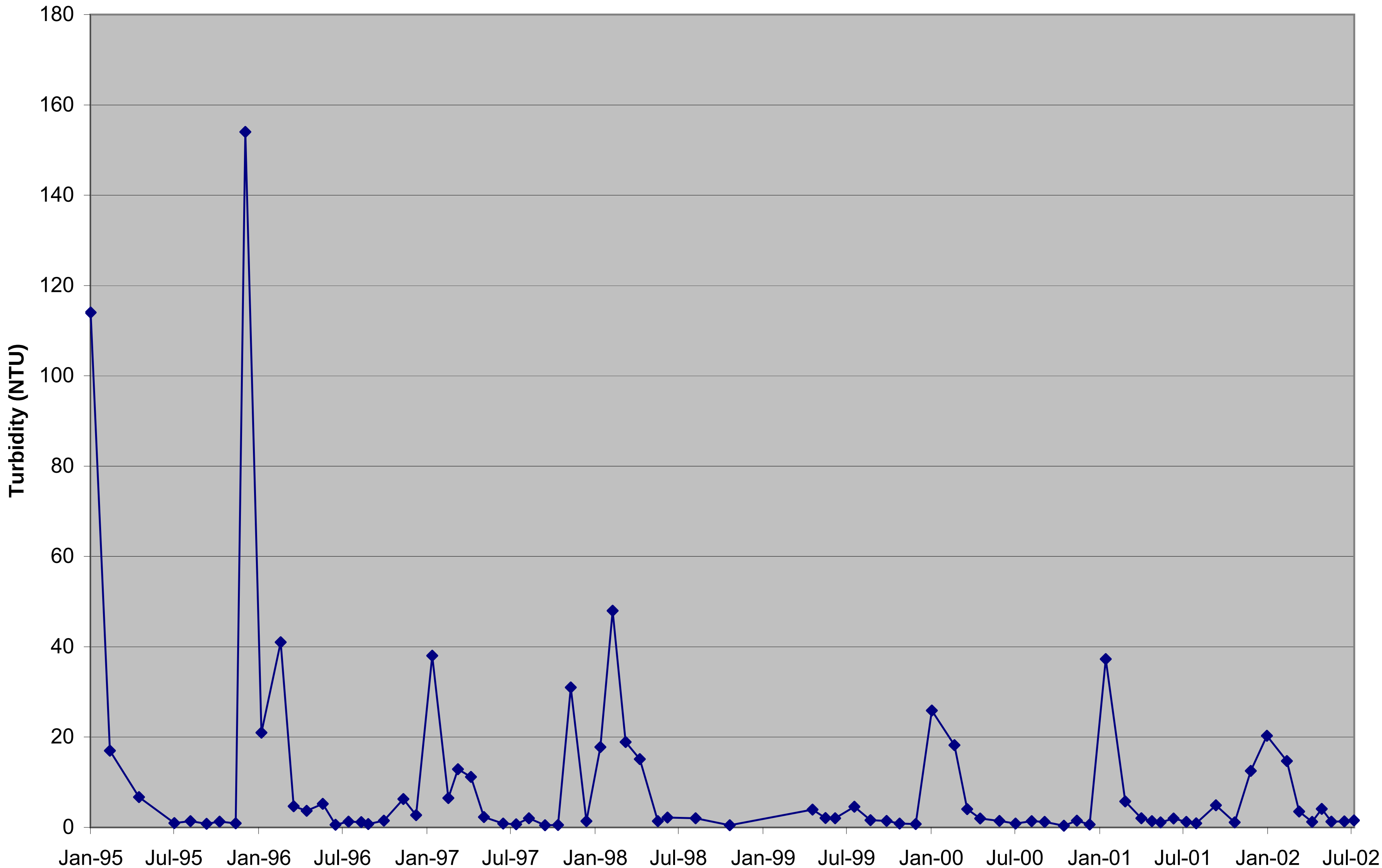


Figure 8. Nicasio CreekTurbidity 1995-2006

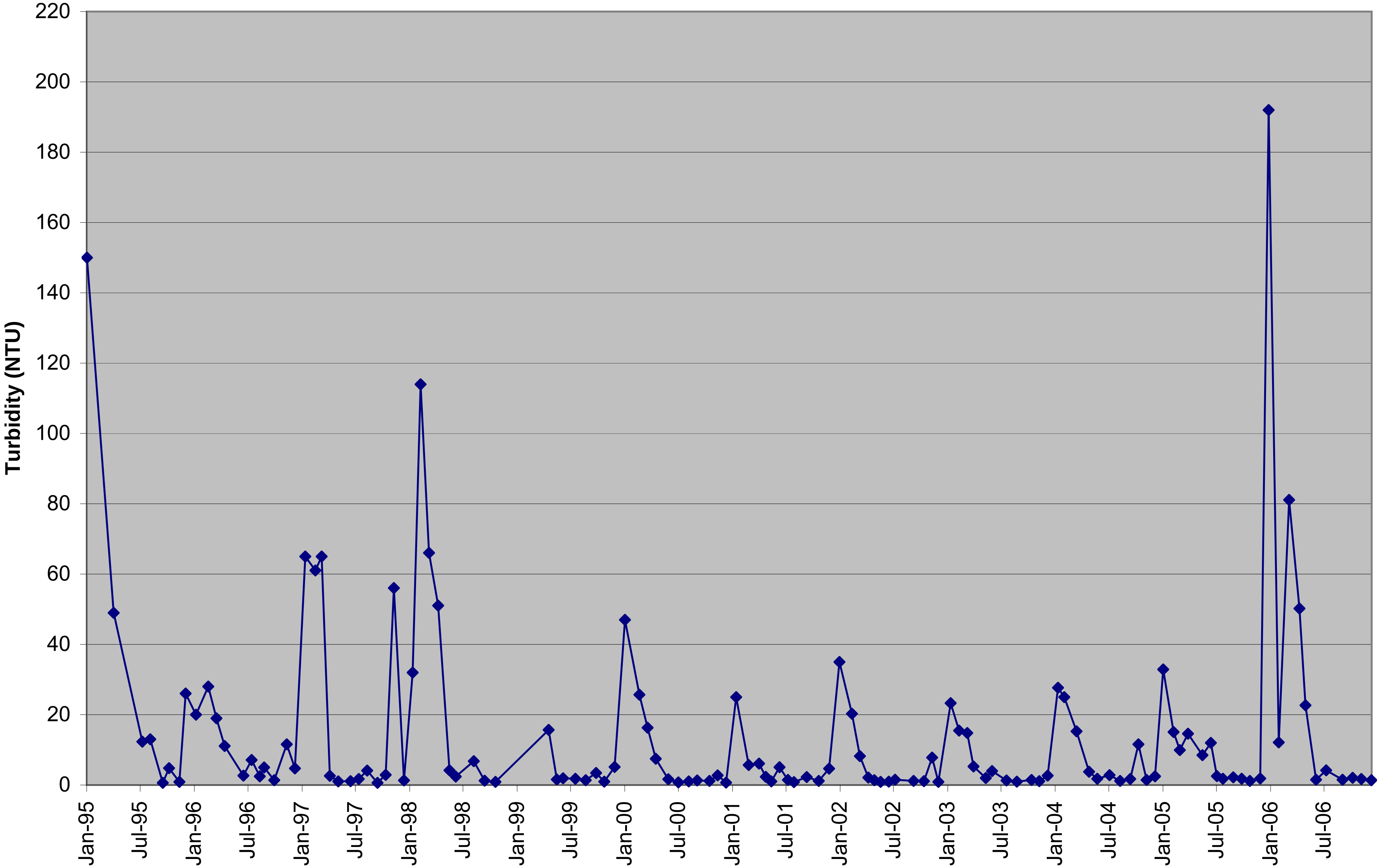
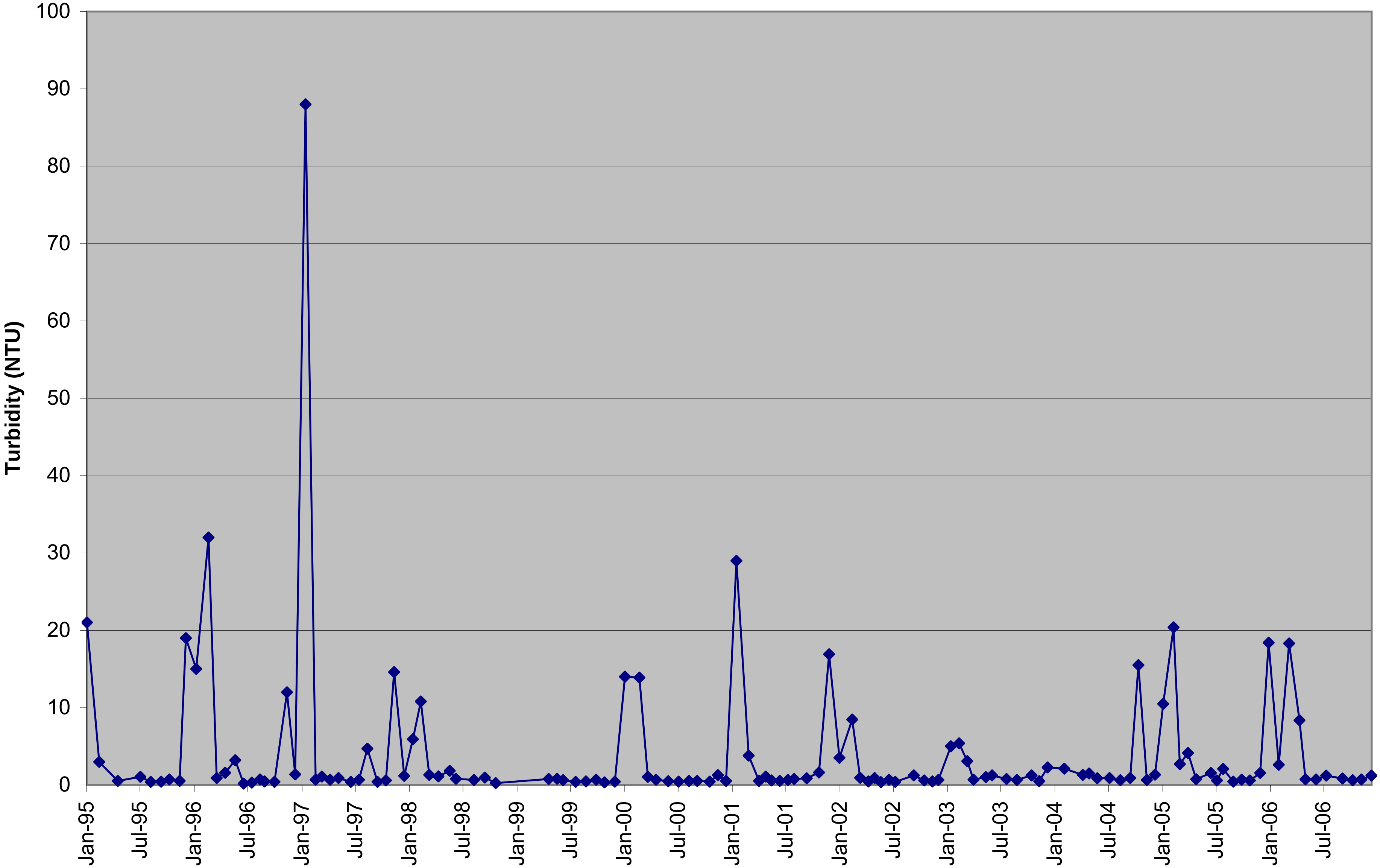


Figure 9. San Geronimo Creek Turbidity 1995-2006



ATTACHMENT A

Marin Municipal Water District

Regional Water Quality Control Board Monthly Creek Monitoring Program

Water Quality Data 1995 – 2006

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (^oC)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)		Copper* (mg/L)		Total suspended solids		Settleable solids (mg/L)
00-79	1/11/1995	Lag Creek @ Kent (Shafter Bridge)	10.6	7.4	30	50.0	60		0.010		37	<	0.5
00-18	1/11/1995	Lag Crk @ Nicasio Crk (Gallagher)	13	7.5	114	49.0	61		0.006		60	<	0.5
00-37	1/11/1995	San Geronimo Creek	11.8	7.7	21	57.0	70		0.006		17	<	0.5
00-17	1/12/1995	Nicasio Creek	12.1	7.8	150	43.0	72		0.012		121	<	0.5
00-79	2/22/1995	Lag Creek @ Kent (Shafter Bridge)	11	7.8	3	75.0	84		0.007		5	<	0.5
00-18	2/22/1995	Lag Crk @ Nicasio Crk (Gallagher)	12.4	7.7	17	74.0	79		0.010		8	<	0.5
00-37	2/22/1995	San Geronimo Creek	11.2	8.1	3	78.0	136		0.008		4	<	0.5
00-17	4/13/1995	Nicasio Creek		8.0	49	45.0	55	<	0.001		12	<	0.5
00-79	4/26/1995	Lag Creek @ Kent (Shafter Bridge)	10.8	7.4	1.9	70.0	84	<	0.001		1	<	0.5
00-18	4/26/1995	Lag Crk @ Nicasio Crk (Gallagher)	13	7.7	6.7	95.0	100		0.001		4	<	0.5
00-37	4/26/1995	San Geronimo Creek	11	7.6	0.53	130.0	149	<	0.001		2	<	0.5
00-79	7/12/1995	Lag Creek @ Kent (Shafter Bridge)	14	7.8	1.13	73.0	79		0.007			<	0.5
00-18	7/12/1995	Lag Crk @ Nicasio Crk (Gallagher)	17.2	7.6	0.95	97.0	122		0.003			<	0.5
00-37	7/12/1995	San Geronimo Creek	15.2	8.1	1.07	160.0	170		0.004			<	0.5
00-17	7/19/1995	Nicasio Creek		8.7	12.3	92.0	80		0.028			<	0.5
00-17	8/15/1995	Nicasio Creek		8.7	13	95.0	96		0.005		13	<	0.5
00-79	8/16/1995	Lag Creek @ Kent (Shafter Bridge)		7.8	1.11	70.0	76		0.018		5	<	0.5
00-18	8/16/1995	Lag Crk @ Nicasio Crk (Gallagher)		7.7	1.39	98.0	93		0.009		5	<	0.5
00-37	8/16/1995	San Geronimo Creek		8.1	0.41	165.0	175		0.017		5	<	0.5
00-79	9/20/1995	Lag Creek @ Kent (Shafter Bridge)	13.2	7.6	1.05	68.0	72		0.010		2	<	0.5
00-18	9/20/1995	Lag Crk @ Nicasio Crk (Gallagher)	17.5	7.6	0.78	94.0	98.4		0.009		4	<	0.5
00-37	9/20/1995	San Geronimo Creek	16.5	8.0	0.43	71.2	179		0.010		3	<	0.5
00-17	9/27/1995	Nicasio Creek	18.2	7.9	0.6	125.0	124		0.006		2	<	0.5
00-79	10/18/1995	Lag Creek @ Kent (Shafter Bridge)	12	7.5	1.37	63.7	71		0.008		1	<	0.5
00-18	10/18/1995	Lag Crk @ Nicasio Crk (Gallagher)	16	7.7	1.29	75.5	82		0.012		2	<	0.5
00-17	10/18/1995	Nicasio Creek	23	8.1	4.8	103.0	109		0.009		7	<	0.5
00-37	10/18/1995	San Geronimo Creek	13	8.1	0.72	168.0	185		0.007		2	<	0.5
00-79	11/22/1995	Lag Creek @ Kent (Shafter Bridge)		7.5	1	65.0	69		0.013	<	1	<	0.5
00-18	11/22/1995	Lag Crk @ Nicasio Crk (Gallagher)		7.6	0.9	142.0	154		0.010		10	<	0.5
00-17	11/22/1995	Nicasio Creek		7.5	0.9	71.0	79		0.005		9	<	0.5
00-37	11/22/1995	San Geronimo Creek		8.0	0.53	175.0	202		0.004	<	1	<	0.5
00-79	12/13/1995	Lag Creek @ Kent (Shafter Bridge)		7.4	16	51.3	68		0.019		9	<	0.5
00-18	12/13/1995	Lag Crk @ Nicasio Crk (Gallagher)		7.4	154	60.8	88		0.016		74	<	0.5
00-17	12/13/1995	Nicasio Creek		7.4	26	52.3	82		0.014		11	<	0.5
00-37	12/13/1995	San Geronimo Creek		7.7	19	56.0	94		0.010		2	<	0.5

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (^oC)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)	Copper* (mg/L)		Total suspended solids		Settleable solids (mg/L)
00-79	1/17/1996	Lag Creek @ Kent (Shafter Bridge)	11.5	7.3	14	51.0	58	0.002		22	<	0.5
00-18	1/17/1996	Lag Crk @ Nicasio Crk (Gallagher)	13	7.5	21	54.0	68	0.003		9	<	0.5
00-17	1/17/1996	Nicasio Creek		7.5	20	54.0	68	0.003		12	<	0.5
00-37	1/17/1996	San Geronimo Creek	11.5	7.6	15	70.0	80	0.002		13	<	0.5
00-79	2/28/1996	Lag Creek @ Kent (Shafter Bridge)	13.6	7.6	3	54.0	60	0.001	<	3	<	0.5
00-18	2/28/1996	Lag Crk @ Nicasio Crk (Gallagher)	14.8	7.6	41	59.0	64	0.007		77	<	0.5
00-17	2/28/1996	Nicasio Creek	13.6	7.5	28	44.0	60	0.007		10	<	0.5
00-37	2/28/1996	San Geronimo Creek	12.6	7.7	32	74.0	86	0.007		45	<	0.5
00-79	3/27/1996	Lag Creek @ Kent (Shafter Bridge)	14	7.8	2	61.0	90	0.016			<	0.5
00-18	3/27/1996	Lag Crk @ Nicasio Crk (Gallagher)	14.8	7.8	4.7	83.0	106	0.009		3	<	0.5
00-17	3/27/1996	Nicasio Creek	17.2	8.4	19	53.0	100	0.011		4	<	0.5
00-37	3/27/1996	San Geronimo Creek	14.5	8.3	0.9	129.0	160	0.006	<	2	<	0.5
00-79	4/24/1996	Lag Creek @ Kent (Shafter Bridge)	12.5	7.7	2	68.0	70	0.012		2	<	0.5
00-18	4/24/1996	Lag Crk @ Nicasio Crk (Gallagher)	14	7.7	3.7	88.0	72	0.010		3	<	0.5
00-17	4/24/1996	Nicasio Creek	15	7.7	11.1	53.0	66	0.011		3	<	0.5
00-37	4/24/1996	San Geronimo Creek	13.2	7.7	1.6	117.0	143	0.019			<	0.5
00-79	5/29/1996	Lag Creek @ Kent (Shafter Bridge)	12	7.6	3.4	63.5	69	0.008	<	2	<	0.5
00-18	5/29/1996	Lag Crk @ Nicasio Crk (Gallagher)	13.5	7.6	5.2	90.0	108	0.009	<	2	<	0.5
00-37	5/29/1996	San Geronimo Creek	11	8.1	3.2	146.0	156	0.009	<	2	<	0.5
00-79	6/26/1996	Lag Creek @ Kent (Shafter Bridge)	11.5	7.5	1	65.0	68	0.011	<	1	<	0.5
00-18	6/26/1996	Lag Crk @ Nicasio Crk (Gallagher)	14.9	7.6	0.6	101.0	105	0.008		1	<	0.5
00-17	6/26/1996	Nicasio Creek		7.7	2.7	99.0	98	0.012		7	<	0.5
00-37	6/26/1996	San Geronimo Creek	13	8.2	0.2	156.0	157	0.009	<	1	<	0.5
00-79	7/24/1996	Lag Creek @ Kent (Shafter Bridge)	12.5	7.5	1.1	62.0	72	0.009	<	1	<	0.5
00-18	7/24/1996	Lag Crk @ Nicasio Crk (Gallagher)	16	7.6	1.3	87.0	94	0.010		1	<	0.5
00-17	7/24/1996	Nicasio Creek	20	8.7	7.1	101.0	106	0.009		14	<	0.5
00-37	7/24/1996	San Geronimo Creek	14.5	8.2	0.3	154.5	170	0.008	<	1	<	0.5
00-79	8/21/1996	Lag Creek @ Kent (Shafter Bridge)	11.4	7.2	1.69	59.0	64	0.008		2	<	0.5
00-18	8/21/1996	Lag Crk @ Nicasio Crk (Gallagher)	16.5	7.7	1.18	86.0	92	0.011		2	<	0.5
00-17	8/21/1996	Nicasio Creek	16	7.6	2.5	132.0	132	0.012		1	<	0.5
00-37	8/21/1996	San Geronimo Creek	13.3	8.0	0.71	163.0	182	0.007		2	<	0.5
00-79	9/5/1996	Lag Creek @ Kent (Shafter Bridge)	12.5	7.8	0.83	61.5	65	0.007		1	<	0.5
00-18	9/5/1996	Lag Crk @ Nicasio Crk (Gallagher)	18	7.8	0.72	84.0	83	0.006		1	<	0.5
00-17	9/5/1996	Nicasio Creek	22.5	8.6	5	108.5	119	0.018		6	<	0.5
00-37	9/5/1996	San Geronimo Creek	14	8.2	0.48	171.0	165	0.008		1	<	0.5

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (^oC)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)	Copper* (mg/L)		Total suspended solids		Settleable solids (mg/L)
00-79	10/9/1996	Lag Creek @ Kent (Shafter Bridge)	11	7.5	0.8	62.0	62.4	0.008		2	<	0.5
00-18	10/9/1996	Lag Crk @ Nicasio Crk (Gallagher)	15.2	7.6	1.5	81.0	94.1	0.009		4	<	0.5
00-17	10/9/1996	Nicasio Creek	10	7.7	1.4	137.0	136	0.008		3	<	0.5
00-37	10/9/1996	San Geronimo Creek	13	8.1	0.4	178.0	205	0.008		3	<	0.5
00-79	11/20/1996	Lag Creek @ Kent (Shafter Bridge)	11.7	7.2	0.7	68.0	74	0.020		2	<	0.5
00-18	11/20/1996	Lag Crk @ Nicasio Crk (Gallagher)	13.1	6.9	6.3	66.0	96	0.010		21	<	0.5
00-17	11/20/1996	Nicasio Creek	14	7.4	11.6	121.0	126	0.009		5	<	0.5
00-37	11/20/1996	San Geronimo Creek	13.1	7.8	12	105.0	130	0.015		11	<	0.5
00-79	12/18/1996	Lag Creek @ Kent (Shafter Bridge)	11.2	7.5	1.11	65.0	70	0.005	<	2	<	0.5
00-18	12/18/1996	Lag Crk @ Nicasio Crk (Gallagher)	8.6	7.9	2.7	99.3	109	0.008		2	<	0.5
00-17	12/18/1996	Nicasio Creek	9.2	7.8	4.7	120.0	125	0.004		2	<	0.5
00-37	12/18/1996	San Geronimo Creek	8.6	7.5	1.38	67.6	82	0.006		3	<	0.5
00-79	1/22/1997	Lag Creek @ Kent (Shafter Bridge)	11.6	7.7	5	59.3	64.5	0.017		4	<	0.5
00-18	1/22/1997	Lag Crk @ Nicasio Crk (Gallagher)	11.4	7.7	38	66.6	74.9	0.008		38	<	0.5
00-17	1/22/1997	Nicasio Creek	11.5	7.3	65	42.6	58.2	0.007		15	<	0.5
00-37	1/22/1997	San Geronimo Creek	10.7	7.7	88	57.2	72.8	0.012		216	<	0.5
00-79	2/26/1997	Lag Creek @ Kent (Shafter Bridge)	11.2	7.4	0.7	55.0	79	0.010		1	<	0.5
00-18	2/26/1997	Lag Crk @ Nicasio Crk (Gallagher)	11.2	7.6	6.5	81.0	95	0.010		3	<	0.5
00-17	2/26/1997	Nicasio Creek	11.2	7.7	61	49.0	70	0.013		8	<	0.5
00-37	2/26/1997	San Geronimo Creek	9.4	8.2	0.7	138.0	184	0.010		2	<	0.5
00-79	3/19/1997	Lag Creek @ Kent (Shafter Bridge)	11.3	7.6	2.8	61.0	85	0.010		3	<	0.5
00-18	3/19/1997	Lag Crk @ Nicasio Crk (Gallagher)	14	7.7	12.9	79.0	104	0.009		4	<	0.5
00-17	3/19/1997	Nicasio Creek	14	7.8	65	47.0	73	0.012		10	<	0.5
00-37	3/19/1997	San Geronimo Creek	11	8.1	1.1	145.0	173	0.016		2	<	0.5
00-79	4/16/1997	Lag Creek @ Kent (Shafter Bridge)	11.3	7.5	1.8	59.0	66	0.011	<	1	<	0.5
00-18	4/16/1997	Lag Crk @ Nicasio Crk (Gallagher)	13.9	7.7	11.2	94.0	108	0.010	<	1	<	0.5
00-17	4/16/1997	Nicasio Creek	13.8	7.7	2.6	95.0	98	0.015		3	<	0.5
00-37	4/16/1997	San Geronimo Creek	11.7	8.1	0.7	159.0	180	0.014	<	1	<	0.5
00-79	5/14/1997	Lag Creek @ Kent (Shafter Bridge)	15.3	7.3	1.8	59.0	60	0.024		1	<	0.5
00-18	5/14/1997	Lag Crk @ Nicasio Crk (Gallagher)	16.6	7.6	2.3	89.0	96	0.012		6	<	0.5
00-17	5/14/1997	Nicasio Creek	17.8	7.8	1	115.0	110	0.011		6	<	0.5
00-37	5/14/1997	San Geronimo Creek	12.8	8.1	0.9	162.0	170	0.012		2	<	0.5
00-79	6/25/1997	Lag Creek @ Kent (Shafter Bridge)	12	7.7	1.05	59.0	62	0.007	<	2	<	0.5
00-18	6/25/1997	Lag Crk @ Nicasio Crk (Gallagher)	17.3	7.7	0.83	81.0	86	0.004		3	<	0.5
00-17	6/25/1997	Nicasio Creek	8.6	7.6	1.1	117.0	130	0.003		22	<	0.5

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (^oC)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)		Copper* (mg/L)		Total suspended solids		Settleable solids (mg/L)
00-37	6/25/1997	San Geronimo Creek	14.8	8.0	0.39	164.0	154		0.003	<	2	<	0.5
00-79	7/23/1997	Lag Creek @ Kent (Shafter Bridge)	9.89	7.8	1	58.0	84		0.007		4	<	0.5
00-18	7/23/1997	Lag Crk @ Nicasio Crk (Gallagher)	15.2	7.7	0.7	77.0	92		0.003		4	<	0.5
00-17	7/23/1997	Nicasio Creek	18.9	8.1	1.7	127.0	144		0.003		7	<	0.5
00-37	7/23/1997	San Geronimo Creek	16.1	8.3	0.7	169.0	192		0.003		4	<	0.5
00-79	8/20/1997	Lag Creek @ Kent (Shafter Bridge)	15.5	7.7	1.22	56.5	58		0.003		2	<	0.5
00-18	8/20/1997	Lag Crk @ Nicasio Crk (Gallagher)	17.8	7.6	2	73.5	84		0.001		8	<	0.5
00-17	8/20/1997	Nicasio Creek	17.4	7.7	4.1	128.0	145		0.001		3	<	0.5
00-37	8/20/1997	San Geronimo Creek	15.5	8.0	4.7	143.0	154	<	0.001		4	<	0.5
00-79	9/24/1997	Lag Creek @ Kent (Shafter Bridge)	12.2	8.1	0.45	166.0	62	<	0.005	<	2	<	0.5
00-18	9/24/1997	Lag Crk @ Nicasio Crk (Gallagher)	17.5	7.2	0.49	60.0	76	<	0.005	<	2	<	0.5
00-17	9/24/1997	Nicasio Creek	17.5	7.8	0.62	144.0	158	<	0.005	<	2	<	0.5
00-37	9/24/1997	San Geronimo Creek	15.3	7.7	0.41	76.0	182	<	0.005	<	2	<	0.5
00-79	10/22/1997	Lag Creek @ Kent (Shafter Bridge)	11.7	7.59	0.5	60.0	68	<	0.005	<	2	<	0.5
00-18	10/22/1997	Lag Crk @ Nicasio Crk (Gallagher)	16.2	7.72	0.55	80.0	84	<	0.005	<	2	<	0.5
00-17	10/22/1997	Nicasio Creek	17.6	7.62	2.9	141.0	150	<	0.005		5	<	0.5
00-37	10/22/1997	San Geronimo Creek	12.7	8.17	0.6	173.0	200	<	0.005	<	2	<	0.5
00-79	11/19/1997	Lag Creek @ Kent (Shafter Bridge)	12	7.10	0.6	61.0	62		0.009	<	1	<	0.5
00-18	11/19/1997	Lag Crk @ Nicasio Crk (Gallagher)	13.2	7.43	31	63.0	78		0.009		36	<	0.5
00-17	11/19/1997	Nicasio Creek	13.1	7.24	56	110.0	122		0.010		17	<	0.5
00-37	11/19/1997	San Geronimo Creek	12.9	7.84	14.6	81.0	104		0.007		7	<	0.5
00-79	12/23/1997	Lag Creek @ Kent (Shafter Bridge)	11.2	7.53	1.02	64.0	66		0.014	<	1	<	0.5
00-18	12/23/1997	Lag Crk @ Nicasio Crk (Gallagher)	8	7.83	1.37	96.0	102		0.008		1	<	0.5
00-17	12/23/1997	Nicasio Creek	8.3	7.62	1.33	119.0	124		0.007	<	1	<	0.5
00-37	12/23/1997	San Geronimo Creek	6.2	7.96	1.19	128.0	140		0.007		2	<	0.5
00-79	1/22/1998	Lag Creek @ Kent (Shafter Bridge)	10.9	7.79	6.9	50.0	66	<	0.005		3	<	0.5
00-18	1/22/1998	Lag Crk @ Nicasio Crk (Gallagher)	12.6	7.68	17.8	58.0	62		0.008		19	<	0.5
00-17	1/22/1998	Nicasio Creek	11.3	7.49	32	49.0	64		0.006		11	<	0.5
00-37	1/22/1998	San Geronimo Creek	10.2	7.96	5.9	94.0	114	<	0.005		3	<	0.5
00-79	2/18/1998	Lag Creek @ Kent (Shafter Bridge)	11	7.39	2.4	79.0	78	<	0.005	<	2	<	0.5
00-18	2/18/1998	Lag Crk @ Nicasio Crk (Gallagher)	11	7.66	48	51.0	50		0.012		26	<	0.5
00-17	2/18/1998	Nicasio Creek	11.5	7.50	114	28.0	38		0.013		44	<	0.5
00-37	2/18/1998	San Geronimo Creek	10.2	7.85	10.8	77.0	80	<	0.005	<	3	<	0.5
00-79	3/18/1998	Lag Creek @ Kent (Shafter Bridge)	10.7	7.80	2.4	52.0	52	<	0.005	<	2	<	0.5
00-18	3/18/1998	Lag Crk @ Nicasio Crk (Gallagher)	12.8	7.73	18.9	72.0	72		0.006	<	2	<	0.5

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (^{o}C)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)	Copper* (mg/L)	Total suspended solids	Settleable solids (mg/L)
00-17	3/18/1998	Nicasio Creek	10.2	7.57	66	41.0	42	0.007	14	< 0.5
00-37	3/18/1998	San Geronimo Creek	12.5	8.11	1.3	112.0	130	< 0.005	< 2	< 0.5
00-79	4/18/1998	Lag Creek @ Kent (Shafter Bridge)		7.58	1.52	51.0	50	< 0.005	< 2	< 0.5
00-18	4/18/1998	Lag Crk @ Nicasio Crk (Gallagher)		7.67	15.1	67.0	68	< 0.005	5	< 0.5
00-17	4/18/1998	Nicasio Creek		7.54	51	44.0	44	0.008	6	< 0.5
00-37	4/18/1998	San Geronimo Creek		7.77	1.11	119.0	122	< 0.005	< 2	< 0.5
00-79	5/27/1998	Lag Creek @ Kent (Shafter Bridge)	11	7.42	3.4	61.0	66	< 0.005	2	< 0.5
00-18	5/27/1998	Lag Crk @ Nicasio Crk (Gallagher)	13.6	7.77	1.4	97.0	102	< 0.005	2	< 0.5
00-17	5/27/1998	Nicasio Creek	14.8	8.12	4.2	90.0	94	< 0.005	2	< 0.5
00-37	5/27/1998	San Geronimo Creek	12.2	8.12	1.85	143.0	148	< 0.005	< 2	< 0.5
00-79	6/17/1998	Lag Creek @ Kent (Shafter Bridge)	15.3	7.69	1.2	61.0	65.6	< 0.005	< 2	< 0.5
00-18	6/17/1998	Lag Crk @ Nicasio Crk (Gallagher)	18	7.72	2.2	91.0	96	< 0.005	< 2	< 0.5
00-17	6/17/1998	Nicasio Creek	18.6	7.70	2.4	121.0	122.4	< 0.005	6	< 0.5
00-37	6/17/1998	San Geronimo Creek	14.7	8.12	0.8	141.0	157	< 0.005	4	< 0.5
00-79	8/17/1998	Lag Creek @ Kent (Shafter Bridge)	11.4	7.17	2.3	57.0	60	< 0.005	2	< 0.5
00-18	8/17/1998	Lag Crk @ Nicasio Crk (Gallagher)	17.7	7.65	2	90.0	88	< 0.005	< 2	< 0.5
00-17	8/17/1998	Nicasio Creek	17.1	7.85	6.8	45.0	126	0.007	6	< 0.5
00-37	8/17/1998	San Geronimo Creek	15.1	8.13	0.66	158.0	164	< 0.005	< 2	< 0.5
00-79	9/23/1998	Lag Creek @ Kent (Shafter Bridge)	11.5	7.60	0.78	61.0	64	0.006	4	< 0.5
00-17	9/23/1998	Nicasio Creek	16	7.84	1.2	139.0	138	< 0.005	4	< 0.5
00-37	9/23/1998	San Geronimo Creek	13.2	8.11	0.98	174.0	170	< 0.005	< 2	< 0.5
00-79	10/30/1998	Lag Creek @ Kent (Shafter Bridge)	10.6	7.40	0.96	60.0	66	0.006	1	< 0.5
00-18	10/30/1998	Lag Crk @ Nicasio Crk (Gallagher)	11.9	7.49	0.48	86.0	89	< 0.005	2	< 0.5
00-17	10/30/1998	Nicasio Creek	17.1	7.39	0.91	138.0	141	< 0.005	2	< 0.5
00-37	10/30/1998	San Geronimo Creek	9.6	7.94	0.25	174.0	182	< 0.005	2	< 0.5
00-79	4/28/1999	Lag Creek @ Kent (Shafter Bridge)	9.5	7.45	2.37	51.0	62	< 0.005		< 0.5
00-18	4/28/1999	Lag Crk @ Nicasio Crk (Gallagher)	13.2	7.64	3.95	80.0	98	< 0.005		< 0.5
00-17	4/28/1999	Nicasio Creek	13.2	8.70	15.7	45.0	56	< 0.005		< 0.5
00-37	4/28/1999	San Geronimo Creek	9.4	8.01	0.78	116.0	144	< 0.005		< 0.5
00-79	5/26/1999	Lag Creek @ Kent (Shafter Bridge)	10.5	7.65	1.88	53.0	66	0.006	2	< 0.5
00-18	5/26/1999	Lag Crk @ Nicasio Crk (Gallagher)	15.3	7.59	2.08	83.0	100	0.037	2	< 0.5
00-17	5/26/1999	Nicasio Creek	15	7.78	1.55	79.0	94	0.015	3	< 0.5
00-37	5/26/1999	San Geronimo Creek	12.2	8.14	0.8	126.0	158	< 0.005	2	< 0.5
00-79	6/16/1999	Lag Creek @ Kent (Shafter Bridge)	10.9	7.35	2.57	67.0	68	< 0.003	1	< 0.5
00-18	6/16/1999	Lag Crk @ Nicasio Crk (Gallagher)	15.6	7.57	2	85.5	96	< 0.003	2	< 0.5

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (^oC)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)		Copper* (mg/L)		Total suspended solids		Settleable solids (mg/L)
00-17	6/16/1999	Nicasio Creek	15.1	7.80	1.93	113.0	110	<	0.003		2	<	0.5
00-37	6/16/1999	San Geronimo Creek	13	8.14	0.62	155.0	164	<	0.003		1	<	0.5
00-79	7/28/1999	Lag Creek @ Kent (Shafter Bridge)	10.6	7.35	2.2	61.0	68	<	0.003		1	<	0.5
00-18	7/28/1999	Lag Crk @ Nicasio Crk (Gallagher)	14.2	7.63	4.6	126.0	122	<	0.003		3	<	0.5
00-17	7/28/1999	Nicasio Creek		7.54	1.78	89.0	88	<	0.003		4	<	0.5
00-37	7/28/1999	San Geronimo Creek	14	8.10	0.42	167.0	166	<	0.003	<	1	<	0.5
00-79	9/1/1999	Lag Creek @ Kent (Shafter Bridge)	10.4	7.68	1.58	61.0	64	<	0.003		1	<	0.5
00-18	9/1/1999	Lag Crk @ Nicasio Crk (Gallagher)	15.2	7.55	1.62	81.0	88	<	0.003		3	<	0.5
00-17	9/1/1999	Nicasio Creek	15.6	7.86	1.34	135.0	126	<	0.003		2	<	0.5
00-37	9/1/1999	San Geronimo Creek	13	8.03	0.48	165.0	170	<	0.003	<	1	<	0.5
00-79	10/6/1999	Lag Creek @ Kent (Shafter Bridge)	11.6	7.57	1.81	60.0	60		0.003		1	<	0.5
00-18	10/6/1999	Lag Crk @ Nicasio Crk (Gallagher)	15.2	7.57	1.44	77.0	76		0.003		1	<	0.5
00-17	10/6/1999	Nicasio Creek	15	7.62	3.43	144.0	140		0.006		4	<	0.5
00-37	10/6/1999	San Geronimo Creek	14.2	7.98	0.7	159.0	166	<	0.003	<	1	<	0.5
00-79	11/3/1999	Lag Creek @ Kent (Shafter Bridge)	11.4	7.55	0.66	78.0	80	<	0.003		23	<	0.5
00-18	11/3/1999	Lag Crk @ Nicasio Crk (Gallagher)	11.6	7.57	0.87	61.0	66	<	0.003	<	1	<	0.5
00-17	11/3/1999	Nicasio Creek	12.6	7.41	0.94	145.0	148	<	0.003		1	<	0.5
00-37	11/3/1999	San Geronimo Creek	10.9	8.03	0.35	168.0	184	<	0.003		5	<	0.5
00-79	12/8/1999	Lag Creek @ Kent (Shafter Bridge)	10.8	7.64	0.7	62.0	66.7		0.004	<	1	<	0.5
00-18	12/8/1999	Lag Crk @ Nicasio Crk (Gallagher)	9.1	7.69	0.72	78.0	83.8	<	0.003	<	1	<	0.5
00-17	12/8/1999	Nicasio Creek	8.9	7.37	5.16	134.0	139		0.004		2	<	0.5
00-37	12/8/1999	San Geronimo Creek	7	8.11	0.45	158.0	171.4	<	0.003	<	1	<	0.5
00-79	1/12/2000	Lag Creek @ Kent (Shafter Bridge)	10.4	7.66	1.01	65.0	62.8	<	0.003		1	<	0.5
00-18	1/12/2000	Lag Crk @ Nicasio Crk (Gallagher)	9.9	7.72	25.9	83.0	78.1		0.004		16	<	0.5
00-17	1/12/2000	Nicasio Creek	9.6	7.61	47	116.0	116.2		0.004		18	<	0.5
00-37	1/12/2000	San Geronimo Creek	9.1	8.02	14	112.0	129.5		0.004		6	<	0.5
00-79	3/1/2000	Lag Creek @ Kent (Shafter Bridge)	11.5	7.88	4.75	54.4	56.2	<	0.003		5	<	0.5
00-18	3/1/2000	Lag Crk @ Nicasio Crk (Gallagher)	10.7	7.78	18.2	58.7	60.9		0.003		42	<	0.5
00-17	3/1/2000	Nicasio Creek	10.4	7.80	25.7	53.4	57.1		0.003		8	<	0.5
00-37	3/1/2000	San Geronimo Creek	10.4	7.95	13.9	76.7	77.1	<	0.003		7	<	0.5
00-79	3/29/2000	Lag Creek @ Kent (Shafter Bridge)	12.1	8.08	2.45	66.0	66		0.006		23	<	0.5
00-18	3/29/2000	Lag Crk @ Nicasio Crk (Gallagher)	11.6	7.97	4.05	89.3	91		0.003		3	<	0.5
00-17	3/29/2000	Nicasio Creek	14.6	8.70	16.3	56.3	57		0.101		6	<	0.5
00-37	3/29/2000	San Geronimo Creek	11.3	8.20	1.05	135.9	144		0.005		1	<	0.5
00-79	4/26/2000	Lag Creek @ Kent (Shafter Bridge)	10.6	7.80	3.52	68.0	70		0.005		8	<	0.5

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (°C)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)		Copper* (mg/L)		Total suspended solids		Settleable solids (mg/L)
00-18	4/26/2000	Lag Crk @ Nicasio Crk (Gallagher)	13.1	7.81	1.98	97.0	100		0.005		3	<	0.5
00-17	4/26/2000	Nicasio Creek	14.3	7.82	7.46	63.0	68		0.007		6	<	0.5
00-37	4/26/2000	San Geronimo Creek	10.8	8.11	0.7	144.0	150		0.007	<	1	<	0.5
00-79	6/7/2000	Lag Creek @ Kent (Shafter Bridge)	10.7	7.84	1.71	65.5	66		0.005	<	1	<	0.5
00-18	6/7/2000	Lag Crk @ Nicasio Crk (Gallagher)	12.6	7.73	1.44	94.0	94		0.006		1	<	0.5
00-17	6/7/2000	Nicasio Creek	14	7.73	1.66	124.0	122		0.005		2	<	0.5
00-37	6/7/2000	San Geronimo Creek	10.6	8.16	0.5	159.0	168		0.006	<	1	<	0.5
00-79	7/12/2000	Lag Creek @ Kent (Shafter Bridge)	11.7	7.88	1.2	64.0	66		0.005		4	<	0.5
00-18	7/12/2000	Lag Crk @ Nicasio Crk (Gallagher)	16.4	7.75	0.85	92.0	96		0.008		2	<	0.5
00-17	7/12/2000	Nicasio Creek	16.9	7.94	0.78	132.0	128	<	0.003		1	<	0.5
00-37	7/12/2000	San Geronimo Creek	14.7	8.18	0.45	166.0	172		0.004	<	1	<	0.5
00-79	8/16/2000	Lag Creek @ Kent (Shafter Bridge)	12.1	7.72	1.18	65.0	66		0.010		4	<	0.5
00-18	8/16/2000	Lag Crk @ Nicasio Crk (Gallagher)	8.8	7.75	1.41	86.0	84		0.008		3	<	0.5
00-17	8/16/2000	Nicasio Creek	8.9	7.78	1.04	145.5	136		0.014		3	<	0.5
00-37	8/16/2000	San Geronimo Creek	6.6	8.11	0.54	171.5	175		0.008	<	1	<	0.5
00-79	9/13/2000	Lag Creek @ Kent (Shafter Bridge)		7.97	1.1	64.5	66		0.018		2	<	0.5
00-18	9/13/2000	Lag Crk @ Nicasio Crk (Gallagher)		7.90	1.2	83.0	80		0.009	<	1	<	0.5
00-17	9/13/2000	Nicasio Creek		7.85	1.27	152.0	144		0.011		2	<	0.5
00-37	9/13/2000	San Geronimo Creek		8.33	0.54	174.0	178		0.006		2	<	0.5
00-79	10/25/2000	Lag Creek @ Kent (Shafter Bridge)	11.7	7.84	1.44	63.0	64		0.006		2	<	0.5
00-18	10/25/2000	Lag Crk @ Nicasio Crk (Gallagher)	11.7	7.74	0.36	79.0	80		0.005		2	<	0.5
00-17	10/25/2000	Nicasio Creek	13.1	7.97	1.16	153.5	150		0.006		8	<	0.5
00-37	10/25/2000	San Geronimo Creek	11.9	8.05	0.45	178.0	188		0.005		1	<	0.5
00-79	11/22/2000	Lag Creek @ Kent (Shafter Bridge)	11	7.47	0.89	65.0	66		0.011	<	1	<	0.5
00-18	11/22/2000	Lag Crk @ Nicasio Crk (Gallagher)	10.4	7.48	1.5	83.0	84		0.007		2	<	0.5
00-17	11/22/2000	Nicasio Creek	8.5	7.38	2.76	149.0	146		0.004		9	<	0.5
00-37	11/22/2000	San Geronimo Creek	7.6	7.92	1.28	161.0	178		0.007		1	<	0.5
00-79	12/20/2000	Lag Creek @ Kent (Shafter Bridge)	10.6	7.54	0.77	62.5	64		0.005		2	<	0.5
00-18	12/20/2000	Lag Crk @ Nicasio Crk (Gallagher)	9.6	7.83	0.62	78.0	79		0.008		3	<	0.5
00-17	12/20/2000	Nicasio Creek	8.3	7.53	0.7	149.0	152		0.008		2	<	0.5
00-37	12/20/2000	San Geronimo Creek	7.4	8.16	0.53	160.0	183		0.004	<	1	<	0.5
00-79	1/24/2001	Lag Creek @ Kent (Shafter Bridge)	9.8	7.57	3.72	67.0	66		0.005		3	<	0.5
00-18	1/24/2001	Lag Crk @ Nicasio Crk (Gallagher)	8.8	7.54	37.3	71.0	81		0.010		17	<	0.5
00-17	1/24/2001	Nicasio Creek	8.2	7.48	25	110.0	46		0.007		7	<	0.5
00-37	1/24/2001	San Geronimo Creek	8.5	7.70	29	79.0	94		0.008		10	<	0.5

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (°C)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)	Copper* (mg/L)		Total suspended solids		Settleable solids (mg/L)
00-79	3/7/2001	Lag Creek @ Kent (Shafter Bridge)	10.1	7.44	3.22	66.0	68	0.020		3	<	0.5
00-18	3/7/2001	Lag Crk @ Nicasio Crk (Gallagher)	11.3	7.57	5.75	67.0	72	0.010		4	<	0.5
00-17	3/7/2001	Nicasio Creek	11.8	7.70	5.66	57.0	64	0.016		3	<	0.5
00-37	3/7/2001	San Geronimo Creek	10.4	7.78	3.8	95.5	102	0.010		2	<	0.5
00-79	4/11/2001	Lag Creek @ Kent (Shafter Bridge)	10	7.62	2.82	65.0	66	0.008	<	1	<	0.5
00-18	4/11/2001	Lag Crk @ Nicasio Crk (Gallagher)	11.2	7.58	2.02	92.0	92	0.010	<	1	<	0.5
00-17	4/11/2001	Nicasio Creek	12.7	7.55	6.09	71.0	74	0.006		2	<	0.5
00-37	4/11/2001	San Geronimo Creek	10	8.00	0.53	154.0	166	0.004		1	<	0.5
00-79	5/4/2001	Lag Creek @ Kent (Shafter Bridge)	10.4	7.88	0.96	67.0	68	0.004	<	1	<	0.5
00-18	5/4/2001	Lag Crk @ Nicasio Crk (Gallagher)	13.8	7.78	1.38	88.0	88	0.006	<	1	<	0.5
00-17	5/4/2001	Nicasio Creek	14	7.80	2.31	105.0	104	0.006		2	<	0.5
00-37	5/4/2001	San Geronimo Creek	11.4	8.28	1.1	166.0	174	0.004		4	<	0.5
00-79	5/23/2001	Lag Creek @ Kent (Shafter Bridge)	10.5	7.81	0.82	67.0	64	0.004	<	1	<	0.5
00-18	5/23/2001	Lag Crk @ Nicasio Crk (Gallagher)	15.7	7.71	1.12	86.0	84	0.005		2	<	0.5
00-17	5/23/2001	Nicasio Creek	16.3	7.56	1.03	119.0	116	0.006	<	1	<	0.5
00-37	5/23/2001	San Geronimo Creek	14.8	8.24	0.6	168.5	174	0.008	<	1	<	0.5
00-79	6/20/2001	Lag Creek @ Kent (Shafter Bridge)	10.4	7.95	0.84	67.0	66	0.016		8	<	0.5
00-18	6/20/2001	Lag Crk @ Nicasio Crk (Gallagher)	17.2	7.80	1.97	83.0	82	0.009		2	<	0.5
00-17	6/20/2001	Nicasio Creek	17	7.96	5.04	126.0	120	0.010		2	<	0.5
00-37	6/20/2001	San Geronimo Creek	15	8.23	0.53	168.0	171	0.008		2	<	0.5
00-79	7/18/2001	Lag Creek @ Kent (Shafter Bridge)	10.7	7.88	0.95	68.0	66	0.010		2	<	0.5
00-18	7/18/2001	Lag Crk @ Nicasio Crk (Gallagher)	15.6	7.80	1.25	84.0	82	0.008		5	<	0.5
00-17	7/18/2001	Nicasio Creek	15.3	8.26	1.46	135.0	128	0.005		2	<	0.5
00-37	7/18/2001	San Geronimo Creek	13.6	8.29	0.66	166.0	170	0.010		1	<	0.5
00-79	8/8/2001	Lag Creek @ Kent (Shafter Bridge)	10.7	7.88	0.53	68.0	70	0.013	<	1	<	0.5
00-18	8/8/2001	Lag Crk @ Nicasio Crk (Gallagher)	16.9	7.83	0.92	81.0	80	0.010		2	<	0.5
00-17	8/8/2001	Nicasio Creek	17.7	8.10	0.83	156.0	154	0.026		3	<	0.5
00-37	8/8/2001	San Geronimo Creek	16	8.23	0.79	174.0	176	0.010		1	<	0.5
00-79	9/20/2001	Lag Creek @ Kent (Shafter Bridge)	9.7	7.96	0.8	68.0	68	0.008		11	<	0.5
00-18	9/20/2001	Lag Crk @ Nicasio Crk (Gallagher)	15.7	7.80	4.91	79.5	80	0.007		11	<	0.5
00-17	9/20/2001	Nicasio Creek	15.7	7.30	2.25	160.0	156	0.012		4	<	0.5
00-37	9/20/2001	San Geronimo Creek	14.7	8.25	0.86	169.0	178	0.012		6	<	0.5
00-79	10/31/2001	Lag Creek @ Kent (Shafter Bridge)	10.6	7.75	0.98	71.0	72	0.008		1	<	0.5
00-18	10/31/2001	Lag Crk @ Nicasio Crk (Gallagher)	13.5	7.60	1.1	77.0	78	0.007		2	<	0.5
00-17	10/31/2001	Nicasio Creek	13.6	7.86	1.19	165.0	160	0.006		17	<	0.5

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (°C)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)	Copper* (mg/L)		Total suspended solids		Settleable solids (mg/L)
00-37	10/31/2001	San Geronimo Creek	11.3	7.90	1.61	168.0	176	0.010		17	<	0.5
00-79	12/5/2001	Lag Creek @ Kent (Shafter Bridge)	11.4	7.59	9.25	64.0	67	0.016		8	<	0.5
00-18	12/5/2001	Lag Crk @ Nicasio Crk (Gallagher)	10.7	7.75	12.5	77.0	86	0.014		13	<	0.5
00-17	12/5/2001	Nicasio Creek	10.6	7.47	4.68	96.0	106	0.004		5	<	0.5
00-37	12/5/2001	San Geronimo Creek	11.2	7.89	16.9	82.0	96	0.007		21	<	0.5
00-79	1/9/2002	Lag Creek @ Kent (Shafter Bridge)	11.5	7.85	5.93	63.0	63	0.016		29	<	0.5
00-18	1/9/2002	Lag Crk @ Nicasio Crk (Gallagher)	10.6	7.75	20.3	67.0	70	0.013		9	<	0.5
00-17	1/9/2002	Nicasio Creek	11.4	7.74	35	49.0	52	0.014		9	<	0.5
00-37	1/9/2002	San Geronimo Creek	11.7	8.05	3.51	100.0	106	0.012		2	<	0.5
00-79	2/21/2002	Lag Creek @ Kent (Shafter Bridge)	11	7.94	3.2	59.0	62	0.008		6	<	0.5
00-18	2/21/2002	Lag Crk @ Nicasio Crk (Gallagher)	10.7	7.82	14.7	60.0	67	0.009		18	<	0.5
00-17	2/21/2002	Nicasio Creek	11.9	7.84	20.3	50.0	56	0.018		7	<	0.5
00-37	2/21/2002	San Geronimo Creek	10.8	7.96	8.48	95.0	100	0.008		3	<	0.5
00-79	3/20/2002	Lag Creek @ Kent (Shafter Bridge)	11.8	8.04	1.04	61.0	62	0.005		2	<	0.5
00-18	3/20/2002	Lag Crk @ Nicasio Crk (Gallagher)	10.5	7.87	3.54	78.0	82	0.005		3	<	0.5
00-17	3/20/2002	Nicasio Creek	9.4	8.09	8.21	56.0	60	0.007		6	<	0.5
00-37	3/20/2002	San Geronimo Creek	11.5	8.15	0.94	135.0	140	0.004		2	<	0.5
00-79	4/17/2002	Lag Creek @ Kent (Shafter Bridge)	10	7.78	1.1	63.0	64	0.010	<	1	<	0.5
00-18	4/17/2002	Lag Crk @ Nicasio Crk (Gallagher)	12	7.78	1.21	88.0	90	0.009	<	1	<	0.5
00-17	4/17/2002	Nicasio Creek	17.4	7.61	2.11	75.0	80	0.011		3	<	0.5
00-37	4/17/2002	San Geronimo Creek	9.3	8.15	0.46	148.0	157	0.011	<	1	<	0.5
00-79	5/8/2002	Lag Creek @ Kent (Shafter Bridge)	10.1	7.74	1.51	65.0	64	0.012	<	1	<	0.5
00-18	5/8/2002	Lag Crk @ Nicasio Crk (Gallagher)	14	7.81	4.1	94.0	96	0.013		11	<	0.5
00-17	5/8/2002	Nicasio Creek	13	7.84	1.38	143.0	116	0.011		4	<	0.5
00-37	5/8/2002	San Geronimo Creek	10.3	8.15	0.9	157.0	166	0.012		2	<	0.5
00-79	5/29/2002	Lag Creek @ Kent (Shafter Bridge)	11.1	7.80	0.85	63.0	64	0.012	<	1	<	0.5
00-18	5/29/2002	Lag Crk @ Nicasio Crk (Gallagher)	15.5	7.74	1.27	89.0	92	0.010		4	<	0.5
00-17	5/29/2002	Nicasio Creek	15.4	7.73	0.9	119.0	120	0.012		2	<	0.5
00-37	5/29/2002	San Geronimo Creek	11.7	8.16	0.36	161.0	169	0.007	<	1	<	0.5
00-79	6/26/2002	Lag Creek @ Kent (Shafter Bridge)	11.1	7.78	11.1	65	66	0.0086		1.6	<	0.5
00-18	6/26/2002	Lag Crk @ Nicasio Crk (Gallagher)	15.9	7.73	1.31	88	90	0.0083		3.6	<	0.5
00-17	6/26/2002	Nicasio Creek	15.7	7.76	0.99	128	126	0.0067		2.4	<	0.5
00-37	6/26/2002	San Geronimo Creek	14.2	8.15	0.69	164	174	0.0071		1.6	<	0.5
00-79	7/17/2002	Lag Creek @ Kent (Shafter Bridge)	10.8	7.79	0.47	62	68	0.0043		0.8	<	0.5
00-18	7/17/2002	Lag Crk @ Nicasio Crk (Gallagher)	N/A	7.71	1.56	77	76	0.004		5.2	<	0.5

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (^oC)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)		Copper* (mg/L)		Total suspended solids		Settleable solids (mg/L)
00-17	7/17/2002	Nicasio Creek	15.9	7.65	1.54	137	138		0.0055		1.2	<	0.5
00-37	7/17/2002	San Geronimo Creek	14.6	8.16	0.39	166	170		0.0036		1.6	<	0.5
00-79	9/18/2002	Lag Creek @ Kent (Shafter Bridge)	10.8	7.73	1	65	64		0.0043		2	<	0.5
00-17	9/18/2002	Nicasio Creek	15.8	7.8	1.16	157	148		0.0157		1.2	<	0.5
00-37	9/18/2002	San Geronimo Creek	14.2	7.97	1.26	175	178		0.0175	<	1	<	0.5
00-79	10/23/2002	Lag Creek @ Kent (Shafter Bridge)	10.6	7.34	0.84	62	62		0.0089		1.2	<	0.5
00-17	10/23/2002	Nicasio Creek	12.8	7.66	1.13	167	160		0.0103		3.2	<	0.5
00-37	10/23/2002	San Geronimo Creek	11.9	8.01	0.6	169	174		0.0121		1.6	<	0.5
00-79	11/20/2002	Lag Creek @ Kent (Shafter Bridge)	10.6	7.65	1.31	66	68		0.002	<	1	<	0.5
00-17	11/20/2002	Nicasio Creek	11.3	7.29	7.82	165	166		0.009		10	<	0.5
00-37	11/20/2002	San Geronimo Creek	8.7	8.07	0.46	178	194		0.008	<	1	<	0.5
00-17	12/11/2002	Nicasio Creek	10.7	7.37	0.87	164	168		0.006		3.6	<	0.5
00-37	12/11/2002	San Geronimo Creek	9.6	8.12	0.65	166	188		0.003		2	<	0.5
00-79	12/11/2002	Lag Creek @ Kent (Shafter Bridge)	11.1	7.6	0.42	64	66		0.004	<	1	<	0.5
00-79	1/22/2003	Lag Creek @ Kent (Shafter Bridge)	10.6	7.78	4.56	60	62		0.0035		29.6	<	0.5
00-17	1/22/2003	Nicasio Creek	11.8	7.7	23.3	50	54		0.0057		7.2	<	0.5
00-37	1/22/2003	San Geronimo Creek	10.6	7.96	5.02	103	112		0.0063		2	<	0.5
00-79	2/19/2003	Lag Creek @ Kent (Shafter Bridge)	11.1	7.83	1.85	59	62		0.0029		N/A	<	0.5
00-17	2/19/2003	Nicasio Creek	11.5	7.75	15.5	52	56		0.0078		N/A	<	0.5
00-37	2/19/2003	San Geronimo Creek	10.1	7.96	5.39	105	106		0.004		N/A		
00-79	3/19/2003	Lag Creek @ Kent (Shafter Bridge)	12	7.98	N/A	61	62		0.0046		1.2	<	0.5
00-17	3/19/2003	Nicasio Creek	13.4	7.91	14.8	54	58		0.0068		6.8	<	0.5
00-37	3/19/2003	San Geronimo Creek	12.5	8.09	3.08	117	122		0.0033		1.6	<	0.5
00-79	4/9/2003	Lag Creek @ Kent (Shafter Bridge)	11.7	7.83	1.45	64	66		0.0066	<	1	<	0.5
00-17	4/9/2003	Nicasio Creek	13.7	9.95	5.26	60	64		0.0043		2	<	0.5
00-37	4/9/2003	San Geronimo Creek	10.2	8.15	0.67	144	148		0.0039	<	1	<	0.5
00-79	5/21/2003	Lag Creek @ Kent (Shafter Bridge)	8.3	7.81	0.96	61	68		0.0047	<	1	<	0.5
00-17	5/21/2003	Nicasio Creek	16.7	7.63	2.01	74	64		0.0086		6.4	<	0.5
00-37	5/21/2003	San Geronimo Creek	8.4	8.17	1.02	152	156		0.0059	<	1	<	0.5
00-79	6/11/2003	Lag Creek @ Kent (Shafter Bridge)	12.6	7.63	0.63	59	62		0.0036	<	1	<	0.5
00-17	6/11/2003	Nicasio Creek	14.1	7.66	3.95	124	124		0.0083		5.2	<	0.5
00-37	6/11/2003	San Geronimo Creek	13.6	8.26	1.26	159	162		0.0047		1.2	<	0.5
00-79	7/30/2003	Lag Creek @ Kent (Shafter Bridge)	11.8	7.55	0.3	63	62	<	0.005	<	1	<	0.5
00-17	7/30/2003	Nicasio Creek	16.9	7.82	1.28	135	134		0.007		1.6	<	0.5
00-37	7/30/2003	San Geronimo Creek	15.5	8.21	0.79	166	172	<	0.005		2	<	0.5

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (^{o}C)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)		Copper* (mg/L)		Total suspended solids		Settleable solids (mg/L)
00-79	9/3/2003	Lag Creek @ Kent (Shafter Bridge)	12.5	7.73	0.57	63	66		0.008		0.8	<	0.5
00-17	9/3/2003	Nicasio Creek	17.5	7.85	0.99	144	140	<	0.005		0.4	<	0.5
00-37	9/3/2003	San Geronimo Creek	16	8.1	0.65	171	178		0.008		1.6	<	0.5
00-79	10/23/2003	Lag Creek @ Kent (Shafter Bridge)	12.2	7.6	0.83	67	68		0.012		6	<	0.5
00-17	10/23/2003	Nicasio Creek	14.5	7.72	1.44	159	166		0.006		1.6	<	0.5
00-37	10/23/2003	San Geronimo Creek	13	8.14	1.26	177	186		0.007		2.4	<	0.5
00-79	11/18/2003	Lag Creek @ Kent (Shafter Bridge)	11.2	7.73	0.57	67	72	<	0.005	<	0.5	<	0.5
00-17	11/18/2003	Nicasio Creek	11.2	7.44	1.1	135	168		0.0056		0.8	<	0.5
00-37	11/18/2003	San Geronimo Creek	9.4	8.17	0.5	167	200		0.005		1.2	<	0.5
00-79	12/17/2003	Lag Creek @ Kent (Shafter Bridge)	N/A	7.29	1.6	65	66	<	0.005	<	0.5	<	0.5
00-17	12/17/2003	Nicasio Creek	8.8	7.35	2.7	116	130	<	0.005		1.6	<	0.5
00-37	12/17/2003	San Geronimo Creek	7.9	8.06	2.27	111	132		0.0084		0.8	<	0.5
00-79	1/21/2004	Lag Creek @ Kent (Shafter Bridge)	10.2	7.75	1.88	66	68		0.009		1.2	<	0.5
00-17	1/21/2004	Nicasio Creek	10.1	7.76	27.7	55	60		0.01		9.2	<	0.5
00-79	2/11/2004	Lag Creek @ Kent (Shafter Bridge)	10.9	7.8	2.22	67	68		0.005	<	1	<	0.5
00-17	2/11/2004	Nicasio Creek	10.8	7.87	25	54	58		0.006		6	<	0.5
00-37	2/11/2004	San Geronimo Creek	10.7	8.04	2.11	119	126		0.008		1.2	<	0.5
00-79	3/24/2004	Lag Creek @ Kent (Shafter Bridge)	12	8.24	1.19	65	72		0.009		0	<	0.5
00-17	3/24/2004	Nicasio Creek	13.8	8.03	15.3	58	66		0.012		1.2	<	0.5
00-79	4/14/2004	Lag Creek @ Kent (Shafter Bridge)	11	7.88	1.02	67	70	<	0.005		1.6	<	0.5
00-37	4/14/2004	San Geronimo Creek	11.5	8.17	1.3	152	164	<	0.005		5.6	<	0.5
00-79	5/5/2004	Lag Creek @ Kent (Shafter Bridge)	14.6	7.86	1.3	67	68	<	0.005		0.8	<	0.5
00-17	5/5/2004	Nicasio Creek	12	7.71	3.78	104	104		0.024		1.6	<	0.5
00-37	5/5/2004	San Geronimo Creek	12.8	8.21	1.48	149	154	<	0.005	<	1	<	0.5
00-79	6/2/2004	Lag Creek @ Kent (Shafter Bridge)	11.2	7.81	0.73	66	70	<	0.005		0.4	<	0.5
00-17	6/2/2004	Nicasio Creek	14.5	7.66	1.78	118	122	<	0.005		1.2	<	0.5
00-37	6/2/2004	San Geronimo Creek	13.5	8.22	0.86	161	176		0.007		0.8	<	0.5
00-79	7/14/2004	Lag Creek @ Kent (Shafter Bridge)	11.3	7.78	0.58	66	70		0.005		0.4	<	0.5
00-17	7/14/2004	Nicasio Creek	16	7.78	2.8	137	142	<	0.005		4.4	<	0.5
00-37	7/14/2004	San Geronimo Creek	15.2	8.11	0.9	169	186		0.009		1.6	<	0.5
00-79	8/19/2004	Lag Creek @ Kent (Shafter Bridge)	11.4	7.94	0.61	65	68	<	0.005		0.4	<	0.5
00-17	8/19/2004	Nicasio Creek	16.8	7.73	1.15	146	142		0.007		2	<	0.5
00-37	8/19/2004	San Geronimo Creek	16.2	7.84	0.61	168	176	<	0.005		3.6	<	0.5
00-79	9/22/2004	Lag Creek @ Kent (Shafter Bridge)	11	7.84	1.24	65	68	<	0.005		1.2	<	0.5
00-17	9/22/2004	Nicasio Creek	14	7.73	1.69	159	156		0.007		3.6	<	0.5

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (^oC)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)		Copper* (mg/L)		Total suspended solids		Settleable solids (mg/L)
00-37	9/22/2004	San Geronimo Creek	12	8.03	0.9	164	178		0.006		4.8	<	0.5
00-79	10/20/2004	Lag Creek @ Kent (Shafter Bridge)	11.2	7.72	0.66	66	70	<	0.005		0.4	<	0.5
00-17	10/20/2004	Nicasio Creek	13.6	7.45	11.6	143	148		0.008		10	<	0.5
00-37	10/20/2004	San Geronimo Creek	12	7.88	15.5	129	150		0.008		10.8	<	0.5
00-79	11/17/2004	Lag Creek @ Kent (Shafter Bridge)	11	7.43	1	66.5	66	<	0.005		1.6	<	0.5
00-17	11/17/2004	Nicasio Creek	11.8	6.95	1.41	153	158		0.01		3.6	<	0.5
00-37	11/17/2004	San Geronimo Creek	11	7.78	0.66	161	184		0.005		0.4	<	0.5
00-79	12/15/2004	Lag Creek @ Kent (Shafter Bridge)	11.3	7.72	2.09	67	70	<	0.005		4.4	<	0.5
00-17	12/15/2004	Nicasio Creek	11.7	7.22	2.5	127	134	<	0.005		2	<	0.5
00-37	12/15/2004	San Geronimo Creek	10.9	8.05	1.33	131	150	<	0.005		1.2	<	0.5
00-79	1/12/2005	Lag Creek @ Kent (Shafter Bridge)	9.8	7.6	4.6	60	62	<	0.005		0.8	<	0.5
00-17	1/12/2005	Nicasio Creek	10.1	7.61	32.9	50	56		0.008		6.4	<	0.5
00-37	1/12/2005	San Geronimo Creek	8.6	7.63	10.5	77	80		0.012		3.2	<	0.5
00-79	2/16/2005	Lag Creek @ Kent (Shafter Bridge)	11	7.82	2.93	66	68	<	0.005		2.8	<	0.5
00-17	2/16/2005	Nicasio Creek	11.7	8.08	15.1	54	58		0.005		8	<	0.5
00-37	2/16/2005	San Geronimo Creek	10.5	7.97	20.4	86	92	<	0.005		9.6	<	0.5
00-17	3/9/2005	Nicasio Creek	15.6	7.74	9.9	56	58		0.006		2	<	0.5
00-37	3/9/2005	San Geronimo Creek	11.6	7.96	2.71	111	120	<	0.005		1.2	<	0.5
00-79	3/9/2005	Lag Creek @ Kent (Shafter Bridge)	12.2	7.94	1.06	60	62	<	0.005	<	1	<	0.5
00-79	4/6/2005	Lag Creek @ Kent (Shafter Bridge)	14.3	7.93	2.74	59	60	<	0.005		2.4	<	0.5
00-17	4/6/2005	Nicasio Creek	14.1	7.52	14.6	58	58	<	0.005		6	<	0.5
00-37	4/6/2005	San Geronimo Creek	12.7	7.91	4.13	110	114	<	0.005		3.6	<	0.5
00-79	5/4/2005	Lag Creek @ Kent (Shafter Bridge)	14	7.83	0.62	69	70	<	0.005		2	<	0.5
00-37	5/4/2005	San Geronimo Creek	12.9	8.1	0.75	144	148	<	0.005		4	<	0.5
00-79	5/25/2005	Lag Creek @ Kent (Shafter Bridge)	15	7.95	1.63	64	64		0.006		2.4	<	0.5
00-17	5/25/2005	Nicasio Creek	17.5	7.44	8.5	52	54		0.01		2	<	0.5
00-79	6/23/2005	Lag Creek @ Kent (Shafter Bridge)	10.2	7.98	0.71	72	74	<	0.005		11.2	<	0.5
00-17	6/23/2005	Nicasio Creek	16	7.52	12	74	78		0.009		1.6	<	0.5
00-37	6/23/2005	San Geronimo Creek	13	8.27	1.56	145	148		0.008		2.1	<	0.5
00-79	7/13/2005	Lag Creek @ Kent (Shafter Bridge)	11.4	8.03	0.713	70	71	<	0.005		11.2		0.5
00-17	7/13/2005	Nicasio Creek	17.1	7.83	2.54	122	100	<	0.005		1.6	<	0.5
00-37	7/13/2005	San Geronimo Creek	14.9	7.94	0.581	70	71	<	0.005		2.1	<	0.5
00-79	8/3/2005	Lag Creek @ Kent (Shafter Bridge)	11	7.38	0.5	64	66	<	0.005		1.2	<	0.5
00-17	8/3/2005	Nicasio Creek	17.2	7.77	1.81	127	120	<	0.005		3.6	<	0.5
00-37	8/3/2005	San Geronimo Creek	15.6	8.17	2.09	161	164	<	0.005		4.8	<	0.5

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (^{o}C)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)		Copper* (mg/L)		Total suspended solids		Settleable solids (mg/L)
00-79	9/7/2005	Lag Creek @ Kent (Shafter Bridge)	11.1	7.91	0.55	69	64		0.005	<	1.2	<	0.5
00-17	9/7/2005	Nicasio Creek	16	7.7	2.16	136	118		0.005		3.2	<	0.5
00-37	9/7/2005	San Geronimo Creek	14	7.87	0.43	173	170	<	0.005	<	1.2	<	0.5
00-79	10/5/2005	Lag Creek @ Kent (Shafter Bridge)	11.4	7.97	0.43	70	68		0.006	<	1.2	<	0.5
00-17	10/5/2005	Nicasio Creek	13.6	7.71	1.8	150	144	<	0.005		3	<	0.5
00-37	10/5/2005	San Geronimo Creek	11	7.91	0.68	172	176	<	0.005		3	<	0.5
00-79	11/2/2005	Lag Creek @ Kent (Shafter Bridge)	11.4	7.52	0.58	68	68	<	0.005		2.1	<	0.5
00-17	11/2/2005	Nicasio Creek	13.2	7.41	1.14	154	146		0.008		3.5	<	0.5
00-37	11/2/2005	San Geronimo Creek	12.2	8.08	0.59	179	180		0.009	<	1.2	<	0.5
00-79	12/7/2005	Lag Creek @ Kent (Shafter Bridge)	9.09	7.55	0.92	66.2	64	<	0.005		1.6	<	0.5
00-17	12/7/2005	Nicasio Creek	8	7.41	1.84	127	138	<	0.005		2	<	0.5
00-37	12/7/2005	San Geronimo Creek	7.4	7.71	1.55	141.5	162	<	0.005		6.8	<	0.5
00-79	1/5/2006	Lag Creek @ Kent (Shafter Bridge)	12.1	7.94	9.32	60	56	<	0.005	<	1.2	<	0.5
00-17	1/5/2006	Nicasio Creek	12.5	7.69	192	48	52		0.009		6.44	<	0.5
00-37	1/5/2006	San Geronimo Creek	11.7	7.74	18.4	75	74	<	0.005		4.4	<	0.5
00-79	2/8/2006	Lag Creek @ Kent (Shafter Bridge)	11.2	7.85	7.34	55	54	<	0.005		2	<	0.5
00-17	2/8/2006	Nicasio Creek	11.2	7.6	12.1	43	52		0.01		31.6	<	0.5
00-37	2/8/2006	San Geronimo Creek	10.8	8.03	2.62	115	120	<	0.005	<	1.2	<	0.5
00-79	3/15/2006	Lag Creek @ Kent (Shafter Bridge)	11.1	7.9	5.88	53	54		0.006		2.4	<	0.5
00-17	3/15/2006	Nicasio Creek	11.5	7.64	81.1	44	52		0.006		16	<	0.5
00-37	3/15/2006	San Geronimo Creek	10.74	7.92	18.3	77	82	<	0.005		4.4	<	0.5
00-79	4/19/2006	Lag Creek @ Kent (Shafter Bridge)	12.8	7.79	7.61	50	50		0.006		1.2	<	0.5
00-17	4/19/2006	Nicasio Creek	14	7.8	50.2	50	54		0.006		7.6	<	0.5
00-37	4/19/2006	San Geronimo Creek	10.7	7.92	8.39	95	98	<	0.005	<	1.2	<	0.5
00-79	5/10/2006	Lag Creek @ Kent (Shafter Bridge)	11.7	7.83	4.53	69	64		0.005		2	<	0.5
00-17	5/10/2006	Nicasio Creek	18.1	8.32	22.7	54	56		0.006		9.6	<	0.5
00-37	5/10/2006	San Geronimo Creek	12.7	8.18	0.758	132	140		0.006	<	1.2	<	0.5
00-79	6/15/2006	Lag Creek @ Kent (Shafter Bridge)	11.7	7.73	4.57	62	62	<	0.005		2	<	0.5
00-17	6/15/2006	Nicasio Creek	15.2	8.04	1.54	110	108	<	0.005		3.6	<	0.5
00-37	6/15/2006	San Geronimo Creek	14.3	8.14	0.727	150	154	<	0.005	<	1.2	<	0.5
00-79	7/19/2006	Lag Creek @ Kent (Shafter Bridge)	12.3	7.66	4.22	62	60		0.006		2.4	<	0.5
00-17	7/19/2006	Nicasio Creek	18.3	7.65	4.19	141	114	<	0.005		8.6	<	0.5
00-37	7/19/2006	San Geronimo Creek	16.8	8.06	1.22	151	156	<	0.005	<	1.2	<	0.5
00-79	9/13/2006	Lag Creek @ Kent (Shafter Bridge)	11.5	7.66	4.08	61	60	<	0.005		3.2	<	0.5
00-17	9/13/2006	Nicasio Creek	16.7	7.67	1.5	115	112	<	0.005		2	<	0.5

Attachment A

REGIONAL WATER QUALITY CONTROL BOARD MONTHLY CREEK MONITORING DATA 1995-2006

Location ID	Date	Site	Temp (^{o}C)	pH	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)		Copper* (mg/L)		Total suspended solids		Settleable solids (mg/L)
00-37	9/13/2006	San Geronimo Creek	13.9	7.98	0.844	167	164		0.005		2.4	<	0.5
00-79	10/17/2006	Lag Creek @ Kent (Shafter Bridge)	9.7	7.56	2.86	60	60	<	0.005	<	1.2	<	0.5
00-17	10/17/2006	Nicasio Creek	13.5	7.58	2.03	118	118	<	0.005		1.4	<	0.5
00-37	10/17/2006	San Geronimo Creek	9.6	7.94	0.61	176	182	<	0.005	<	1.2	<	0.5
00-79	11/15/2006	Lag Creek @ Kent (Shafter Bridge)	11.4	7.1	2.44	57	56	<	0.005		3.2	<	0.5
00-17	11/15/2006	Nicasio Creek	11.8	7.56	1.72	109	112		0.005		4.8	<	0.5
00-37	11/15/2006	San Geronimo Creek	10.6	7.92	0.717	142	160	<	0.005		2.6	<	0.5
00-79	12/20/2006	Lag Creek @ Kent (Shafter Bridge)	11.4	7.48	1.76	61	60	<	0.005	<	1.2	<	0.5
00-17	12/20/2006	Nicasio Creek	11.4	7.58	1.36	117	126	<	0.005		2	<	0.5
00-37	12/20/2006	San Geronimo Creek	5.2	8.03	1.21	133	156	<	0.005		2.4	<	0.5

APPENDIX G

Lagunitas Creek Technical Advisory Committee Recommendations to MMWD Board of Directors for the Future of Lagunitas Creek Fisheries Management
2007

APPENDIX G

TAC RECOMMENDATIONS to MMWD BOARD 6/1/07
THE FUTURE OF LAGUNITAS CREEK
FISHERIES MANAGEMENT

Priority	RECOMMENDATION
1	**Develop a summary report for compliance with Order WR95-17.** The summary should be of the 10 years of the Lagunitas Creek Sediment and Riparian Management Plan. Include lessons learned and recommendations for the future. Summarize the ten years of streambed monitoring data. Evaluate potential links between the results of the fisheries monitoring surveys and the streambed monitoring surveys, to more fully understand if and how enhancement efforts are affecting fish populations.
2	**Develop a new plan.** In the interim, continue with the existing Sediment and Riparian Management Plan. Develop a consensus on the priorities of the new plan, possibly using a technically proficient facilitator to assist in this effort. Include woody debris recruitment as a priority.
3	**Maintain the current TAC.** Explore changing or broadening the mission of the TAC. Explore ways to enhance connections with the Tomales Bay Watershed Council. More generally, explore the development of partnerships that share responsibilities for funding and implementing conservation activities.
4	**Extend efforts downstream.** Conduct studies and implement enhancement projects in the estuary and lower section of Lagunitas Creek.
5	**Continue to utilize MMWD's Special Projects Crew.** They should continue to implement enhancement projects since they are now the best in the State for this type of work.

GUALALA RIVER WATERSHED COUNCIL

Quality Assurance Project Plan

For Monitoring Sediment Reduction

December 2002

QUALITY ASSURANCE PROJECT PLAN FOR MONITORING SEDIMENT REDUCTION IN THE GUALALA RIVER WATERSHED

Prepared for:
California State Water Resources Control Board
and
California North Coast Regional Water Quality Control Board

By
Kerry Williams, Sotoyome Resource Conservation District
Kathleen Morgan, Gualala River Watershed Council

A. PROJECT MANAGEMENT

1. Title Page and Approvals

QUALITY ASSURANCE PLAN FOR MONITORING SEDIMENT REDUCTION IN THE GUALALA RIVER WATERSHED

This Document was compiled by:
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Approvals:

North Coast Regional Water Quality Control Board

By: Peter Otis
Environmental Planner
Quality Assurance Manager

Date: December 4, 2002

2. Table of Contents

APPENDICES

3. Distribution List

Primary distribution list for the Gualala River Watershed Monitoring Program Quality Assurance Plan:

NAME	AGENCY/ORGANIZATION
Lauren Clyde	North Coast Regional Water Quality Control Board
Bill Cox & Doug Albin	California Department of Fish & Game
Matt O'Connor	O'Connor Environmental, Inc.
Steering Committee	Gualala River Watershed Council
Technical Advisory Committee	Gualala River Watershed Council
Field Team Leaders	Gualala River Watershed Council

Once approved, this Quality Assurance Project Plan (QAPP) will be available to any interested party by requesting a copy from the Sotoyome Resource Conservation District (SRCD) (see address on title page).

4. Project/Task Organization

The members of the Gualala River Watershed Council (GRWC) in partnership with the SRCD are implementing the Gualala River Watershed Monitoring Program. The GRWC is an association of stakeholders in the Gualala River watershed. These stakeholders include any persons and/or entities that live within, own property within, use water from, operate commercial businesses within or are affected by land uses within the Gualala River Watershed. There is also consistent participation by representatives of local, state and federal agencies.

Formation of the GRWC in 1997 was facilitated by the North Coast Regional Water Quality Control Board (NCRWQCB), the California Department of Forestry (CDF), the Redwood Coast Land Conservancy (RCLC) and with ongoing support from the SRCD.

The development of a Gualala River Watershed Monitoring Program with a QAPP is part of the ongoing development of a watershed enhancement plan for the Gualala River watershed. This program is currently being funded by grants from the State Water Resource Control Board (State WRCB) 319(h) program and the California Department of Fish and Game (CDFG) SB271 program.

The GRWC monitoring program is managed by the SRCD with program over site and coordination by the GRWC Steering Committee, and Matt O'Connor, O'Connor Environmental, Inc.

The following personnel and subcontractors will perform sample collection and analysis:

- Trained GRWC citizen volunteers
- Trained GRWC supervising staff

- O'Connor Environmental, Inc.
- Forest Science Project
- Macroinvertebrate Lab

The Sediment Reduction in the Gualala River Watershed Monitoring 319(h) Project is a multi-organization project. Consultants and volunteer citizen monitors and staff from Gualala Redwoods, Inc. (GRI) will work together to monitor and assess natural streams in the Gualala River watershed at monitoring sites selected as outlined in the scope of work for the project. The results of this monitoring shall be reviewed during periodic technical advisory committee (TAC) meetings. In addition, any problems, concerns, and/or proposed amendments to this QAPP will also be reviewed and discussed by the TAC.

The following is a list of key personnel and their project responsibilities.

TASK	KEY PERSONNEL
Contract Manager	Lauren Clyde, North Coast RWQCB
Project Director	Kerry Williams, Sotoyome RCD
Coordinator for Field Teams & TAC	Kathleen Morgan, GRWC
Equipment Supply, Calibration	Nola Craig, DFG Staff, SRCD Staff, GRI Staff, Kathleen Morgan, Matt O'Connor, GRWC volunteers
Field Data Collection	Nola Craig, DFG Staff, SRCD Staff, GRI Staff, Kathleen Morgan, Matt O'Connor, GRWC volunteers
Data Management	Matt O'Connor, Kathleen Morgan, Kerry Williams, SRCD Staff, GRI staff
Quality Assurance/Quality Control	Matt O'Connor, GRWC Team Leaders
Technical Advisors	Matt O'Connor, agency members of TAC

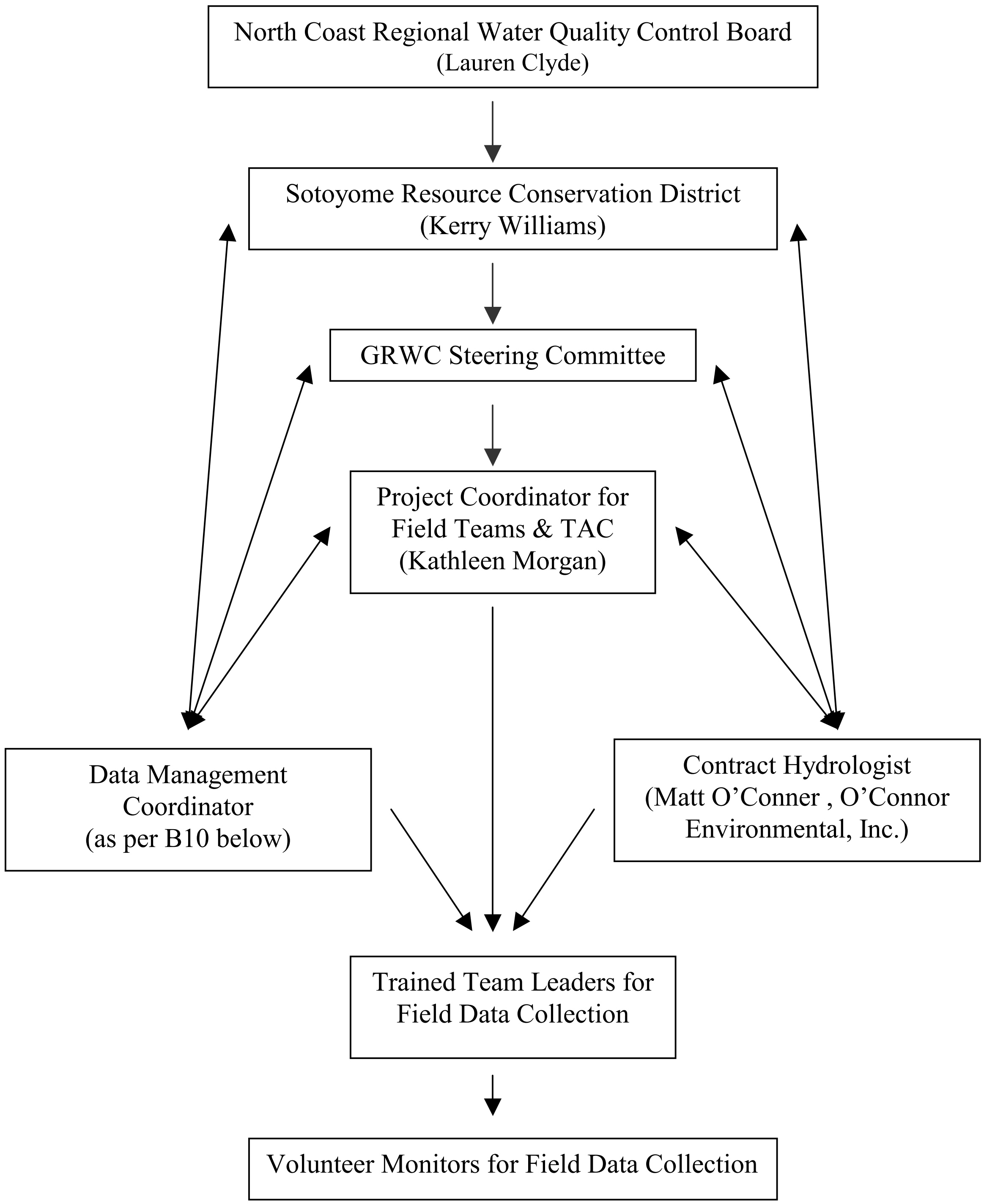
The organizational structure of the GRWC monitoring program is illustrated in Figure A-1.

5. Problem Definition/Background

Land use practices, combined with erosive landscape characteristics have accelerated the rate of erosion and mass wasting, and contributed to sedimentation in the Gualala River and its tributaries. Sedimentation is a result of a variety of natural and anthropogenic factors, including mass wasting, roads, and surface erosion. Sedimentation is believed to be a major contributing factor to the decline of historic runs of salmon and steelhead..

There is insufficient information to adequately assess the status of aquatic resources in the Gualala River watershed. The GRWC was formed in order to address watershed conditions and activities, including water quality concerns within the watershed. There are also small citizen monitoring groups forming to conduct monitoring in the various areas of the watershed and some private landowners have been conducting monitoring for several years. If quality assurance is adequate, valuable information will be provided for watershed management. One of the primary tasks of the GRWC is to design and implement a monitoring program for the watershed. A TAC has been formed to advise on this task.

Figure A-1 Organizational structure of the GRWC monitoring program.



6. Project/Task Description

This project will supplement existing agency information by monitoring streams in the Gualala River watershed. The focus of the project is on physical aquatic habitat and physical and biological water quality measures that will assist in identifying the status of these aquatic resources. Analysis, for the most part, will be conducted in the field with test kits and field instruments.

The objective of this project is to improve water quality through collaboration between public agencies, community groups, and private landowners. The project involves a three-year incremental process to implement non-point source controls, emphasizing on road improvements and to develop a mechanism for further assessments and implementation for reducing sedimentation in the watershed. The assessment and implementation will be aimed at improving water quality by reducing up-slope erosion impacts to the aquatic resources, improving the riparian zone, and enhancing anadromous salmonid habitat in the tributaries and main stem of the Gualala River watershed.

A map of the Gualala River watershed is attached as Appendix A.

The GRWC monitoring groups will be monitoring water quality in Gualala River watershed. Physical and biological parameters are measured; however, not all groups are measuring all parameters. Table 6.1 identifies the type and frequency of the monitoring parameters.

This QAPP addresses data quality objectives for the following parameters:

- Temperature
- Longitudinal Profiles & Benchmarks
- Cross-section Measurements
- Pebble Counts
- Large Woody Debris
- Canopy and Riparian Measurements
- Benthic Macroinvertebrate
- Streamflow, Turbidity and Total Suspended Solids

Table 6.1 Type and Frequency of Monitoring in the Sediment Reduction in the Gualala River Watershed Monitoring Program

Parameter	Maximum Frequency	Time of Year
Temperature	A	Summer
Longitudinal Profiles & Benchmarks	B	Summer
Cross-sections	B	Summer
Pebble Counts	B	Summer
Large Wood Debris	B	Summer
Canopy & Riparian Measurements	B	6/1-8/31
Benthic Macroinvertebrates	B	Fall
Stream Flow, Turbidity & Total Suspended Solids (Optional monitoring element)	C	Winter/Spring

Frequency: A: Annual B: Annual or less frequently depending on objectives C: Seasonal, frequency depending on objectives and flow conditions

7. Quality Objectives and Criteria

Table 7.1 Data Quality Objectives for Conventional Water Quality Parameters

Parameter	Method/range	Units	Detection Limit	Sensitivity	Precision	Accuracy	Completeness
Temperature	Thermometer (-5 to 50)	^{o}C	-5	$0.5\,^{o}C$	± 10%	± 10%	80%
Turbidity	Tubes (5 -)	JTUs	< 5	5 JTUs	± 5 JTUs	NA	80%
Total Suspended Solids (TSS)	Residue, Non-Filterable (EPA Method 160.2)	mg/l	4	NA	NA	NA	NA

NA: not applicable

Table 7.2 Data Quality Objectives for Physical Aquatic Habitat Parameters

Parameter	Time scale	Spatial scale	Endpoints/units	Tolerated error	Supporting documentation	Prep by professionals
Large woody debris survey	1 year maximum and after major events.	Stream reaches of 1000 ft or 20 bankfull widths, whichever is more.	All LWD > 6 in. diameter and > 4 ft length within the bankfull channel; locate position of LWD in the long-profile.	Length +/- 1 ft per 5 ft, Diameter +/- 2 in. per 6 in., Root wad dimensions +/- 1 ft per 2 ft of size. Distance from start point (long profile survey) +/- 3 ft to center point of log.	Notes on how to locate beginning and ending points of reach, associated long-profile data, associated cross-section data.	Measurement techniques, how to handle odd LWD shapes, how to estimate jam volumes when all pieces are not visible.
Longitudinal channel profile	1 year maximum and after major events.	Stream reaches of 1000 ft or 20 bankfull widths, which ever is more. Thalweg elevation minimum of 10 ft intervals.	The most important features to measure are: riffle crests, breaks in slope and deep points of pools. Measure elevation (± 0.02 ft) whenever the channel bed changes slope and at least every 15 ft where the slope is relatively uniform (e.g. a long run, riffle or pool).	Elevation +/- 0.02 ft; distance (± 3 ft) from start point and left right offset (± 4ft). Elevation closure within 0.01 ft for each benchmark, each turning point, and each 500 linear feet of distance.	Notes on how to locate beginning and end points of reach, associated cross-section data, pebble count data, photo-documentation of stream channel and benchmarks.	Surveying techniques, site selection.
Cross-sections	1 year maximum and after major events.	3 per 1000 ft reach are conventional; sites initially selected are likely spawning sites defined as riffles located at pool tails.	Elevation observations at inflections points with at least one intervening point between breaks in slope. The most important features to measure are: breaks in slope, bankfull, wetted width and thalweg. Average spacing between observations equivalent to < 5% of bankfull width.	Elevation closure within 0.01 ft for each benchmark, each turning point, and each 500 linear feet of distance.	Notes on how to locate beginning and ending points of cross-section, associated long-profile data, pebble count data, and photo-documentation of stream channel.	Surveying techniques, site selection.

Table 7.2 continued…

Parameter	Time scale	Spatial scale	Endpoints/units	Tolerated error	Supporting documentation	Prep by professionals
Pebble count (Wolman 1954) (as specified for GRWC) Refer to Appendix F	1 year maximum and after major events.	4 per 1000 ft reach are conventional; sites initially selected are likely spawning sites defined as riffles located at pool tails.	100 measurements in a random walk on the riffle surface from upstream to downstream, collecting a pebble diameter at 3 ft intervals (about one stride by the observer). Lateral extent of observation area defined by active bed deposits lacking significant vegetation or leaf litter.	Individual pebbles to +/- 1mm	Location within long profile and associated cross-section stations and reach end point.	Measurement techniques and data recording.
Riparian Canopy Closure	1 year at time of installation of the temperature data logger.	Thermal reaches of a 1000 to 2000 feet above data logger installation site.	Using a spherical densiometer adapted to the Strickler method (1959). From center of channel take measurements at 100 ft. intervals along the thermal reach.	+/- 2 intersections in the field of view	Notes on how to locate beginning and ending points of a thermal reach and center of channel, associated Forest Science protocols.	Measurement technique and data recording.
Riparian Canopy Density	1 year maximum and after major events.	In stream channel and riparian forest stand plots located at 200 ft intervals along monitoring reach.	Using a spherical densiometer, measure the percentage of overhead canopy density at 5 locations along a transect perpendicular to the stream channel: center of channel, at the left and right edge of the bankfull channel, and at 50ft beyond the bankfull channel edge in the riparian zone.	+/- 2 squares in the field of view i.e. +/- < 10%	Notes on how to locate beginning and ending points of reach, associated long-profile data, reference to associated riparian stand inventory plots.	Measurement technique, sampling rules regarding non-standard situations (e.g. what is done if the 50 ft distance ends on a road, or a very steep slope that cannot be negotiated?).

Table 7.2 continued…

Parameter	Time scale	Spatial scale	Endpoints/units	Tolerated error	Supporting documentation	Prep by professionals
Riparian forest stand inventory	1 year maximum and after major events.	Sample of <u>trees</u> and downed logs within a 100 ft long, 21.8 ft wide (20th acre) rectangular plot and <u>understory</u> in a 100th acre sub-plot in riparian forest stands located at 200 ft intervals along monitoring reach.	Measure height and live crown % and distance of the first 3 conifer trees > 5.6 in DBH from the origin of the plot centerline. Estimate DBH and measure distance of all remaining tree species >5.6 in DBH. The diameter of all down logs that intersect the 100 ft centerline of the plot is also measured. A 100th acre lesser vegetation sub-plot is established 15 ft from bankfull. The plot is established and monumented with rebar at the edge of the bankfull channel and the 100 ft end point.	Length/Height +/- 1 ft. Diameter +/- 1 in. Distance from plot start point +/- 1 ft	Notes on how to locate beginning and ending points of plot, adjust 100 ft measurement for slope, associated long-profile data, reference to associated riparian canopy data.	Measurement techniques and sampling rules for non-standard situations (e.g. what is done if the 100 ft distance ends on a road? or a very steep slope that cannot be negotiated?).
Turbidity	Instantaneous during periods of storm runoff	Designated cross-section locations within larger monitoring sites	NTU's, see Table 7.1	See Table 1, +/- 10%	Manufacturer's instruction manuals.	Training of monitoring team leaders; QA/QC on data and instrument logs
Stream Discharge	Instantaneous during periods of storm runoff	Designated cross-section locations within larger monitoring sites	cubic feet per second (cfs)	+/- 10%	US Geologicial Survey WRI Report 00-4036, ver. 1.1 (CD-ROM interactive training manual)	Training of monitoring team leaders; QA/QC on data and instrument logs

Table 7.2 continued…

Parameter	Time scale	Spatial scale	Endpoints/units	Tolerated error	Supporting documentation	Prep by professionals
Total Suspended Solids	Instantaneous during periods of storm runoff	Designated cross-section locations within larger monitoring sites	Sample collected using a depth-integrated sampler; sample represents verticle spatial average concentration of solids in the water column; optimal sample is in or near channel thalweg as flow conditions permit; number of samples likely to be limited by funds available for lab processing; intended for correlation with turbidity data and stream discharge collected at the same site and time	See Table 1, +/- 10%	Manufacturer's instruction manual for use of depth integrated sampler (equivalent to USGS DH-48 sampler)	Training of monitoring team leaders; QA/QC on data and instrument logs

Benchmarks for each parameter are addressed separately

Table 7.3 Data Quality Objectives for Biological Parameters

Parameter	Method/range	Units	Detection Limit	Sensitivity*	Precision	Accuracy	Completeness
Benthic Macro-invertebrates	Calif. Stream Bioassessment Protocol (CDFG)	N/A	Family level	N/A	≤ 5% difference	≤ 5% difference	80%

8. Special Training/Certification

The Gualala River Watershed Coordinator, members of the GRWC, employees of SRCD, employees of Gualala Redwoods, Inc. and volunteers from the community will collect data at selected sites in the watershed and will receive training in techniques used to evaluate general watershed condition. All protocols and example data collection sheets are attached in the Appendices and source documentation is identified in the protocols themselves.

The data will be made available to the public to use for educational and informational purposes. It is hoped that information gained from the ongoing volunteer monitoring program will lead to land management decisions that consider the health of the watershed.

All citizen-monitoring leaders must participate in three hands-on training sessions related to water quality and channel monitoring conducted by either GRWC or a comparable entity and approved by the SRCD and RWCQB. Training sessions will be held in the Gualala River watershed. Certificates of completion will be provided once all training as been completed. The following topics will be covered under this training:

- General hydrology
- Ecology
- Health and Safety
- Quality Assurance and Quality Control (QA/QC) Measures
- Sampling Procedures
- Field Analytical Techniques
- Data recording

The trainer will ensure that volunteer citizen monitoring leaders are reading instruments and recording results correctly. Individual trainees are evaluated by their performance of analytical and sampling techniques, by comparing their results to known values, and to results obtained by trainers and other trainees. Sampling and safety techniques will also be evaluated. The trainer will discuss corrective action measures with the volunteers, and the date by which the action will be taken. The citizen-monitoring leader is responsible for reporting back if any corrective action is taken. Certificates of completion will be provided once all training has been completed.

To be certified for macroinvertebrate bioassessment citizen monitoring leaders must also participate in a three-day training course provided by the CDFG, the Sustainable Lands Stewardship Institute, the American Fisheries Society, or the State WRCB.

9. Documents and Records

All field results will be recorded at the time of completion in the field, using the data sheets (data sheets are included with each individual protocol in the appendices B through H) and field logbooks. Each monitoring group will also keep and record information in the instrument maintenance logs.

Data sheets will be reviewed for outliers and omissions before leaving the sample site at the completion of each data collection. Data sheets will be signed after review by a team-monitoring leader. Data sheets will be turned in to data headquarters within one week of actual data collection. Data headquarters will be either the SRCD office or.(we need to choose another alternate location in Gualala area)The monitoring coordinator's house. Copies of all data sheets will be made immediately upon receipt at data headquarters. Original copies will be stored in an "original binder" and copies will be put into a "working binder." Copies of all information in the field logbooks will be made and inserted into the working copy binder. Entry of all data will be made into a computer database within three months of data collection. computer backup copies will be made on a quarterly basis and will be made and held at data headquarters. All data entry and other tasks involving data sheets will utilize the working binder. The original binder shall be used as a reference only. Field sheets are archived for three years from the time they were collected.

Instrument maintenance logs will also be kept by each citizen-monitoring group for each instrument in use. These include HOBO temperature units. The instrument logs detail the dates of equipment inspection and calibrations, as well as the dates reagents are replaced. The logs will be returned to the team-monitoring leader following each monitoring event, in case a review is necessary. Instrument logs will be turned in with data sheets and photocopies will be placed in the working binder.

A field site log pertaining to the location, including maps, specific directions to locating sample sites in the field, photographs, and site characteristics (including site selection criteria particular to each site) will be maintained at headquarters and updated annually. Within one week after each site visit, copies of the field log will be made and inserted in the working binder. Once field logs are full, the original will be kept at data headquarters along with other original documentation.

The Monitoring Program Coordinator and scientific members of the Technical Advisory Committee will complete an annual audit of data sheets and instrument logs.

B. DATA GENERATION AND AQUISITION

1. Sampling Process Design

Up to 30 sampling sites will be selected as part of this program with the GRWC and TAC participation. The following criteria will be evaluated when choosing sampling locations:

- sample can be taken in main river current or where homogeneous mixing of water occurs (pertains to temperature and turbidity measurements);
- sample is representative of the part of the river of interest which may include sampling related to implementation projects;
- location complements or supplements historical data;
- location represents a stream reach that possesses typical representative value for fish and wildlife or recreational use.

Additional criteria that will help determine the location of sampling sites includes:

- access (convenience in terms of time and effort);
- safety (access and specific site conditions anticipated during periods of field data collection);
- permission to cross private property (access agreement).

The monitoring program, as outlined in task 4 of the 319h contract, requires reference sites to assess the effectiveness of implementation projects. These locations will be chosen upstream and downstream of any potential impact, and upstream and downstream of any secondary discharge or disturbance.

Prior to final site selection, permission to access the stream is obtained from all property owners. If access to the site is a problem, the citizen-monitoring leader will select an alternate site. Safety issues will be included in the Gualala River Watershed Monitoring Manual.

The group leader will review sample sites. Relevant site characteristics will be observed and recorded on the field data forms and logs.

Data pertaining to date and time of sampling and weather conditions will be transcribed to the field data log (described in A9 above). A catalog of site photographs will be maintained as part of the field data log. See tables 6.1, 7.1, 7.2, 7.3.

2. Sampling Methods

<u>Field Observations</u>

Sampling Site Observations

Site condition observations will include pertinent detail about the location of the site, access, special considerations, photos obtained, and sampling point location(s), as well as climatic and hydrologic variables. These observations will be documented in a waterproof field data log as well as on data collection sheets (referred to in A9) to maintain standardization of information, and ensure all variables are recorded. All forms for data collection will be included in the appendices for each individual protocol. The field data pertaining to site conditions will be transcribed to the field data log (see A9).

Automated Sample Collection

Data loggers are effective in collecting physical-chemical measurements on short time intervals over many days without constant staff oversight. Data are stored on internal memory chips and downloaded to a computer in the field or office for further data analysis. The only protocol utilizing automated sample collection in this QAPP is temperature.

Temperature

Temperature loggers manufactured by Onset® Corp., will be programmed to sample at least every 96-minutes. With 8K of internal memory, a full summer of data can be collected. Additionally, the 96-minute sampling interval is the minimum specified in the cooperative effort developed by the Forest Science Project (FSP 1998) to detect daily maxima (Appendix B).

Basic considerations for site selection are presented in the modified protocol. The primary use of the data at this point is for characterizing a stream reach, so placement is in a well-mixed, flowing section of the stream that is representative of a reach.

A thermal reach is a reach with similar (relatively homogenous) riparian and channel conditions for a sufficient distance to allow the stream to reach equilibrium with those conditions. The length of reach required to reach equilibrium will depend on stream size (especially water depth) and morphology (TFW, 1993). A deep, slow moving stream responds more slowly to heat inputs and requires a longer thermal reach, while a shallow, faster moving stream will generally respond faster to changing riparian conditions, indicating a shorter thermal reach. Generally, it takes about 1000 feet of similar riparian and channel conditions to establish equilibrium with those conditions in fish-bearing streams.

Data sheets for calibration, deployment, and site conditions accompany the data for each deployment and are provided in Appendix B. Raw field data is delivered to the Forest Science Project (FSP) for processing and analysis according to FSP protocols. The processed temperature data is then returned to the GRWC in both raw and analyzed form.

Channel Measurements

Stream channels form and are maintained by the interaction of streamflow and sediment regimes in a process that yields consistent average channel shape and size (Dunne and Leopold 1978). A reach is a section of a stream at least 20 times longer than its average channel width (Flosi and Reynolds, 1994) that maintains relatively homogenous channel morphology, flow, and physical, chemical, and biological characteristics.

The width and depth of a channel reflects the discharge and sediment load the channel receives, and must convey, from its drainage area. Channels are formed during peak flow events, and channel dimensions typically reflect hydraulic conditions during bankfull (channel-forming) flows.

Channel form and composition is monitored at low water. The monitoring is done within a section of a stream called a study reach. All locations for study reaches will be selected, reconnoitered with respect to reach criteria described above, and flagged by GRWC Technical Committee Members (TAC) and/or Technical Advisors before the sites are assigned to be surveyed. During reach reconnaissance, locations where cross-sections and bed composition protocols will be implemented are flagged. The study reach will be re-visited on a seasonal schedule consistent with the monitoring objectives. The study reach procedure for channel form monitoring is outlined below and specific information regarding basic surveying techniques is available in Appendix C.

- The study reach is first laid out on the ground
- Bankfull indicators are identified and bankfull width is determined
- Three benchmarks are established
- Three cross-sections are then located and staked
- A longitudinal survey is performed
- Cross-sections are surveyed
- Bed composition protocols are performed
- Large woody debris is surveyed
- Riparian measurements and Canopy Density are recorded
- Water quality tests are run

The following descriptions are summaries of the measurements with reference to specific literature. Specific methods and the actual references for these metrics are presented in the appendices.

Longitudinal (Thalweg) Profiles & Benchmarks

The amount of variability in thalweg along a longitudinal axis in the stream is a good measure of complexity of the wetted stream channel. Pools, logs, boulders, riffles, etc. add complexity to the channel that affect sediment transport, channel form, and fish habitat. Changes in the thalweg profile reflect overall changes in the channel complexity, which are a result of channel-forming forces in the stream. Reduction of complexity occurs with excessive sediment introduction. Increased complexity indicates a recovery from such a condition. Thalweg profiles provide information on existing conditions, but are useful in trend analysis over the long term.

Strictly implemented, a thalweg profile or survey, as mentioned above, measures the streambed elevation along the thalweg of the stream, taking particular care to measure all breaks-in-slope, riffle crests, maximum pool depths, and pool tail-outs. Concurrently, while the tapes, levels, etc., are set up for measuring thalweg profiles, the locations of transects for cross-sections are also usually documented and measured (Madej, and Ozaki, 1996; Ramos, 1996). Since it is impossible to uniformly arrange the longitudinal tape exactly over the thalweg, measurements should be perpendicularly referenced to the centerline tape, and read to within one foot. Ramos suggests that as thalweg measurements intersect the point of a designated cross-section, the thalweg should be measured at the intersection first, and then the cross-section is surveyed before proceeding upstream. In addition to the thalweg elevations, other variables, such as water surface, bar height, substrate size, high water marks, and comments on local channel features such as pools, riffles, runs, and the presence or absence of large woody debris can be recorded. Subsequent analysis of the profile allows the detection of changes in the vertical dimensions of channel features. Depending on the data obtained from the thalweg survey, standard parametric and non-parametric statistical methods can be applied to more fully interpret survey results.

Depending on the study's intent, the reach length surveyed in a thalweg profile may vary from 20 to 50 channel widths. Rather than channel widths, surveys can also be modeled around a specific number of meander segments, generally three to four, within a reach (Madej, and Ozaki, 1996; Trush, 1997; Rosgen, 1996). The important consideration in selecting a specific length for a reach to conduct thalweg profiles is the ability of the study design to answer any questions or hypotheses proposed, whether it is to detect changes over time in channel aggradation or degradation, or to inventory available pool and riffle habitat for salmonids and other insteam biota.

Specific methods and the actual references for Longitudinal Profile surveys are presented in Appendix E.

Cross-sections

Channel cross-section measurements provide valuable information on the shape and dimension of a stream channel and its relationship to the flood plain. Coupled with other measurements, cross-sections measured repeatedly over a period of years provide valuable information on the transport and storage of sediment in the stream channel and inter-annual variation of stream channel geometry. Common parameters can include width/depth ratio, bankfull depth, entrenchment, and flood-prone area. For utility and ease of reference, other parameters, such as scour chain and bank-pin placement (for monitoring bed scour and fill and bank erosion and accretion, respectively), pebble counts, riparian canopy measurements, etc., can also be combined and conducted at cross-section locations.

Monitoring the long-term changes in cross-sectional data can provide insights into channel bed and bank stability, and relationships between sediment transport and discharge (Beschta and Platts 1986). , For example, stream aggradation may be manifested by changes in channel geometry such as decreasing thalweg depth, increasing channel width, and increasing mean bed elevations. Channel incision (i.e. downcutting) may be indicative of a return to more "natural" conditions from previous management and/or impacts of major storms and floods (McDonald, et al., 1991).

A typical study design can have as few as three, or as many as 15-20 cross-sections located in a study reach. A reach has been variously defined as 20-50 bankfull flow widths (Kondolf and Micheli), one thousand meters (Knopp, 1993), or a predetermined length based on the geomorphic characteristics of the watercourse under study. For example, Madej and Ozaki, defined a study area as 26 kilometers long in Redwood Creek from its confluence with the

Pacific Ocean to a slope-determined end point. Within the study area the 26 km stream segment was divided into three interconnected reaches, an upper, middle, and lower reach. A total of 58 cross-sections were nested within the three reaches. The end points of each reach were determined by major breaks in stream gradient.

A cross-sectional profile is developed by measuring points along a tape measure stretched across the stream and recording the distance, and surveying streambed elevations at each specific point along the tape. Streambed characteristics, such as changes in bottom elevations, the position of the field estimated bankfull height, wetted width, breaks in slope, and the deepest points in the particular channel feature being measured are recorded. The end points of the cross-section should extend at least above the estimated bankfull stage and preferably beyond the current floodplain.

Specific methods and the actual references for Longitudinal Profile surveys are presented in Appendix E.

Pebble Counts

One of the most widely used methods of sampling grain size from a streambed is the pebble count technique (Wolman, 1954). It can be used as a simple and rapid stream assessment method that may help in determining if land use activities or natural land disturbances are introducing fine sediment into streams (Potyondy and Hardy, 1994). Pebble counts are routinely used by geomorphologists, hydrologists and others to characterize bed material particle size distributions of wadable, gravel bedded streams. The procedures have been adapted in fisheries studies as a preferred alternative to visually characterizing surface particle sizes commonly used during instream flow studies (Kondolf and Li, 1992). The methodology is best applied in gravel and cobble streams with a single channel and are not applicable to lower gradient, sand-bed dominated channels. A recent, comprehensive review of [Bunte, 2001 #641] measurement of streambed sediment in wadable, gravel bedded streams describes the advantages and constraints of a wide variety of sampling designs.

Pebble counts are conducted by randomly collecting, counting and measuring the intermediate diameter (b-axis) of 100, and up to 200 (Kappesser, 1993) particles from the surface of a given streambed. Bunte and Abt (2001) suggest that accurate characterization of the size distribution of sediment for a given reach requires a sample of 400 measurements. Riffles deemed suitable for spawning salmonids are the preferred location for sampling efforts (Schuett-Hames, et al., 1999). Pebbles are collected along transects at measured points following a predetermined grid pattern, or by walking the streambed and picking up individual pebbles at the toe of a boot along a toe-to-heel, zigzag pattern. Whether the structured grid pattern or the toe-to-heel method is used, all transects should traverse the stream channel from the estimated bankfull to bankfull stage.

After at least 100 pebbles are sampled cumulative size distribution curves can be developed for the D50, median particle size, the diameter at which 50% of the particles are finer, and the D16 and D84, the diameters at which 16% and 84% of the particles are finer. Other analyses that may be applied are the geometric mean diameter: $dg = [(D84)(D16)]^{0.5}$ and the geometric sorting coefficient: $sg = (D84/D16)^{0.5}$ (Kondolf and Li, 1992). As mentioned, it has been shown that shifts toward the lower end of the pebble count cumulative frequency curves may be indicative of significant increases in streambed fines from accelerated natural and or land-use disturbances. Conversely, a progressive coarsening of streambed surface particles may indicate improving conditions from past upstream and/or upslope disturbances.

Specific methods and the actual references for pebble count procedures are presented in Appendix F.

Large Woody Debris

Large Woody Debris (LWD) is known to be an important structural element of stream channels. It improves juvenile Coho salmon and steelhead trout summer rearing habitat by increasing the numbers and depths of pools. Large amounts of LWD also increase winter cover that is critical for salmonid protection from predation and the reduction of water velocity.

Beechie and Sibley (1997) concluded that when the number of LWD pieces (>8 inches in diameter) reached about 122 pieces /1,000 Ft., pool formation is less sensitive to further increases in LWD loading. Similarly, Martin (1999) found that the effectiveness of LWD for forming pools in alluvial channels was diminished when the LWD load exceeded a threshold of approximately 137 pieces. LWD loading (m^3 of LWD per 100 m of channel length) in surveyed stream reaches in northern California have been compiled and may provide another useful basis for assessment of LWD abundance [O'Connor Environmental, 2000 #687].www.fire.ca.gov/bof/pdfs/garcia_LWD_final.pdf

To monitor large woody debris we use an inventory method developed in partnership by GRI and the GRWC after reviewing other accepted techniques. It is designed to allow sorting and recompiling of data to answer different questions over time. A measurement is made of every piece that breaks the plane of the bankfull line and is at least 6” in diameter on the small end and 4’ long.

Specific methods and references for monitoring LWD are presented in Appendix G.

Riparian Measurements and Canopy

Riparian, or streamside forest, provides habitat for many types of wildlife, shades the creek keeping water temperatures cool for salmon and trout, and protects creek banks. When a tree is undercut and falls into the creek it becomes the large wood, and essential element for fish habitat. There are several features of riparian forest that indicate its value as habitat and as part of the stream system. The density and diversity of plant species, the width of the riparian corridor beyond the edge of the creek scour channel, the size of the trees in the corridor and the occurrence of dead trees, vines, downed wood and other features, all describe the habitat value of the forest for birds, mammals, reptiles, amphibians and salmonids.

The density of the streamside tree canopy creating shade over the creek, and the availability of large trees along the banks to become wood in the stream are features of the riparian forest, which relate to salmon and trout habitat in the creek channel. The extent of creeks in the watershed with dense riparian corridor indicates where water temperatures are likely to be low. By assessing the riparian area the current conditions of the riparian areas will be documented and these current conditions can be compared throughout the watershed. The objective of the riparian assessment is to understand and identify areas in need of restoration and enhancement. In addition, monitoring over time will provide the opportunity to investigate the relationship between riparian stand conditions and LWD recruitment to stream channels and effect on aquatic habitat.

The riparian surveys use the Forest Projection System (FPS) developed by Dr. Jim Arney of Forest Biometrics. Riparian forest stands will be inventoried by identifying a sample of trees by species within 20th acre plots at 200 ft intervals along the established monitoring reaches. The 20th acre fixed plots are run up-hill from bank-full to 100 feet and are 21.8' wide. Measurements of live trees, snags, down-logs and understory vegetation are documented.

Canopy density is measured using a spherical densiometer to record the riparian vegetation shading the creek. The measurements are taken in conjunction with the riparian surveys. Measurements are taken at five points at the established riparian plot sites: center of channel, bank-full (right & left), and 50 ft. inland from the bankfull point. Four readings per location are made first facing upstream, left bank, downstream, and right bank then the results are averaged to provide an estimate of canopy cover for that point.

Specific methods and the actual references for canopy and riparian monitoring procedures are presented in Appendix H.

Biological Sample Collection

Freshwater benthic macro invertebrates include worms, snails, clams, crustaceans, aquatic beetles, the nymph form of mayflies, stoneflies, dragonflies and damselflies and larval form of caddisflies and true flies. They are a minimum of 0.5 mm in length and live primarily on instream boulder, cobble or gravel substrate. They are most easily categorized into feeding guilds, species that obtain a common food source in a similar manner. The most common feeding guilds are shredders, filter-collectors, collect-gatherers, scrapers-grazers, and predators.

The physical structure of rivers and streams are measured by stream order, which is related to watershed size. Stream order influences the assemblage of benthic macro invertebrates. The Gualala River mainstem is a fourth order stream, all other tributaries within the basin are of smaller order. The predominant feeding guilds in fourth order streams are scrapers, which consume the algal growth associated with a more open canopy cover and collectors utilizing the high amount of fine particulate organic matter, which has drifted downstream. Shredders, which process leaf litter and other forest debris, and collectors, which further process shredder excrement, usually dominate first and second order streams.

Macroinvertebrate samples will be obtained using the methodology outlined in the *California Stream Bioassessment Procedure* (CDFG 1999). Sampling sites will be selected according to guidance provided in those protocols as well as knowledge of the watershed and land uses upstream of the site.

Other interesting, descriptive, or unusual biota will be noted in the field log at the time of sampling to provide additional qualitative information on the relative health of the water body.

Stream Discharge, Turbidity, and Total Suspended Solids

The measurements and data analysis presented below describe a limited monitoring program utilizing field observations and measurements collected by monitoring personnel that could be used to quantitatively characterize the magnitude of the measured parameters. Although the protocol provides for the collection of quantitative data, the interpretation of the data is limited by high sample variance and small sample size. A statistically robust data set that could potentially be used to assess trends or cause-effect relationships between water quality and land management would require at minimum a continuous data record that could be produced only by automated samplers, supplemented by a field monitoring program comparable to that presented here. It would be possible for committed field personnel to produce a valuable data set using this monitoring protocol, however, the investment of time and effort would be high.

Simultaneous measurements of stream discharge (instantaneous rate of flow in units of cubic feet per second), water turbidity, and total suspended solids in the water column form a discrete component of the monitoring program that can be conducted during periods of storm runoff from October through the end of the rainy season. Monitoring sites will require installation of a monumented cross-section, a staff plate allowing observation of water surface elevation surveyed in the cross-section, and must be relatively accessible and safe for sampling during periods of runoff.

The field protocol includes observations of time and stream stage, collection of a depth integrated water sample for subsequent lab analysis of suspended solids, collection of a surface grab sample for field measurement of turbidity, and measurement of stream discharge (requires at least 0.5 hours of wading and measurement of stream velocity with a current meter). Supplemental data on flow velocity at the water surface will be collected using a float test. The relationship between stream discharge and surface velocity will be used to improve the accuracy of estimated stream discharge during periods when in-stream measurements are not possible or unsafe. Following the discharge measurement, a second set of stage and water samples are collected. Observations of stage, turbidity, and suspended solids immediately before and following discharge measurements are intended to account for variability of conditions in the short-term, including potentially rapid changes in stream stage and discharge.

The surface grab sample for field measured turbidity should be taken as near the channel thalweg as possible, and must be collected from a location where flow is well-mixed. The same criteria apply to the depth integrated sample. Samples for turbidity will be processed immediately in the field. Samples for suspended solids will be labeled and refrigerated and will be transported to a contract laboratory as soon as possible, normally within 72 hours. Chain of custody forms will be maintained for these samples.

Stream discharge measurements typically require measurement of stream velocity at a minimum of 10 points, and preferable 20, in the cross-section. These measurements necessarily include periods of storm runoff. Safety considerations are paramount, and it is anticipated that there will be periods of flow when field personnel will determine that in-stream measurements are not sufficiently safe. In recognition of this reality of field work in streams, supplemental observations of surface velocity are included in the monitoring protocol.

Specific methods and the actual references for canopy and riparian monitoring procedures are presented in Appendix I.

Photo Documentation

Photos of the downstream end of the reach are taken to document location of benchmarks used to relocate and resurvey the reach. In addition, instream photo monitoring using photos taken both upstream and downstream from station zero, at each cross-section station, and at end of the reach is conducted to record general channel conditions and assist in interpretation of channel change over time. No formal analysis of photos is conducted. Specific methods are included in the monitoring procedure where photo documentation is part of the methodology (i.e. longitudinal profiles, cross-sections).

3. Sample Handling and Custody

Field teams will collect data with a team leader supervising. All data sheets and instrument logs will be turned into the team leader who will check the data for quality and completeness. As noted above, chain of custody will be documented for water samples collected for laboratory processing, withshipment to laboratory based on the protocols for the individual metrics. Chain of custody (COC) forms will be maintained for all samples.

4. Analytical Methods

The parameters being measured as part of this QAPP are physical in nature and do not involve analytical methods, with the exception of turbidity and total suspended solids. Turbidity measurements will be collected using a field instrument approved for this purpose by the California Regional Water Quality Control Board, North Coast region (RWQCB). Total suspended solids would be determined using EPA Method 160.2. Additional information regarding these methods is provided in Appendix I.

5. Quality Control Requirements

Each of the parameters being used in this QAPP has an associated Quality Control, which is addressed in the Appendices.

Field data sheets will be checked and signed in the field by the monitoring leader. For laboratory samples the monitoring team leader will discard any results where holding times have been exceeded, sample identification information is incorrect, samples were inappropriately handled, or calibration information (recorded in the instrument logs) is missing or inadequate. Following each event, the team leader will collect the field notebooks and data sheets. All notebooks and data sheets will then be copied and stored in a site-specific binder. The binder and the original data will be stored in a specied location.

Independent laboratories will report their results to the monitoring leader. The leader will verify sample identification information, review the chain-of-custody forms, and identify the data appropriately in the database.

Data sheets and data files will be reviewed quarterly by the technical advisors to determine if the data meet the Quality Assurance Project Plan objectives. They will identify outliers, spurious results or omissions to the citizen-monitoring leader. They will also evaluate compliance with the data quality objectives. They will suggest corrective action that will be implemented by the citizen-monitoring leader. Problems with data quality and corrective action will be reported in final reports.

If data do not meet the project's specifications (see Table 2 –error tolerance), the following actions will be taken. First, the technical advisors will review the errors and determine if the problem is equipment failure, calibration/maintenance techniques, or monitoring/sampling techniques. If the problem cannot be corrected by re-training, revision of techniques, or replacement of supplies/equipment, then the technical advisors and the TAC will review the DQOs and determine if the DQOs are feasible. If the specific DQOs are not achievable, they will determine whether the specific DQO can be relaxed, or if the parameter should be eliminated from the monitoring program. Any revisions to DQOs will be appended to this QAPP with the revision date and the reason for modification. The appended QAPP will be sent to the quality assurance panel and contract manager. When the appended QAPP is approved, the citizen-monitoring leader will work with the data coordinator to ensure that all data meeting the new DQOs are entered into the database. Archived data can also be entered.

6. Instrument/Equipment Testing, Inspection and Acceptance Maintenance

All sampling equipment will be inspected for broken or missing parts, and will be tested to ensure proper operation. Inspection of equipment will occur as a pre-sampling check prior to use or as indicated by an exceeded QC limit. Maintenance will be performed in accordance with manufacturers recommendations or more frequently if problems are identified by QC checks.

Testing, inspection, and calibration for each specific piece of equipment are addressed in the Appendices. The following is a list of equipment that will be needed for the parameters being measured in this QAPP:

- ✓ Onset Hobo Temperature Data Loggers
- ✓ Non-Mercury Thermometers (NIST certified)
- ✓ Engineers Level, tripod, Stadia rod, 8" carpenter level
- ✓ Compass
- ✓ Clinometer
- ✓ Densiometer
- ✓ Calculator
- ✓ Camera
- ✓ 200' Fiberglass 2-sided tape, 150" Fiberglass tape, Spenser tape, 25'steel tapes, clear metric rulers
- ✓ (optional) Turbidometer, field unit (issued by RWQCB to GRWC)

Additional equipment that will be used but will not require any testing, QA/QC related inspection or maintenance will include:

- ✓ Fence Posts
- ✓ D-shaped kick net (0.5 mesh)
- ✓ Lag Bolts & Driver
- ✓ 3' Rebar
- ✓ Flagging
- ✓ Rudd Paint
- ✓ Aluminum & Code Tags
- ✓ Sledge Hammer
- ✓ Fence Post Pounder
- ✓ Clippers & Machete

7. Instrument/Equipment Calibration and Frequency

The equipment calibration and frequency is addressed for each protocol where equipment needs to be calibrated. This includes the calibration of the data loggers discussed in the temperature protocol (Appendix B) and the calibration of the turbidometer used in the optional water quality protocol (Appendix I).

8. Inspection/Acceptance of Supplies and Consumables

The inspection of supplies and consumables for the macroinvertebrate sampling are outlined in California Stream Bioassessment Procedure. Inspection of equipment will occur as a pre-sampling check prior to use or as indicated by an exceeded QC limit. Maintenance will be performed in accordance with manufacturers recommendations or more frequently if problems are identified by QC checks.

9. Non-direct Measurements

N/A to project

10. Data Management

Refer to A9 above for discussion regarding handling of data sheets and instrument logs. The designated data management coordinator will review the field sheets and enter the data deemed acceptable by the citizen monitoring leader(s) and the technical advisors. Data will be entered into a spreadsheet or a database using a format that is approved by the RWQCB. The data coordinator will review electronic data, compare to the original data sheets and correct entry errors. After performing data checks, and ensuring that data quality objectives have been met, data analysis will be performed. Summary statistics will be generated annually.

Raw Data

Raw data will be provided to the State WRCB and RWQCB in electronic form at least once every year so that it can be included in the 305(b) report and referenced for other watershed improvement projects and/or studies. Appropriate quality assurance information can be provided upon request. This should occur when the data files are updated and backed up (see A9 above). Refer to B2, B3 and B5 for additional discussion regarding data quality control processes.

Analysis

Temperature

Raw temperature data will be processed according to the methods outlined in the FSP protocols. A core set of metrics will be calculated from the data on a seasonal basis. These will include:

- daily minimum
- daily maximum
- daily average
- seven-day moving average of the daily mean
- seven-day moving average of the daily maximum

Yearly summary statistics calculated from the daily and weekly data will be produced for each site for each year. Yearly site-specific statistics of the seasonal maximum for the Maximum Weekly Average Temperature (MWAT) and the seasonal Maximum (Max) will be produced in chart form for each Super Planning Watershed (NCWAP Synthesis Report, 2002).

Longitudinal (Thalweg) Profiles & Benchmarks

Subsequent analysis of the channel profile may reveal subtle changes in channel morphology resulting from small scale shifts in bed sediment associated with low-magnitude annual floods and will document major changes in the stream bed that may result from high-magnitude floods that occur relatively infrequently. A core set of metrics will be calculated from the thalweg elevation data on an annual basis. These will include:

- channel slope

- a plot of the thalweg profile and associated summary data used to evaluate:
  - local changes in bed conditions, including location and depth of pools
  - changes in channel elevation relative to base year elevation
- Variation Index (Madej, 1999), a metric developed in northern California to evaluate channel response to and recovery from bed aggradation.

Summary statistics for slope, the thalweg profile and channel elevation are calculated by using an Excel database developed for Gualala Redwoods, Inc. The Variation Index is a means to quantifying variability in a longitudinal channel profile and is calculated by using the Longpro database developed by the USGS and Redwood National Park.

Cross-sections

Analysis of the cross-sectional profile may reveal changes in streambed elevation, bank stability, bankfull width/depth ratio, and channel scour and/or fill (aggradation/degradation). A core set of metrics will be calculated on an annual basis. These will include:

- bankfull width/depth ratio
- a cross-sectional profile plot to evaluate changes in streambed elevation and bank stability.
- changes in channel elevation relative to base year elevation
- channel scour and/or fill (Madej, 1999)

Summary statistics for bank-full width/depth ratio are calculated by using the CDF&G protocol. The cross-sectional profile plot and the channel elevation change are calculated by using an Excel database developed by Gualala Redwoods, Inc. Channel scour and/or fill is calculated by using the Winscour database developed by the USGS and Redwood National Park

Pebble Counts

It has been shown that shifts toward the lower end of the pebble count cumulative frequency curves may be indicative of significant increases in streambed fines from accelerated natural and or land-use disturbances. Conversely, a progressive coarsening of streambed surface particles may indicate improving conditions from past upstream and/or upslope disturbances. A core set of metrics will be calculated on an annual basis. These will include:

- d50, median particle size, the diameter at which 50% of the particles are finer
- d16, the diameter at which 16% of the particles are finer
- d84, the diameter at which 84% of the particles are finer

Summary statistics for the particle size diameters will be provided for individual sites and averaged by study reach. Other analyses that may be applied on a site-specific basis are the geometric mean diameter, $dg = [(D84)(D16)]^{0.5}$, and the geometric sorting coefficient, $sg = (D84/D16)^{0.5}$ (Kondolf and Li, 1992).

Large Woody Debris

Beechie and Sibley (1997) concluded that when the number of LWD pieces (>8 inches in diameter) reached about 122 pieces /1,000 Ft., pool formation is less sensitive to further increases in LWD loading. Similarly, Martin (1999) found that the effectiveness of LWD for forming pools in alluvial channels was diminished when the LWD load exceeded a threshold of approximately 137 pieces.

Calculating the size, position and number of LWD pieces within a survey reach will allow monitoring of natural LWD recruitment and assist in planning and monitoring future LWD restoration plans. A core set of metrics will be calculated from the data on an annual basis. These will include:

- cubic feet of LWD per 1,000 feet (also determined in units of m^3/100 m)
- number of LWD pieces per 1,000 feet

Yearly summary statistics are reported by monitoring study reach. A comparison of LWD load in each sample reach to the frequency distribution for regional values may be provided.

Riparian Measurements and Canopy

Subsequent analysis of riparian data allows the calculation of the riparian habitat within the study reaches. A core set of metrics will be calculated from the riparian surveys and canopy data on an annual basis. These will include:

- canopy density at center of channel, bank-full and 50' into the riparian zone
- riparian composition
- basal area
- tree height

Summary statistics for canopy density, riparian composition and basal area are averages for the study reach sites. Tree height is calculated by averaging the height of the 100 tallest trees per acre.

Turbidity

If and when turbidity data are collected, simultaneous measurement of stream discharge must occur. The turbidity data would be summarized in tabular format, including collection time and date, location of sample site, and stream discharge. In addition, for each sample station, a scatter plot showing turbidity as a function of stream discharge will be presented, and a linear regression analysis will be performed using stream discharge as the independent variable and turbidity as the dependent variable. If a relatively large data set is collected, it is expected that turbidity will be correlated with discharge.

Stream Discharge

In addition to the data report above, stream discharge observations will also be computed in terms of discharge per unit watershed area for comparison to continuous gauge data collected at the North Fork, Wheatfield, and South Fork gauges. If a relatively large data set is collected, it is expected that discharge will be correlated with one of the continuous gauges, and that a predictive relationship using linear regression can be developed whereby the continuous gauge data can be used to estimate discharge in smaller tributary watersheds based on drainage area.

Total Suspended Solids

These data are collected to determine the extent to which turbidity is correlated with suspended sediment transport. To the extent that these parameters are correlated at a monitoring site, turbidity data can be interpreted as an estimator for sediment load. Where available, total suspended solids will be reported in the summary table along with turbidity and discharge data. In addition, for each sample station, a scatter plot showing total suspended solids as a function of turbidity will be presented, and a linear regression analysis will be performed using turbidity as the independent variable and total suspended solids as the dependent variable. If a relatively large data set is collected, it is expected that total suspended solids will be correlated with turbidity. For individual sampling stations, a predictive relationship will be developed using linear regression which relates total suspended solids to turbidity. It is anticipated that the number and frequency of collection of samples for analysis of total suspended solids will decrease over time, once the predictive relationship is established.

Biological Sample Collection

Benthic macro invertebrate biotic condition is commonly measured by species richness, species composition, and tolerance/intolerance metrics. Species richness and composition tend to decrease in response to habitat disturbance. Harrington (2000) developed the Russian River Index of Biological Integrity, which includes six metrics:

- taxa richness
- percent dominant taxa
- EPT taxa
- modified EPT taxa
- Shannon diversity
- tolerance value

These six metrics will be integrated into a single score, which is compared to determine biotic condition categories: excellent (30-24), good (23-18), fair (17-12), and poor (11-6).

C. ASSESSMENT AND OVERSIGHT ELEMENTS

1. Assessment and Response Actions

Review of all field and data activities is the responsibility of the monitoring leader, with the assistance of the TAC. The monitoring leader, or a technical advisor will accompany volunteers on the 1st and 2nd sampling trips. If possible, volunteers in need of performance improvement will be retrained. All volunteers must attend a refresher course offered annually by the GRWC, SRCD or other recognized agency or entity. If errors in sampling technique are consistently identified, retraining may be scheduled more frequently.

Within the first three months of the monitoring project, State WRCB staff, or its designee, will evaluate field and laboratory performance and provide a report to the citizen-monitoring group. All field and laboratory activities, and records may be reviewed by state and EPA quality assurance officers as requested. If corrective action is required, State WRCB and the Regional WQCB staff will work with the SRCD and monitoring group to implement improvements.

2. Reports

The technical advisors will review draft reports to ensure the accuracy of data analysis and data interpretation. Raw data will be made available to data users per their request. The individual citizen monitoring organizations will report their data to their constituents after quality assurance has been reviewed and approved by their technical advisors. Every effort will be made to submit data and/or a report to the State and/or Regional Board staff in a fashion timely for their data uses, e.g. 305(b) report or special watershed reports.

D. DATA VALIDATION AND USABILITY ELEMENTS

1. Data Review, Validation and Verification

Data sheets will be reviewed quarterly by the technical advisors to determine if the data meet the Quality Assurance Project Plan objectives. They will identify outliers, spurious results or omissions to the monitoring team leaders. They will also evaluate compliance with the data quality objectives. They will suggest corrective action that will be implemented by the citizen-monitoring leader. Problems with the data quality and corrective action will be reported in final reports.

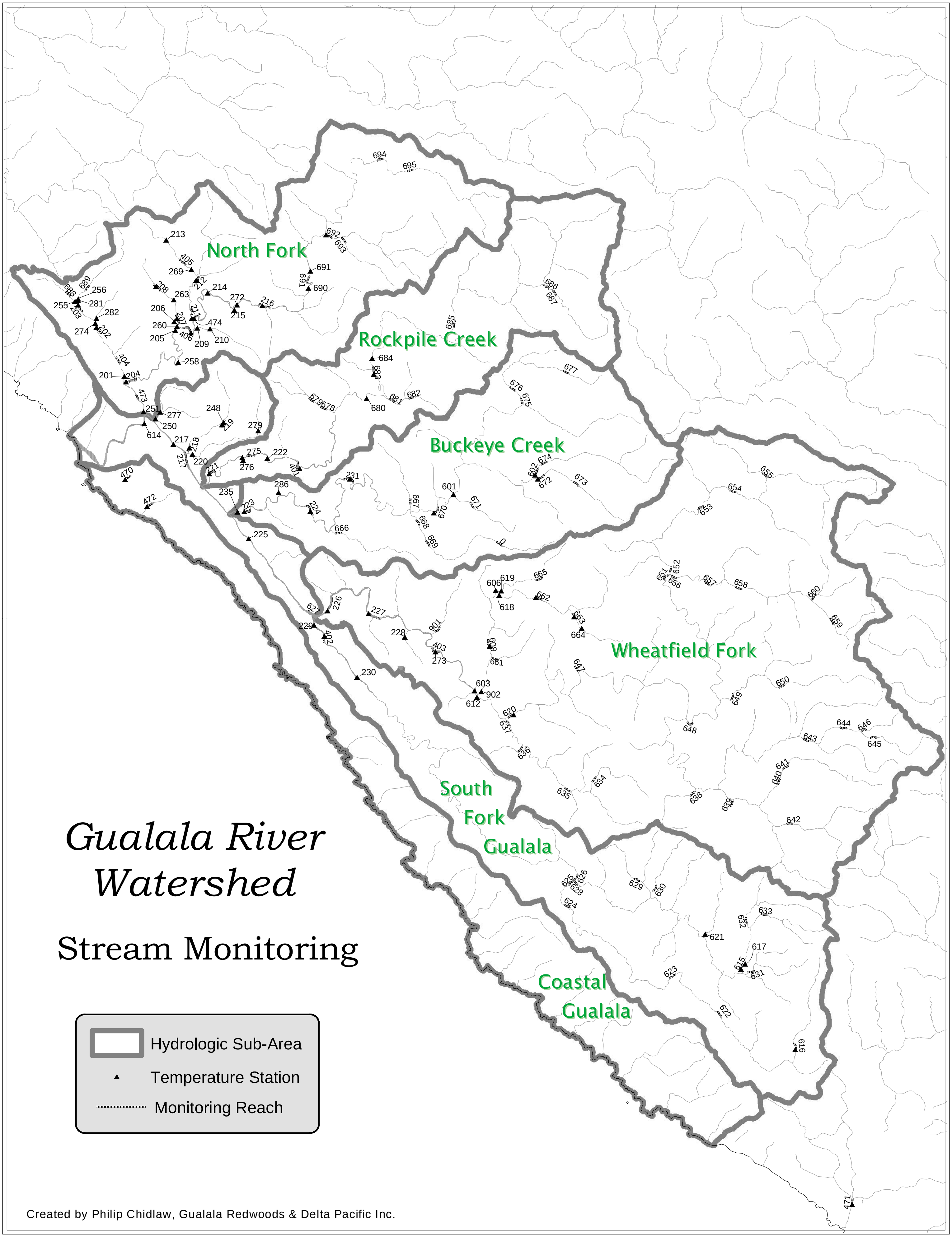
2. Validation and Verification Methods

As part of the standard field protocols, any sample readings out of the expected range will be reported to the monitoring team leader. A second sample will be taken as soon as possible to verify the condition. It is the responsibility of the team monitoring leader to re-train volunteers until performance is acceptable.

3. Reconciliation with User Requirements

All references are contained in the appendices.

Appendix


Gualala River Watershed
Stream Monitoring
North Fork
Rockpile Creek
Buckeye Creek
Wheatfield Fork
South Fork Gualala
Coastal Gualala
Hydrologic Sub-Area
Temperature Station
Monitoring Reach
Created by Philip Chidlaw, Gualala Redwoods & Delta Pacific Inc.

Appendix B
Water Temperature Monitoring

Introduction

Background
This protocol has been adapted in large part from the Forest Science Project's Protocol (FSP 1998). Stream temperature is one of the most important environmental factors affecting aquatic ecosystems. The vast majority of aquatic organisms are poikilothermic--their body temperatures and hence their metabolic demands are determined by temperature. Temperature has a significant effect on cold-water fish, both from a physiological and behavioral standpoint. Below is a brief list of the physiological and behavioral processes affected by temperature (Spence et al., 1996):

- Metabolism
- Food requirements, appetite, and digestion rates
- Growth rates
- Developmental rates of embryos and alevins
- Timing of life-history events, including adult migrations, fry emergence, and smoltification
- Competitor and predator-prey interactions
- Disease-host and parasite-host relationships

This protocol sets forth a sampling approach that will provide consistent data that can be used to address stream temperature issues at broad regional scales, i.e., watershed, basins, and regions.

Scope and Application
The field methods described in this protocol are for obtaining representative stream temperatures from perennial streams for regional monitoring. The field methods are specifically applicable for the deployment of continuous monitoring temperature sensors (e.g., Hobo Temps, Temp Mentors, Stowaways, etc.) for the purpose of identifying diurnal changes in temperature, seasonal changes in thermal regime as well as seasonal changes. Possible interferences in the accurate and precise measurement of stream temperature include: 1) exposure of the sensor to ambient air, 2) improper calibration procedures, including date and time settings, 3) improper placement of the sensor in the stream, 4) low battery, 5) inherent malfunctions in the sensor or data logger, and 6) vandalism.

Summary of Method

All continuous stream temperature monitoring sensors should be calibrated against a National Institute of Standards and Technology (NIST) traceable thermometer. Sensors not meeting precision and accuracy data quality objectives should not be used. Sensors should be placed in a well-mixed zone, e.g., at the end of a riffle or cascade. Monitoring location should represent average conditions — not pockets of cold water refugia or isolated hot spots. Location of sampling points should either avoid or account for confounding factors that influence stream temperatures such as:

- confluence of tributaries
- groundwater inflows
- channel morphology (particularly conditions that create isolated pools or segments)
- springs, wetlands, water withdrawals, effluent discharges, and other hydrologic factors
- beaver ponds and other impoundments

The sensor should be placed toward the thread or thalweg of the channel. Keep in mind that flow will decrease throughout the summer resulting in an exposed sensor. The thermistor portion of the device should not be in contact with the bottom substrate or other substrate that may serve as a heat sink (e.g., bridge abutment or boulder). Secure the sensor unit to the bottom of the channel with aircraft cable, surgical tubing, rebar, or diver's weights. The sensor should be set to record temperatures at sampling intervals that should not exceed 1.6 hours (96 minutes).

Equipment and Supplies

Calibration and Standardization

Prior to deployment of sensors, calibration of each sensor must be performed. The following is a list of equipment and supplies for calibration:

- NIST traceable thermometer - resolution of 0.2ºC or better, an accuracy of ±0.2ºC or better.
- controlled-temperature water bath, or water-filled thermos
- ice chest
- laboratory notebook
- ice

Field Measurements

There are several useful materials and pieces of equipment that should be taken to the field to install or service temperature sensors. These include:

- securing material such as zip ties, bailing wire, aircraft cable, surgical rubber tubing, locks, rebar, cinder blocks, large rocks with drilled holes, diver's weights
- GPS w/extra batteries
- surveyors marking tape or flagging
- sledge hammer (e.g., two-pound)
- wire cutters and/or pocket knife

- thermistor equipment items (silicone rings, submersible cases, silicone grease, silica packets)
- portable computer or interface for data downloading and launching
- backup batteries and thermistors
- timepiece/watch
- Rite-in-the-Rain field book w/ extra field sheets
- NIST-traceable auditing thermometer
- waders
- camera and film
- brush removal equipment (e.g., safety axe)
- maps and aerial photos
- first aid kit
- spray paint, rags and clean up cloths
- metal stakes or spikes, rebar

Pre- and Post-Deployment Calibration and Standardization

A. A NIST-traceable thermometer must be used to test the accuracy and precision of the temperature sensors. The NIST-traceable thermometer should be calibrated annually, with at least two calibration points between 10ºC (50ºF) and 25ºC (77ºF). Calibrations should be performed using a thermally stable mass of water, such as a controlled-temperature water bath, or water-filled thermos or ice chest. The stable temperature of the insulated water mass allows direct comparison of the unit's readout with that of the NIST-traceable thermometer. Accuracy of the NIST-traceable thermometer must be within ±0.5ºC.

B. Prior to use, all continuous monitoring devices should be calibrated at room temperature (~25ºC, 77ºF) and in an ice water bath to insure that they are operating within the accuracy over the manufacture's specified temperature range. Calibrate all continuous monitoring devices with a NIST-traceable laboratory thermometer at two temperatures, room temperature (i.e., ~77ºF, 25ºC) and near the freezing point of water as follows:

When calibrating and prior to deployment, set all units to the same current date and synchronize all devices using an accurate watch/clock that will be used to time the recording intervals of the reference thermometer. Call for the correct time.

Set the record interval of each thermograph to a short period, six to 30 seconds.
Record the date, sensor serial number, data logger serial number, and analyst's name in a laboratory notebook. Table 1 is an example of a format that can be used for data collection. The same sensor and same data logger should be deployed in the field as they were paired together during calibration.

Place the reference thermometer and the continuous monitoring devices in a five-gallon pail filled with about three gallons of water that has reached room temperature overnight or in a controlled-temperature water bath that has reached room temperature (~77ºF, 25ºC). Make sure the casings of all continuous monitoring devices are completely submerged. Stir the water, just prior to, and during the calibration period to prevent any thermal stratification.

After allowing 10 to 20 minutes for the continuous monitoring devices to stabilize, begin recording data for a 10-minute interval. Record the time, the reference thermometer temperature, and the continuous monitoring device temperatures measured at the predetermined sampling frequency (e.g., 6 second, 10 second) used during the 10-minute interval. After all readings are completed, calculate the difference between the reference thermometer and each of the continuous monitoring devices for each reading and calculate the mean difference. Record the data using a format similar to that shown in Table 1.

Table 1. Example of Calibration Data Collection Table

4/12/98	**Sensor Serial Number = 10043 Data logger S.N. = 2S256S**	**Analyst: Joe Celsius**	**Reference Thermometer No. 412**
Time (sec)	**NIST Thermometer Reading (ºC)**	**Device Reading (ºC)**	**Difference (ºC)**
0	25.0	24.8	-0.2
10	25.1	25.0	-0.1
20	25.0	24.9	-0.1
30	25.2	25.0	-0.2
40	25.0	24.6	-0.4
Etc.			
		Mean = 24.9 S.D. = 0.16	Mean Diff. = -0.16

C. Any continuous monitoring devices not operating within their specified accuracy range should be thoroughly scrutinized. If a particular device returns readings that are outside of the manufacturer's accuracy limits, but is still precise, then a correction factor (addition and/or multiplication) can be applied to the data. Precision should be within 0.2 standard deviations (S.D.) of the mean. Acceptable precision should be observed over the range of temperatures that will be experienced in the field. The correction factor, when applied over the calibration range, should give temperature values that are within the accuracy limits of the device. If units are inaccurate and imprecise they should not be used.

D. Using the same water bath, add enough ice to nearly fill the bucket and bring the temperature down to nearly freezing. Stir the ice bath to achieve and maintain a constant water temperature. Place the reference thermometer and the continuous monitoring devices in the water bath or five gallon pail. Again, make sure that the casings are completely submerged.

E. Repeat steps 2B-D with ice water bath.

F. Also confirm that thermograph batteries have sufficient charges for the entire monitoring period (will the length of the upcoming field season fit into the life expectancy of the unit's lithium batteries?).

G. Calibration (post-deployment calibration) should also be repeated when sensors are retrieved at the end of the sampling season. Repeat steps 2A-F.

Quality Assurance and Quality Control

Laboratory

Precision and accuracy should be 0.2 SD and ±0.5ºC, respectively for each continuous monitoring device.

Monitoring equipment with detachable sensors must be marked in order to match the sensor with the data logger. This allows instrument and sensor to be calibrated and tested prior to deployment, and also makes malfunctions easier to diagnose and correct. A logbook must be kept that documents each unit's serial number, calibration date, test results, and the reference thermometer used (Table 1).

Field

In addition to laboratory quality control checks, temperature monitoring equipment should be audited during the field season if possible. A field audit is a comparison between the field sensor and a hand-held NIST-traceable reference thermometer. The purpose of a field audit is to ensure the accuracy of the data and provide an occasion for corrective action, if needed. A minimum of two field temperature audits should be taken during the sampling period — one after deployment when the instrument has reached thermal equilibrium with the environment, and ideally one prior to recovery of the device from the field. Reference thermometers used for field audits must meet the same specifications as those used for laboratory calibrations: accuracy of ±0.5ºC, resolution of 0.1ºC. Exercise caution with mercury thermometers in the field.

A field audit is performed as follows:

Place the reference thermometer in close proximity to the continuous monitoring device.

Record the reference thermometer temperature and the sensor temperature in a field notebook. A stable reading is usually obtained within 10 thermal response units or time constants. For example, a reference thermometer with a ten-second time constant should give a stable reading in 100 seconds.

Post-processing audit accuracy must be within ±0.5ºC .

> Response time (time constant) is the time required by a sensor to reach 63.2% of a step change in temperature under a specific set of conditions. Response time values should be provided by the manufacturer. Five time constants are required for the sensor to stabilize at 100% of the step change value. Ten time constants are recommended to ensure that the reference thermometer has reached equilibrium with the stream temperature.

Data loggers typically set date and time based on the set-up computer's clock. It is important that field personnel synchronize their watches to the computer clock's time. Prior to the field audit, the computer clock should be set to the correct date and time by calling for the correct Pacific time.

Procedures

Water temperatures vary through time and space. The temporal and spatial aspects of deploying stream temperature monitoring devices is discussed in the following sections.

Temporal Considerations of Sensor Deployment

Sampling Window
Launch sensors to capture the hottest period of the field season, which will vary with watershed location. Coastal streams in Humboldt and Del Norte Counties require deployment at least during July, August, and September; whereas Mendocino County and more inland streams may require longer recording periods (June-October) (FFFC, 1996). For consistency it is recommended that the sampling window be from June 1 to October 1. This sampling window will ensure that the highest temperatures during the summer will be captured in the data set.

Sampling Frequency
The time interval between successive temperature readings can be adjusted from every few seconds, to every few hours, to every few days, for most continuous monitoring devices. Table 2 shows some of the typical sampling frequencies and the number of days the device can be left in the field prior to data downloading. In most monitoring activities, the primary objective is to determine the highest temperatures attained during the year. Thus, one of the deciding factors in setting the sampling frequency on a device will be to ensure that the daily maximum temperature is not missed.

The more frequent the monitoring, the more precisely the duration of daily maximum temperature can be characterized. The disadvantage of frequent data collection is reduced number of days of data storage and increased number of data points to be analyzed. Some agencies and other groups have found that an 80-minute sampling interval still captures the daily maximum stream temperatures for sites (OCSRI, 1996). If a less frequent sampling interval is desired, then a pilot study must be performed with monitoring at 30-minute intervals over a one to two week period during the hottest time of the year to determine how rapidly stream temperatures change. Pilot study information can provide information on the time interval most appropriate for capturing the daily maximum.

Table 2. Typical Sampling Frequencies and Storage Capacity of a Hobo® Data Logger Used for Stream Temperature Monitoring

2K Memory / 1,800 Meas.	8K Memory / 7,944 Meas.	32K Memory / 32,520 Meas.	Sample Frequency
37.5 days	165 days	677 days	30 min
45 days	198 days	813 days	36 min
60 days	264 days	1084 days	48 min
75 days	331 days	1355 days	1 Hr
90 days	397 days	1626 days	1.2 Hr
120 days	529 days	2165 days	1.6 Hr
150 days	662 days	2710 days	2 Hr
180 days	799 days	3270 days	2.4 Hr
240 days	1050 days	4300 days	3.2 Hr
360 days	1590 days	6540 days	4.8 Hr

Note: BoxCar and LogBook software's launch menu allows the user to choose from 42 intervals ranging from 0.5 seconds to 4.8 hours. The table shows the most likely settings that may be used for stream temperature monitoring. Mention of trade names does not denote endorsement by the Fish, Farm, and Forests Community Forum, the Forest Science Project, or any of their cooperators.

Selection of appropriate sites for monitoring is dependent upon the purpose and monitoring questions being asked. There are two scales of consideration for the appropriate monitoring site: selection of a sample point or location in the stream which provides representative data and the broader strategy of selecting sites that can provide useful information to answer the questions being asked.

Data Downloading

It is preferable to have the data cover the entire monitoring without interruptions. However, if data must be downloaded during the monitoring period due to insufficient data logger memory, record the date and time the sensor was removed from the stream and the date and time when it was returned to the stream. Some models may allow for downloading of data without interruption or removal of the sensor from the stream. Be sure to return the sensor to the same approximate location and depth after downloading. During a field visit for data downloading or auditing, record in the field notebook whether the sensor was exposed to the air due to low flow, discontinued flow, or vandalism. This information will be valuable for verification and validation of the data in the office.

Mid-Season Field Audit/Calibration Check

If data downloading is performed in mid-season, an opportunity for a mid-season field audit and calibration check presents itself. See Field Section for mid-season field audit and calibration procedures.

Spatial Considerations of Sensor Deployment

Stream Sample Point Location
The simplest and most specific scale is a sampling point on a stream. Here, the focus is on sample collection methods that will reduce variability and maximize representativeness.

Monitoring must record daily maxima at locations which represent average conditions - - not pockets of cold water refugia or isolated hot spots. Measurements should be made using a sampling protocol appropriate to indicate impact to beneficial uses (OCSRI, 1996). Thus, location of sampling locations should be done in a manner that is representative of the waterbody or stream segment of interest. In order to collect representative temperature data, sampling site selection must minimize the influence of confounding factors, unless the factor is a variable of interest. Some confounding factors include:

- confluence of tributaries
- groundwater inflows
- channel morphology (particularly conditions that create isolated pools or segments)
- springs, wetlands, water withdrawals, effluent discharges, and other hydrologic factors
- beaver ponds and other impoundments

Site Installation
Unless study design dictates differently, all sensors should be placed in the thalweg of riffles to insure a complete mixing of the water and to maintain sufficient water depth for the duration of the sampling window. Alternatively, if riffles are too shallow place the sensor in a pool or glide that exhibits well-mixed conditions. Do not place the sensor in a deep pool that may stratify during the summer, unless this is the objective of your study. This measure insures that sensors are not selectively placed in cooler areas such as stratified pools, springs, or seeps or in warm, stagnant locations (hot spots) that would misrepresent a stream reach's temperature signature. A hand-held thermometer can be used to document sufficient mixing by making frequent measurements horizontally and vertically across the stream cross-section. If stream temperatures are relatively homogenous (±1-2 C) throughout the cross-section during summer low-flow conditions, then sufficient mixing exists.

Monitoring devices should be installed such that the temperature sensor is completely submerged, but not in contact with the bottom. Place the sensor near the bottom of the stream by attaching it to a rock, large piece of woody debris, or a stake. Use zip ties, surgical tubing, or aircraft cable to attach the sensor to the bottom substrate. Rebar or diver's weights can be used if no suitable fastening substrate is available. For non-wadeable streams, the sensor should be placed one meter below the surface, but not in contact with a large thermal mass, such as a bridge abutment or boulder (ODF, 1994). If the monitoring site is not in a heavily visited area, mark the location of the sensor by attaching flagging marked with the gauge number or site ID number to nearby vegetation.

Precautions against vandalism, theft, and accidental disturbance should be considered when installing equipment. In areas frequented by the public, it is advisable to secure or camouflage equipment. Visible tethers are not recommended because they attract attention. When equipment cannot be protected from disturbance, an alternative monitoring site should be considered. For external data loggers that are not waterproof, place them above the mean high water line to prevent loss during a freshet. Some data loggers must be housed in a waterproof metal or plastic box that should be locked and chained to a tree. Data logger boxes and cables should be covered with rocks, moss, and wood to hide equipment.

Install the sensor in a shaded location; shade can be provided by canopy cover or some other feature such as large woody debris. If no shaded locations are available, then it may be necessary to construct a shade cover for the sensor (e.g., using a section of large diameter plastic pipe.) The intention for this measure is to avoid direct solar warming of the sensor. The intent is not to suggest that sensors should be placed only in shaded thermal reaches.

Sensors should be located at the downstream end of a thermal reach, so as to characterize the entire thermal reach, as opposed to local conditions. Protocols for characterizing thermal refugia can be found in FFFC (1996).

The number of thermograph units deployed will vary with 1) drainage area of the watershed, 2) numbers and sizes of inflow tributaries or other transitions in riparian condition, 3) changes in elevation, and 4) proximity to coastal fog zone. In all circumstances, a continuous monitoring device should be located as far downstream as surface water flows during the summer. In watersheds with multiple sensors locate them in a lower/upper or lower/middle/upper distribution.

Mark all monitoring site locations on a USGS 1:24,000 topographic map, aerial photo, or GIS map. Clearly show the location of the site with respect to other tributaries entering the stream, e.g., above or below the confluence. Record measured distance to a uniquely distinguishable map feature (i.e., road crossing, specific tributary, etc.) Draw a diagram of the monitoring area. Include details such as: harvest unit boundaries, sensor location and thermal reach length, tributaries with summer flow, description of riparian stand characteristics for each bank, areas where portions of the stream flow become subsurface, beaver pond complexes, roads near the stream, other disturbances to the channel or riparian vegetation (heavy grazing, gold dredging, gravel mining, water withdrawals).

Record the serial number of each sensor/data logger combination at each monitoring site. Make an effort to deploy the same sensor/data logger combination at the same site each year.

Once a sensor/data logger combination has been deployed at a site, do not move the equipment to another location. Adjustments in sensor location may be necessary if the initial location ran dry, and the sensor must be moved to the active, flowing channel. This will necessitate a unique site_id for spatial statistical analysis. Make notes of such relocations in the field notebook.

If sensors are used to collect long-term baseline or trend data in specific watersheds, establish fixed-location monitoring stations so that data sets will be comparable.

Site-Specific Data Collection
Other site-specific data should be collected at the time of sensor deployment or retrieval. These additional attributes will greatly assist in post-stratification and interpretation of status and trends in stream temperatures.

Length of Thermal Reach or Stream Segment
The thermal reach extends 300-600 meters above the site, depending on stream size (TFW, 1993). With a hip chain or measuring tape, measure the length of thermal reach or stream segment (in feet). If the stream has more than one channel, measure along the channel that carries most of the summer flow.

Canopy Closure
Use a spherical densiometer at evenly spaced intervals to determine average canopy closure for the thermal reach above the monitoring site. Take canopy closure measurements at 50-meter intervals along the thermal reach. If the percent canopy cover varies by more than 20% between measurements, then take additional measurements at 25-meter intervals to more accurately determine the average percent canopy closure for the reach. In order to save time, it may be advantageous to determine canopy closure at 25-meter intervals from the start, thus avoiding the need to back-track in cases where the variability exceeds 20%. In addition to calculating the average canopy closure, keep a record in a field notebook of the percent canopy closure at each sampling interval and note the locations on a map or sketch of the reach to document how the shade level varies through the reach. At each 25- or 50-meter interval, stand in the center of the channel and measure canopy closure four times: facing upstream, downstream, right bank, and left bank. Average these four values to obtain canopy closure for the location.

Elevation
Determine the elevation at the midpoint of the thermal reach from a USGS topographic map, or altimeter and record on data sheet to nearest feet.

Average Bankfull Width and Depth
Bankfull width and depth refer to the width and average depth at bankfull flow. These dimensions are related to discharge at the channel-forming flow, and can be used to characterize the relative size of the stream channel. This characterization will be useful for later post-stratification and assessment of stream temperature data. In addition, the ratio of bankfull width to depth (width:depth ratio) of a stream channel provides information on channel morphology. Width:depth ratio is related to bankfull discharge, sediment load, and resistance to bank erosion (Richards, 1982). For example, channels with large amounts of bedload and sandy, cohesionless banks are typically wide and shallow, while channels with suspended sediment loads and silty erosion-resistant banks are usually deep and narrow. Changes in width:depth ratio indicate morphologic adjustments in response to alteration of one of the controlling factors (Schumm, 1977).

Refer to Channel Form Monitoring Appendix E for step-by-step procedures for estimating bankfull width and depth.

Average Wetted Width
Measure the wetted channel width at the location where the sensor is placed. This measurement should be collected at the time of deployment and at the time of retrieval. Change in wetted width over the field season will provide information on the change in flow during the monitoring period. Follow the method outlined in Flosi (1998).

Habitat Type
Record the habitat type in which the sensor was placed. Use the following codes for the habitat types:

Riffle	Shallow reaches with swiftly flowing, turbulent water
run	Relatively uniform flowing reaches with little surface agitation
spool	Shallow pools less than 2 feet in depth with good flow (no thermal strata)
mpool	Mid-sized pools 2 to 4 feet in depth with good flow (no thermal strata)
dpool	Deep pools greater than 4 feet in depth or pools suspected of maintaining thermal strata (possible thermal strata)

Stream Class
Record the stream classification as defined by the California Forest Practice Rules.

1 - ***Class I Watercourse:*** Domestic supplies, including springs, on site and/or within 100 feet downstream of the operations area and/or 2) Fish always or seasonally present onsite, includes habitat to sustain fish migration and spawning.

2 - ***Class II Watercourse:*** a) Fish always or seasonally present offsite within 1000 feet downstream and/or 2) Aquatic habitat for nonfish aquatic species. 3) Excludes Class III waters that are tributary to Class I waters.

3 - ***Class III Watercourse:*** No aquatic life present, watercourse showing evidence of being capable of sediment transport to Class I and II waters under normal high water flow conditions after completion of timber operations.

4 - ***Class IV Watercourse:*** Man-made watercourses, usually downstream, established domestic, agricultural, hydroelectric supply or other beneficial use.

For Class I watercourses make a concerted effort to collect fish presence/absence and/or abundance data in the same thermal reaches or stream segments where stream temperature data is being gathered. Conduct fish surveys during the period when stream temperatures are highest (July-August).

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Data Field Form

To assist in the collection and organization the site-specific information a field data form has been adapted from the Forest Science Project form. The form can be found below. Please photocopy the form onto Write-in-the-Rain paper for data collection activities. Please use a No. 2 pencil.

GRWC Stream Temperature Field Data Form

Station ID:	**File Name:**
Stream Name:	
X Coordinate:	**Y Coordinate:**
Projection (UTM Zone 10 NAD 27 preferred):	
Basin Name:	**USGS Quadrangle:**
Describe Placement:	
Surveyor:	**Organization:**
Device ID (serial #):	**Device Type:**
Calibration Date:	
Installation:	***Removal:***
Date Launched:	**Date Retrieved:**
Time:	**Time:**
Air Temperature ©:	**Air Temperature ©:**
Water Temperature ©:	**Water Temperature ©:**
Depth at Instument:	**Depth at Instrument:**
Depth of Instrument:	**Depth of Instrument:**
Maximum Depth:	**Maximum Depth:**
Wetted Width:	**Wetted Width:**
Wetted Length:	**Wetted Length:**

Habitat Type (circle one):

Riffle	shallow reaches with swiftly flowing, turbulent water
Run	relatively uniform flowing reaches with little surface agitation
Spool	shallow pool less than 2 feet in depth with good water flow
Mpool	mid-sized pool 2 to 4 feet in depth with good water flow
Dpool	deep pools greater than 4 feet in depth or pools suspect of maintaining thermal strata
Mpool	mid-sized pool 2 to 4 feet in depth with good water flow

Thermal Reach Information:	Diagram or Photo
Bankfull Width:	
Bankfull Depth:	
Reach Length:	
Mean Canopy Closure:	
Average Channel Gradient:	
Average Channel Aspect:	
Channel Type (Flossi et al., 1998):	
Stream Class (I,II, etc.):	
Elevation:	
Drainage area:	
Comments:	

Appendix C
SURVEYING BASICS

Introduction

Topographic surveying is an essential tool in watershed monitoring. A basic field survey establishes the horizontal and/or vertical location of a series of points in relation to a starting point (called a benchmark). Repeated surveys of the stream channel, in each study reach, are used to document changes over time in the shape of the streambed. Changes in the sediment supply affect the shape of the streambed. The shape of the streambed, in turn, affects the amount of bedload material that the stream can carry.

Sediment levels are an important factor in determining the quality of salmon habitat. Salmon spawn on gravel beds in the stream. High levels of sediment prevent the circulation of oxygen and inhibit the ability of salmon eggs to develop into fry.

Protocol Summary

The objectives of the survey include measuring the bankfull width of the stream, the slope of the streambed and the size of bed material. By making annual survey measurements, over a number of years, it is possible to assess changes in the amount of material stored in the bed of the stream, this information will indicate trend in the amount of bedload that is being delivered to the study reach.

Figure 1. Automatic Level

The cross-section survey, in conjunction with identifying bankfull indicators, allows the direct measurement of the bankfull width. The longitudinal survey measures the channel slope. The longitudinal survey also shows the shape of the streambed along the direction of flow.

A survey of the stream channel is accomplished by using a surveying tool called an *automatic level* (see Figure 1). The automatic level is carefully set up to establish a horizontal reference plane. The horizontal reference plane allows the relative elevation of different features on the streambed to be measured. Distances from the horizontal reference plane are measured down to the surface of the ground using the *survey rod*. The Survey Protocol (*page 2*) describes, in detail, the steps to be followed in setting up the tripod and the automatic level. It describes how to use the automatic level (Figure 1) and the survey rod to measure elevation.

Surveying requires at least two people. The *Instrument Person* operates the automatic level and records the measurements in the level logbook. The *Rod Person*, selects sites and holds

the survey rod at the site while the Instrument Person is reading it. The protocol explains how to calibrate the instrument using a point of known elevation called a *benchmark*.
The general procedure for surveying is to first set up the instrument. Once the instrument is level, the rod is placed on a point with a known elevation called a benchmark. The instrument person looks through the telescope on the level and reads the number on the rod. The reading (backsight) is added to the elevation of the benchmark to give the elevation of the instrument crosshairs. The rod is then placed on a point whose elevation is to be determined. The reading (foresight) is subtracted from the elevation of the instrument to get the elevation of the new point.
Distances between points are measured with a tape measure or are measured optically with the level and the rod. Careful notes, including sketch maps, are taken to help interpret the survey information.

Surveying Protocols

Directions for Instrument Person

- Step 1: Setting Up the Tripod.
  1. Extend the legs of the tripod until the top of the tripod is level with your chin.
  2. Push one of the legs firmly into the ground. Spread the tripod legs 3' to 4' apart. Push the other two legs into the ground.
  3. Level the top of the tripod by raising or lowering the legs.
     Note: Leveling the instrument will be easier if the tripod head is on a nearly horizontal plane.
  4. After the head is level check that the leg adjusting screws are tight and the legs are firmly set in the ground.

- Step 2: Setting Up the Level.
  1. Place the instrument on the tripod.
  2. Screw the level snugly (finger-tight) to the head of the tripod.
     Note: Do not over-tighten the screw.
  3. Move the level screws in pairs to bring the bubble into the target circle on the level vial.
  4. Rotate the scope 90^0 degrees and re-level.
  5. Repeat until the bubble stays in the target circle throughout a 360^0-degree rotation. This procedure brings the instrument into the range where the self-leveling pendulum prism can operate.
  6. Turn the telescope to bring the rod into the field of vision.

- Step 3: Reading the Rod

The numbers on the face of the rod show the distance measured from the ground in feet. The scale can be read to the one hundredths of a foot. Whole numbers of feet are marked off on the scale on the left of the rod by the longer line with an angled end. For example, see the number 3.00 in Figure 2. The number of feet is read at the top of this line and is indicated by the large red numbers. Tenths-of-feet are also marked by a line with an angled end. For example, see the number 2.90 in Figure 2. The black numbers indicates the number of tenths-of-feet.

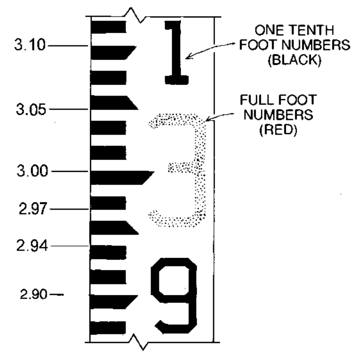


Figure 2. Face of the survey rod

Each black line and each white space on the scale is exactly one hundredths of a foot. The top of each black line, between the angled tenth-of-a-foot lines, mark off 2/100th's of a foot. Even number hundredths of a foot can be read at the top of the lines. Odd number hundredths of a foot are read at the bottom.

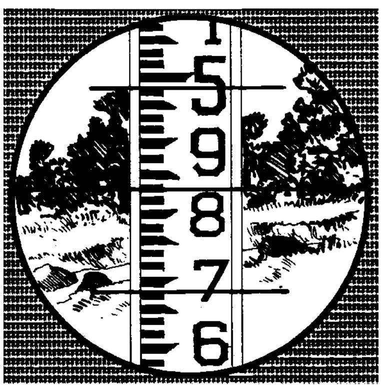


Figure 3. Reading the rod. The elevation is read at the middle line. The upper and lower lines are called stadia.

Point the telescope towards the rod. The center crosshairs should cross the face of the rod (Figure 3). Turn the focus knob until the rod can be clearly seen. Adjust the eyepiece to darken or lighten the cross hairs. I f the rod is leaning to the side, ask the rod person to move the top of the rod until it is vertical. The rod person should try to keep the rod vertical along your line-of-sight. The center crosshair gives the elevation. Do not use the upper or lower lines for elevation. The upper and lower lines are called stadia. Using the stadia lines to measure distance will be described later.

Directions for the Rod Person

The rod person decides where to set the rod, which is the most vital part of the survey.

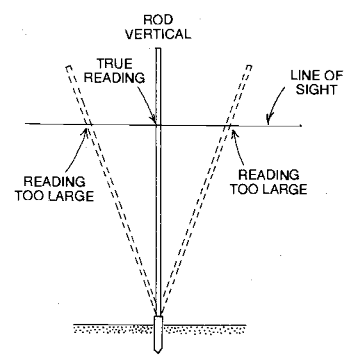


Figure 4. Keep the rod vertical.

The level is attached to the back of the rod. Use the bubble on the level to adjust and maintain the rod so that it is vertical. Stand behind the rod so that the rod can be held vertical and the level can be read. Holding the rod vertical is essential. If the rod leans forward or backwards the reading will be larger than the true value, see Figure 4.
When changing the length of the rod it is essential that each section be fully extended and properly secured. When a section of the rod is fully extended a locking button should pop into place.

Measuring Distance

Measuring with Tape

- Tapes marked in feet that can be read to the hundredth of a foot can be used to measure distance. Always make sure that the tape for the horizontal distance is the same standard as your stadia rod.
- When measuring horizontal distance stretch the tape tight before making the reading.
- Do not use a tape to measure the horizontal distance if the tape cannot be stretched out on a horizontal line between the points.

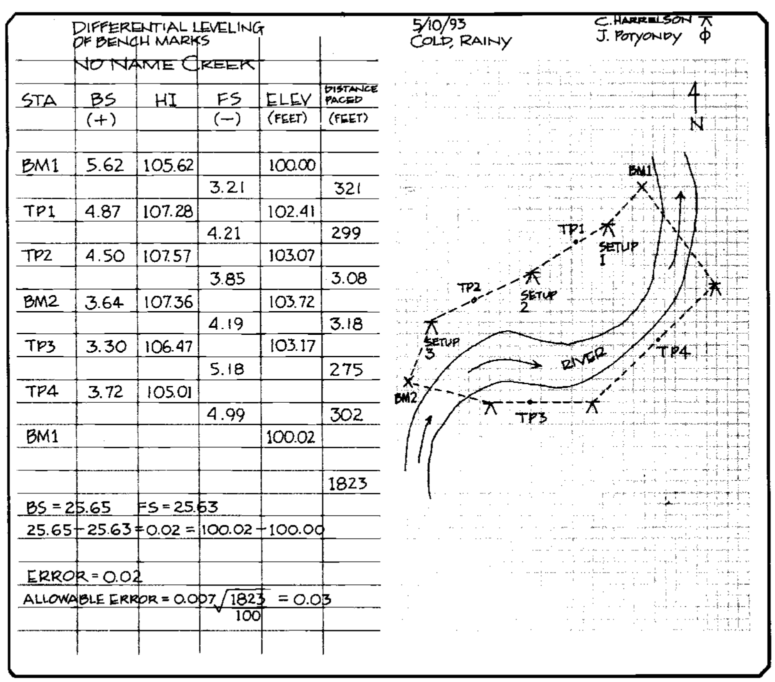
Measuring distance with surveying level

Use the level and the survey rod to estimate distances where stretching a tape would be difficult. To do this read the *stadia,* the short crosshairs above and below the central crosshair on the survey rod.

- Set up the level at one end of the distance to be measured. Place the Survey Rod at the other point.
- Read the rod at the upper and the lower stadia line.
- Subtract the lower stadia reading from the upper stadia reading
- Multiply the difference by 100 to get the distance from the instrument to the rod.

Differential Level Survey

A differential level survey is used to measure the relative elevation of points that are quite far apart. For example, a differential level survey can be used to determine the true elevation of your benchmark if a point of known true elevation is several hundred feet from your site. It consists of making a series of instrument setups along a route that ends back where it began. The route of the survey is called a *traverse*. From each instrument setup, the rod is taken to a point of known elevation to establish the *instrument height*. The instrument height is used to calculate the elevation of new points after the rod is read on the new point. Temporary reference points, called *turning points*, are



DIFFERENTIAL LEVELING OF BENCH MARKS
NO NAME CREEK

STA	BS (+)	HI	FS (−)	ELEV (FEET)	DISTANCE PACED (FEET)
BM1	5.62	105.62		100.00	
			3.21		321
TP1	4.87	107.28		102.41	
			4.21		299
TP2	4.50	107.57		103.07	
			3.85		3.08
BM2	3.64	107.36		103.72	
			4.19		3.18
TP3	3.30	106.47		103.17	
			5.18		275
TP4	3.72	105.01			
			4.99		302
BM1				100.02	
					1823

BS = 25.65 FS = 25.63
25.65 − 25.63 = 0.02 = 100.02 − 100.00
ERROR = 0.02
ALLOWABLE ERROR = $0.007\sqrt{\frac{1823}{100}} = 0.03$

Figure 5. Field notes from a differential survey. The purpose of the survey is to find the elevation of BM-2 relative to BM-1. The traverse starts at BM-1. Returning to BM-1 closes the survey.

established before the instrument is moved to a new location. The details of the process are described below.

- The first reading (a reading is also called a *shot*) is to the benchmark. In Figure 5, the benchmark is BM-1. The elevation of the benchmark is known or assumed, see Figure 6. If the elevation of the benchmark is assumed it is strongly recommended that you survey from your benchmark to a benchmark with known elevation.
- Place the rod on the benchmark.
- Get the rod vertical.
- Read the scale where the crosshair crosses the rod face.
- Record the reading in the field book as a *backsight*. In the notes, *backsight* is abbreviated as BS.

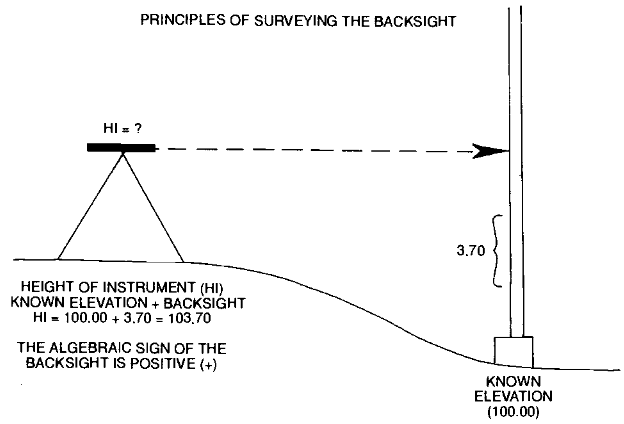


Figure 6. Shooting the backsight to find the instrument height.

- The shot to the benchmark is called a backsight. The backsight reading is added to the elevation of the benchmark to calculate the *instrument height*, see Figure 6. The instrument height is the elevation of the instrument crosshair.
- The notes shown in Figure 5 give an example of a differential survey. The elevation of BM-1 is given as 100.00 feet. The backsight to BM-1 is 5.62 feet. Thus, the height of the instrument, for the first setup, is 105.62 feet.
- Use a tape, the stadia method, or pacing to measure the distance from the instrument to the benchmark. Record the distance in the field book. The total distance covered by the survey is used to calculate the allowable error of the survey. This will be explained below.
- In Figure 5, the distance was determined by pacing. The distance between BM-1 and TP-1 is shown as 321 feet.
- The rod person should drive a stake in the ground as a temporary reference known as a turning point, TP. The TP should be in the direction of the survey and about the same distance from the instrument as the benchmark. The stake should be solidly in the ground so that it does not shift.
- The rod is then placed on the TP and the instrument person reads the elevation and records it as a foresight, see Figure 7.
- For example, in Figure 5, the foresight, FS, of TP-1 is 3.21.
- The foresight of TP-1 is subtracted from the instrument height to determine the elevation of TP-1.

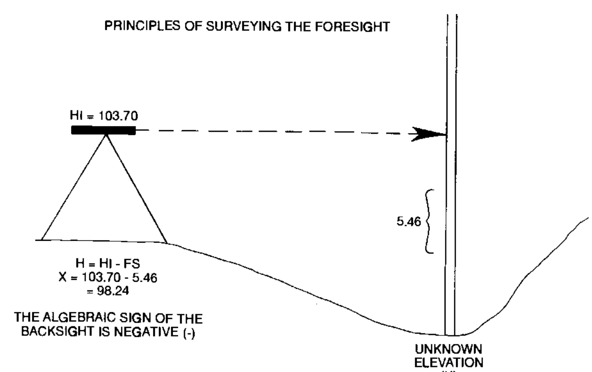


Figure 7. Shooting a foresight. The instrument height is already known.

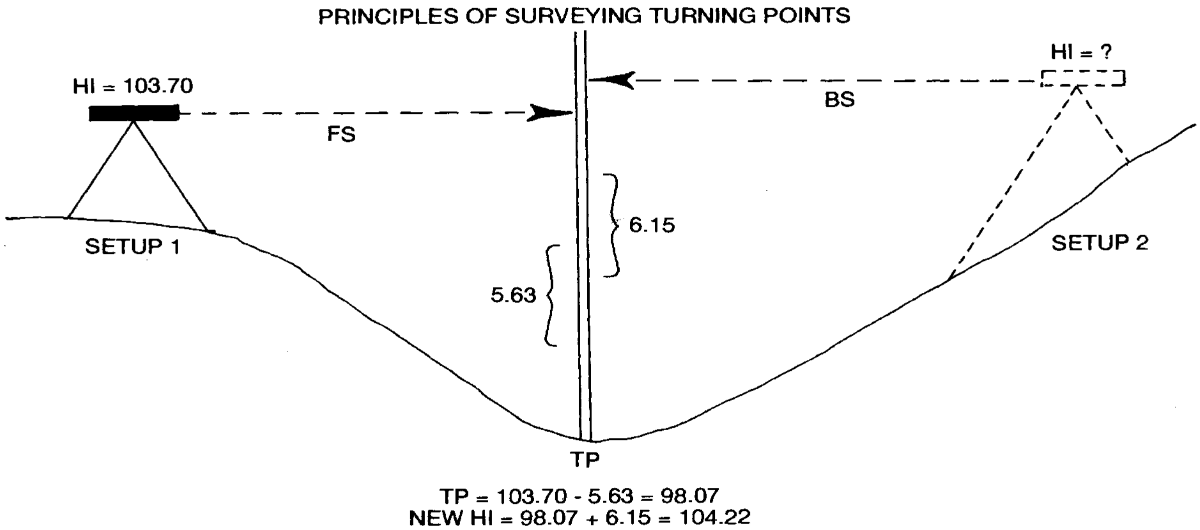


Figure 8. Using *turning points* to move the instrument.

- For example, in Figure 5, the foresight of TP-1 (3.21) is subtracted from the instrument height (105.62) to calculate the elevation of TP-1 (102.41).
- The instrument is then moved to the other side of TP-1.
- The rod is then placed on TP-1 and the rod is read as a backsight, after the instrument has been setup and leveled. The backsight is added to the elevation of TP-1 to calculate the instrument height. For example, the backsight to TP-1 from setup 2 is 4.87 feet. The backsight (4.87) is added to the elevation of TP-1 (102.41) to calculate the instrument height (107.28) at setup 2.
- The process outlined in steps 1-8 is repeated until the traverse is closed by shooting the original benchmark as a foresight. See the map in Figure 5.
- After you have closed the survey, the elevation of the benchmark at the end of the survey is compared to its original value. This process is known as closing the survey. The difference between the calculated elevation of the benchmark and its original value is the error.

  The acceptable amount of error depends on the total distance of the differential level survey. One equation to estimate the acceptable error is:

$$Acceptable\ \ Error \leq 0.007\sqrt{(total\ \text{distance})/100}$$

Where the *total distance* is the sum of the distances between the instrument stations in the differential level survey loop. For example, in Figure 7, the total distance of the differential level survey is 1,823 feet and the acceptable error is 0.03 feet.

A differential level survey can be performed as part of a longitudinal survey or cross-section survey. These types of surveys are described in other protocols. The purpose of the longitudinal and cross-section surveys is to gather elevation and distance data for selected points along the stream channel.

References

Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy, (1994) *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, USFS General Technical Report RM-245.

Appendix D
Field Equipment

Introduction
There are a variety of different types of equipment and instrumentation available to help take field measurements. Below is a description of the equipment we will be using for in-stream monitoring program. Please carefully read the instructions describing the use of each. For quality and measurement control each surveying team will have to fill out the attached instrument form.

Tapes
We have two types of tapes: lineal tapes that measure distance, and Spenser diameter tapes for measuring tree diameter.

Lineal Tapes
We have several lengths of tapes. The longest tapes are 200 ft. tapes, fiberglass and marked in tenths of feet. These tapes are used for the longitudinal profiles and cross-sections. The tapes that are marked in inches (usually reel tapes) are used for the riparian plots.

Spenser diameter tapes
Spenser tapes are two sided tapes. One side is calibrated so that when the tape is wrapped around the circumference of a tree, the tape is actually showing the diameter of the tree [so it is adjusted by a factor of π because C (circumference) = π (diameter)]. This side of the tape is printed in red ink. The other side is a lineal tape. A common error is to read the lineal side of the tape instead of the diameter side. Be sure to check your reading of the tape to make sure the number you have called out for diameter actually makes sense.
Diameter is almost always measured at breast height (DBH). DBH is the point on the tree trunk that is 4.5 feet from the ground. An easy way to measure DBH in the field is to pre-measure where 4.5 ft. is located on your body, then you will be able to easily estimate this height.

Pacing
In many field situations, pacing (or counting your steps) is the preferred method of measuring distance, where very precise distance measurements are not necessary. With practice, pacing can be quite accurate. However, it is usually not so accurate in the mountains of the Pacific Northwest, where slopes are steep, slipping is common, and large logs often interfere with straight-line travel. Nevertheless, pacing is a standard method used for rough separations of distance.

Start with a lineal tape and lay out a straight-line course of at least 300 feet. A pace is defined as two steps, so if you start walking with your right foot, the spot where your left foot lands is equivalent to one pace. Pace to the end of the calibrated line and total the number of paces you took. Repeat the process several times. The average number of paces, divided into the length of the line, is your pace length. Some people find that pace length in meters is preferable, others like the English units of feet (which are a little more precise as the unit is smaller). Pick your favorite, but know the conversion factor between them (feet X 3.3 = meters, meters/3.3 = feet).

Once you know your pace, you can follow simple compass courses on flat ground with relative ease.

Clinometers

A clinometer is a handy device for determining slope (in percent) and for measuring tree height. The standard Suunto brand will be employed. It has a dial containing two scales: percent on the left, and degrees on the right. As one sights the clinometer with one eye and leaves the other eye open, objects are lined up with the horizontal line in the dial, and a degree or percent then can be read off the dial. In case there is confusion about the dial, turn the clinometer up vertically and the scales are defined on the left and right side of the dial. We employ the percent scale to denote slope steepness, and the angle scale for an estimate of tree height.

Slope Determinations

In order to determine slope steepness, sight the clinometer directly upslope or downslope on an object that is at eye height in either direction. The reading on the clinometer is the percent slope (left scale) or slope angle (right scale). In the upslope direction, the reading will be (+), while in a downslope direction it will read (-). Often, an upslope and downslope measurement will be averaged to determine average slope steepness, but the direction of the reading (+ or -) is not included.

Tree Height Determinations

The determination of tree height uses the angle scale on the clinometer.

You must be a known distance of 66 ft away from the tree. Sight the clinometer at the base of the tree and then the top of the tree. On flat ground, you are generally sighting from zero to the top of the tree, but "zero" is really eye height, so your eye level must be added to the height.

If you have to take readings on slopes. Try to move laterally (across slope) for tree height measurements - your horizontal distance will be more accurately measured.

On a slope you will generally be either below or above the base of the tree. Generally the position above the tree is more accurate than being below the tree. If above the tree base but below the top, you must add both sightings together. If below the tree base, you must take a sighting to the top of the tree, and subtract from it the sighting to the bottom of the tree: (for example, 100 to top, 30 to bottom = 70 ft. reading). If above both the tree base and the top of the tree, usually you'll have to move your position.

Spherical Densiometers

The spherical densiometer can be used as a hand held instrument to estimate relative vegetative canopy closure or canopy density caused by vegetation. Vegetation canopy closure is the area of the sky over the selected stream channel that is bracketed by vegetation (regardless of density). Canopy density is the amount of the sky blocked within the closure by vegetation. Canopy closure can be constant throughout the season if fast growing vegetation is not dominant, but density can change drastically if canopy vegetation is deciduous.

Canopy density is measured in conjunction with the riparian plot surveys and canopy closure is measured when installing temperature data loggers.

Operation of the Spherical Densiometer to Estimate Canopy Density

The spherical densiometer should be held 12-18 inches in front of your body and at elbow height, so that the operator's head is not visible in the mirror (and will not be counted as canopy cover!). Make sure the level bubble is level. In each square of the grid, assume that there are four dots, representing the center of quarter-square subdivisions of each of the grids. In the following instructions, it is assumed that you are under a forest canopy where openings are less common than canopy. Systematically count the number of dots NOT occupied by canopy (where you can see sky at that dot). Multiply the total count by 1.04 to obtain the percent of overhead area not occupied by canopy, as there are only 96 dots to count. The difference between this and 100 is the canopy cover in percent. Make four readings per location – start by facing upstream then turn in a clockwise fashion taking a reading every 90 degrees – and average them to provide an estimate of canopy cover from that point.

Obviously, this instrument is not useful for measuring understory tree, shrub, or herb cover.

Operation of the Spherical Densiometer to Estimate Canopy Closure

These instructions are for using a convex spherical densiometer that has adapted to the modifications developed by Strickler (1959). Strickler uses only 17 of the line intersects as observation points by taping a right angle on the mirror surface (Figure D-1).

Stand in the middle of the stream channel facing upstream. The densiometer is held in the hand, in front of the body at waist level, with the arm from the hand to the elbow parallel to the water surface. The convex densiometer is held away from the observer's body with the apex of the V pointed towards the observer. The observer's eye reflection should be seen along the margin of the original grid (Figure D-1). Level the densiometer using the bubble indicator and maintain the level and standard eye positions while recording. The grid between the V formed by the tape encloses 17 observation points. Each point has a value of 1.5 percent when four different readings are made. The number of points surrounded by vegetation are counted when measuring canopy closure.

Measurements are taken in four quadrants while standing on the same point (facing upstream, right bank, downstream, left bank).

The points counted for each reading are totaled and multiplied by 1.5 to obtain the percentage of canopy closure.

If all possible observation points are counted, the total value will be 102 percent (68 x 1.5 = 102). Although this error is small and not considered important for comparisons of relative values, the following correction factor can be applied to determine the correct percentile:

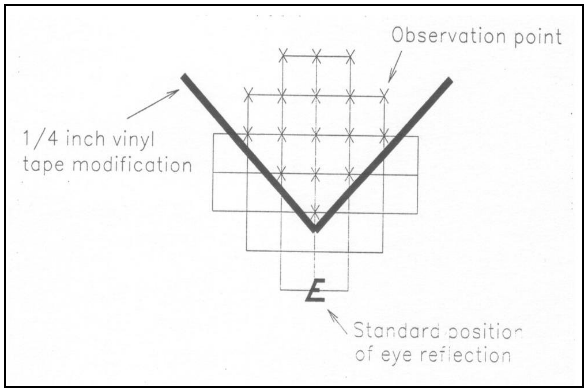


Figure D-1: Modified grid of spherical densiometer.

Calculated Value	Subtract from Calculated Value
Less than 30	0
30 to 60	-1
Over 60	-2

Example: (8+11+7+12)(1.5) = 57% subtract 1% = 56% closure

The Compass

Compasses come in many types. The examples below use the Silva Ranger Type 15 compass. This may or may not be the type of compass you have in the field. The Silva Ranger has some adjustments not seen in other compasses. While the principles of compass use are standard, their application to a particular compass type may be unique. This compass is graduated in 2 degree (^{o}) increments of azimuth from 0^{o} to 360^{o}. North is 0^{o}, east is 90^{o}, south is 180^{o}, west is 270^{o} and north again is 360^{o} (0^{o}). The compass has three basic parts. The Magnetic Needle is attracted by the magnetic North Pole of the earth. The red end points north and the white end south. The Graduated Dial turns and can be set to any desired bearing. The bearing is set to read in degrees. The Base Plate with Sighting Mirror is the housing of the compass and serves to point out the line of travel.

Beware of iron or steel objects if they are close to the compass. They will throw off the readings of the compass.

Map and Field Bearings

If you are working from a bearing on a map, it is referenced to true north and is called a true bearing. This is not the same as working from uncorrected bearings in the field, such as the location of a mountaintop in the distance that you take a compass bearing on. Sections A, B, C, D, and E below are based on working from "map to terrain" and deal with true bearings. Sections F and G are uncorrected bearings and are based on working from terrain to map.

Section A. How to use the compass to point out desired directions

First, the dial must be set to the desired degree reading. If this is known, simply turn the dial so that the correct reading appears at the index pointer. Second, without changing the dial setting, the entire compass must be positioned so that the orienting arrow lines up with the magnetic needle and the red end of the needle lies within the two orienting points. When these two conditions are fulfilled, the desired direction is indicated by the sighting line. Always keep the compass level so that the needle can move freely.

Section B. Using the compass without the sight.

When the dial is set as described in Section A, you can use the compass either with or without the aid of the sight. In situations where fast action is important, open the cover wide and make sure the orienting arrow and magnetic needle are lined up. The sighting line extends straight from the index pointer across the sight. Fix your sight on a distant object and head for it.

Section C. Using the compass with the sight.

For situations where accuracy counts, use the sight. The dial is set as in Section A. Hold the compass at eye level and adjust the cover to slightly less than a 90^{o} opening, so the mirror reflects a top view of the compass dial. While looking in the mirror, move your sighting eye sideways until you see the sighting line intersect one of the two luminous points. Without changing the relationship between compass and eye, pivot yourself and compass together until you see in the mirror that the orienting arrow is lined up with the magnetic needle and the red end of the needle is between the orienting points. Your direction or objective will now lie straight beyond the sight on the upper edge of the cover.

Section D. How to obtain your bearing from a map.

In Section A, one of the two basic conditions for using the compass is to set the dial at the desired degree setting. If this degree, or bearing, is not known, it can be easily determined from a map. First, lay the compass on the map so either the inch scale or millimeter scale is exactly on (or parallel with) the line on the map you wish to travel, AND the hinged cover points in the direction you wish to travel. Then, while holding the compass in position on the map, turn the dial so the meridian lines of the compass are exactly parallel with any meridian (north-south) line on the map, AND the letter "N" on the top of the dial is toward North on the map (not turned down toward South). You may now remove the compass from the map. In these two steps your compass was set for the degree reading to your destinations and this reading may now be used as the index pointer. In fact, while performing these two steps you automatically fulfilled the first basic condition mentioned in Section A, and you may directly proceed to use the compass as per Section B or C.

Section E. How to Take a Bearing.

A "bearing" means the direction or the degree reading from one object to another. One of those objects is usually YOU. To "take" a bearing means to determine the direction from one object to another.

A. From a map, bearings are taken as described in Section D. The "bearing" is the degree reading indicated at the index pointer.

B. Out in the terrain, bearings can be taken by reversing the steps described in Sections B and C. For example, if you are using the compass without the sight, open the cover wide and hold it level and waist high in front of you. The sight and sighting line should be pointing directly ahead of you. The sighting line acts as a pointer. Pivot yourself and your compass around together until the sighting line points straight to the object on which you are taking the bearing. Without changing the position of the compass, carefully turn the dial until the orienting arrow and the magnetic needle are lined up and with the red end of the needle lying between the two orienting points. The "bearing" to your objects is now the degree reading indicated at the index pointer.

C. In a similar manner, bearings can be taken by using the sight. In this case, hold the compass at eye level and adjust the cover so the top of the dial is seen in the mirror. Face toward your object and sight across the compass sight. Look in the mirror and adjust the position of the compass so that the sighting line intersects one of the luminous points. While you simultaneously see your object across the sight, and the sighting line across one of the luminous points, turn the dial so that the orienting arrow is line up with the needle, red end being between the orienting points. The "bearing" to your object is now the degree reading indicated at the index pointer.

References

Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy, (1994) *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, USFS General Technical Report RM-245.

State of California Resources Agency, Department of Fish and Game (1998), *California Salmonid Stream Habitat Restoration Manual,* Third Edition.

Appendix E
CHANNEL FORM MONITORING

Getting started

Before the fieldwork starts surveyors need to organize their notebooks, forms and equipment. Verify with the GRWC that all the property owners along the study reach have given permission for the monitoring. In addition, make sure that proper notice is given to the property owners before starting the fieldwork.

Directions for Organizing the Level Notebook

Set up the level notebook for the site. Use a *Rite-in-the-Rain* (or equivalent brand) All-Weather Level Notebook. These books are about 5"x 7" and each page has six columns. Laid flat, they photocopy onto 8-1/2" x 11" sheet for standard filling.

- Step 1: Number all the pages in your notebook.
  Note: Leave the first page blank for the Table of Contents, which will be filled in after the survey is finished.
- Step 2: Introductory page. Go to the second page and prepare an introductory page with the site name and number, project description, date and weather, names and tasks of crew.
  Note: This information will be repeated in a new introductory page each day before you start surveying.

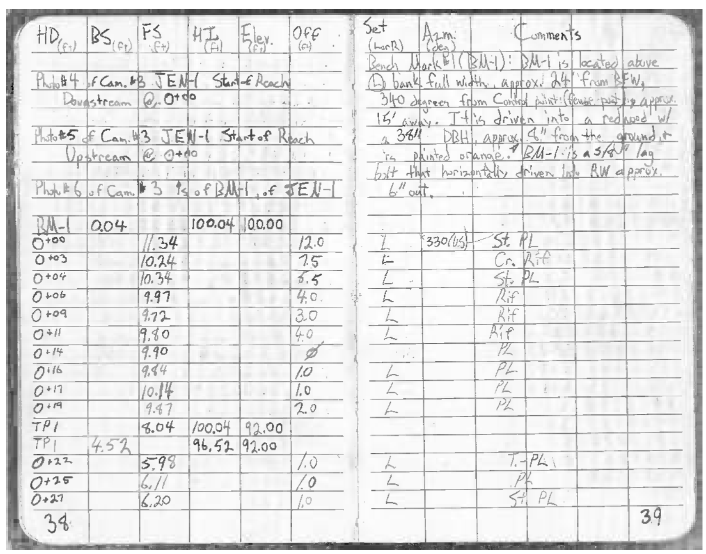


Figure 9: Sample page from Level Notebook

- Step 3: Label the notebook columns, see Figure 2.
  - The first column is labeled **HD** for *Horizontal Distance*.
    The HD is the distance along the thalweg where the elevation readings are taken.
  - The second column is labeled **BS** for *Backsight*.
    The BS is the actual vertical distance from the point of known elevation to a horizontal line projected by the instrument. There is only one BS for each setup of the instrument and it will always be your first reading after setup.
  - The third column is labeled **FS** for *Foresight*.
    The FS is a rod reading taken on any point to determine its elevation.

- The fourth column is labeled **HI** for *Height of the Instrument.*
  The HI is computed by adding the backsight reading to the benchmark elevation or the elevation on which the backsight was taken. HI=Elev +BS
- The fifth column is labeled **Elev**ation.
  The point at which elevations are known or determined are either benchmarks or turning points. To determine the elevation of all other points use Elev=HI-FS.
- The sixth & seventh column is labeled **Offset** for the *horizontal distance offset.*
  The offset is the distance from the HD tape to the actual rod placement site in the thalweg. It is rounded to the nearest foot. Which side of the tape the offset is on is also noted by listing left or right bank.
- The eighth column is labeled **AZM** for the *azimuth* of the *horizontal distance* tape.
  The azimuth of the horizontal distance tape is taken looking upstream and always when there is a change in the direction of the tape.
- The last four columns are labeled **Comment**.
  This is where the surveyors record the type of habitat being surveyed (i.e. pool, riffle, run). In addition, surveyors should record other factors such as fish or amphibian presence, types of vegetation or unusual features.

Be neat and orderly so that the data you record can be easily read. Note all pertinent details in your descriptions. Over the years, the field book will be used to re-locate the benchmark and various survey stakes or markers. The field book will also be the source of data used to analyze the changes in stream shape with time.

Directions for Organizing the Supplemental Forms

Set up a binder or covered clipboard that contains the following documents and supplemental data forms copied onto *Rite-in-the-Rain* paper:

Figure 10: Surveying Equipment

- ❑ A topographical map
- ❑ Copies of old field notes and data forms
- ❑ Copies of all the landowner access agreements
- ❑ Equipment Form
- ❑ Pebble Count Forms (2 sheets)
- ❑ Large Woody Debris Forms (5)
- ❑ Canopy Forms (1)
- ❑ Riparian Plot Forms (12 sheets)

Directions for Organizing the Equipment

Make sure all your equipment has been properly calibrated and is in good working order, see Figure 10. Fill out the Equipment List Form (page 12) making sure you include all the serial numbers. Check your equipment against the following list:

- ❑ Engineer's Level
- ❑ Tripod
- ❑ Stadia Rod
- ❑ Bullet Level
- ❑ Compass
- ❑ Calculator
- ❑ 11 Fence Posts
- ❑ 10 Lag Bolts & Driver

- ❑ 200’ Fiberglass Tape
- ❑ 150’ Fiberglass Tape
- ❑ Spencer Tape
- ❑ 25’ Steel Tape
- ❑ Clear Metric Ruler
- ❑ Clinometer
- ❑ Densiometer
- ❑ 24 pieces of 3’ Rebar
- ❑ Flagging
- ❑ Rudd paint
- ❑ Aluminum & Code Tags
- ❑ Sledge Hammer
- ❑ Fence Post Pounder
- ❑ Clippers & Machete

Identifying Bankfull

A stream is said to be at bankfull when the water is at the top of the bank and just about to overflow, see Figure 4. The flow at bankfull (bankfull discharge) is the flow that, over time, shapes the channel. The bankfull width is measured by locating indicators of the bankfull level on opposite banks of the channel and measuring the horizontal distance between the points.

Bankfull Indicators (Leopold, 1994).

1. The point bar is the sloping surface that extends into the channel from the bank on the inside bend of a curve in the channel. The top of the point bar is usually at the level of the floodplain. Floodplains generally result from the extension of point bars as the river moves laterally by erosion and deposition through time. The top of a point bar is the lowest possible level of bankfull.
2. The bankfull level is usually marked by a change in vegetation. For example, the change from bare gravel bar to forbs, herbs and grass. Willows can occur well below bankfull. Usually large mature alders do not occur below bankfull. The type of lichens or moss may change at the bankfull level.
3. A topographic break usually occurs at bankfull. The ground may change from a slope bar to a near vertical bank. The change in topography may be subtle.
4. The bankfull level is often marked by a change in size of material on the bed. The change can be from fine to coarse or from coarse to fine.
5. Deposits of flood debris are unreliable and should be used only as a confirmation of other indicators. Debris deposits often indicate the level of the last large flood and may not indicate the bankfull level. Debris in willow branches may have been deposited when the branches were bent over by the force of the floodwater.

Directions for Locating Bankfull Indicators

Use the following procedure to flag bankfull indicators on both sides of the stream. The most consistent indicators on both sides of the channel will indicate the bankfull level. Designate one color of flagging for bankfull indicators. An easy method to flag the bankfull indicators is to put a nail through a piece of flagging and push the nail into the ground

- Step 1: Flag the top of any point bars in the marked reach.
- Step 2: Look for the lower limit of perennial vegetation or a change in vegetation type or density. Flag several of these points on both banks.

  Note: Remember that after extended periods of drought, perennial plants may invade the channel.
- Step 3: Flag the lower limit of moss or lichens on the banks or rocks.

- Step 4: Flag the lowest mature alders on both sides of the channel.
- Step 5: Look for and flag changes in the slope of the bank.

  Note: A change from a near vertical to a horizontal surface is the best indicator of the floodplain and bankfull level. Many streambanks have multiple changes in slope so be careful. A slope break may also indicate a terrace. A terrace is an old floodplain that has been abandoned by a downcutting stream. A terrace usually has perennial vegetation and definite soil structure.

- Step 6: Flag changes in bank materials.

  Note: Typically, a change from coarse to fine material on the surface of the bank indicates the bankfull level. However, the change can also be from fine to coarse. Changes in bank slope are often associated with a change in the size of the bank material.
- Step 7: Look for undercut banks covered by dense root mat from perennial vegetation. Feel up beneath the root mat and estimate the upper extent of the undercut. A spike or pin-flag may be inserted horizontally through the root mass and located by touch at the upper extent of the undercut. This will probably be slightly lower than bankfull.

  Note: Undercut banks are often the best indicators in steep or confined streams that lack a floodplain.
- Step 8: Note any inundation water lines. These may be marked by sediment or lichen. Stain lines are often left by frequent low flows so bankfull is at or above the *highest* stain line.
- Step 9: Wade to the center of channel to view bankfull on both banks. Note features such as bars, boulders, root wads that may effect the water surface elevation or direct the current.
- Step 10: Discuss the significance of individual indicators. Assess the indicators and determine bankfull.
- Step 11: Remove flagging that does not designate bankfull.

Clean-Up

Remove all the temporary stakes from the channel bed. Remove all the flagging used to mark the bed-material regions. Pick up any trash you may have dropped.

Establish the Benchmarks

When the study reach is established a primary benchmark is selected and its location documented. The survey level is set up where the benchmark and the stream channel are visible. The elevation of the benchmark is shot and recorded. In subsequent years, the benchmark is used as the vertical (elevation) reference for the survey.

A benchmark is a permanent mark near the area to be surveyed that can be located every year. The benchmark serves as the vertical or elevation reference point for the study reach. The elevation may be assumed (100 ft. is normally used) or tied into a project datum or mean sea level.

- For long-term permanent sites three benchmarks are established near the beginning of the study reach. Each cross-section associated with a longitudinal profile must have a benchmark installed on the left and right bank.
- The benchmarks are located outside of the channel, above bankfull and if possible above the floodplain but within line of sight of the reach start point.
- One of the benchmarks should be located on the opposite bank from the other two. This will allow recovery in case of a bank failure.
- The two recommended methods for establishing benchmarks are:
  1. Lag bolt monument – screw a 6-inch lag bolt into the base of a large, healthy tree so the stadia rod can be set on its head and be visible and leveled (no over-hanging branches, etc.). Select a healthy tree (typically a conifer) 14'' in diameter or larger, with roots that are protected from stream erosion, and not subject to windthrow.
  2. Fence post monument – drive an 8' fence post vertically to within 2' of the ground surface. Fence posts need to be installed above bank-full.

Before starting to survey always review the material in the Surveying Basics, Appendix C.

Directions for Installing Benchmarks

- Step 1: Install the access marker for the study reach.
  Install a fence post marker at the nearest road access point. Tag with station ID (stream name & site #).
- Step 2: Install the benchmarks.
  Install 3 benchmarks using lag bolts screwed into the base of trees or fence posts. Number the benchmarks and tag (use aluminum tags) with station ID (stream name and site #), and benchmark #.

  > *Note: All benchmarks need to be installed outside of bankfull, in stable ground. At least one benchmark should be installed on the opposite bank. All benchmarks need to have a clear line of sight to the reach start point. Benchmark #1 should be the primary benchmark with the most secure location and the best line of sight to the study reach start point.*
- Step 3: Document the primary benchmark position.
  Stand at the access marker and with your compass find the azimuth and estimate the distance from the access marker to the primary benchmark (benchmark #1). Record the azimuth in your level notebook.
- Step 4: Document the secondary benchmarks positions.

Stand at the primary benchmark (benchmark #1), find the azimuth and estimate the distance to both secondary benchmarks (benchmarks #2 and #3), record in your level notebook under site description.

- Step 5: Photo Documentation.
  From the access marker take a photo of the primary benchmark (benchmark #1). From the primary benchmark take photos of the secondary benchmarks (benchmarks #2 & #3). Log the photo numbers with a description of the photos (i.e. Photo #1 = BM1 taken from access marker) in your level notebook.
- Step 6: Mapping.
  In your level notebook describe in detail the location of your benchmarks, access marker and study reach start. Draw a site map of the area.

Reviewing the Study Reach

After finding bank-full at the start of the study reach, installing or finding the existing access markers and benchmarks, your next step is to walk the study reach from beginning to end. As you walk up the reach, observe the following:

- Location of benchmarks
- Bankfull and the active channel
- Location of all cross-sections
- Location of logjams
- Location of the reach end points
- Roads and topographic features

Documents from past surveys will help you identify the beginning and end of the reach and cross-section benchmarks. If the study reach has not been previously surveyed then you need to look for flagging that delineates the reach segments. Also note access points to the nearest road. As you work your way up the study reach you may find it helpful to find new access points along the way.

Clean-Up

Remove all the temporary stakes from the channel bed. Remove all the excess flagging. Wind up all of the tapes. Pick up any trash you may have dropped.

Longitudinal (Thalweg) Profiles

Repeated longitudinal profile surveys of the stream channel are done to document changes in channel form and hydraulic variables. After the benchmark elevation is calculated, the rod person moves to the downstream end of the study reach and the thalweg is profiled. Riffles, runs and pools are defined and the elevations measured.

The survey is conducted in conjunction with the benchmarks, the cross-sections, the pebble counts and the Large Woody Debris surveys. All five surveys are linked by either elevation or horizontal distance.

Before starting to survey always review the material in the Surveying Basics, Appendix C.

Directions for Laying out the Horizontal Distance

- Step 1: Monument the start of the study reach.
  Install fence posts outside of bankfull on the left and right banks in a line, which is perpendicular to the flow. Starting at left bank lay a tape between the fence posts.
- Step 2: Find the starting point for the horizontal distance (HD).
  Find the center of the channel in the lay line between the two fence posts marking the start of the study reach. *This is your starting point for the HD*. Stake by using a temporary piece of rebar.
  > *Note: This is your starting point for the longitudinal profile. You will attach the zero (0+00) end of your thalweg tape to this stake.*
- Step 3: Document the HD starting point.
  Record the distance from the left bank fence post to the HD starting point.
  Then stand at the primary benchmark. Take a bearing to the HD starting point, record.
  Measure and record the distance from the primary benchmark to the HD starting point.
  > *Note: Record all distances and azimuths in your level notebook under the description of the site. The measurements will assist future surveyors to find the exact starting point of your survey.*
- Step 4: Laying the horizontal distance tape.
  Attach the zero ft end of a 200' fiberglass tape to the HD starting point stake. Walk up-stream near the thalweg and lay the tape in as straight a line as possible. Stake any curves in the tape. Stake the 200 ft end.
  > *Note: The tape may be layed up to 20' from the thalweg. Any curve in the tape needs to be staked to an angle.*
- Step 5: Flagging for riparian plots.
  Flag left and right bankfull at the HD starting point for the riparian plot surveys. You will continue to flag bankfull every 200' when you start a new segment.
  > *Note: Always record on flagging: stream name, site #, distance, date, purpose, crew.*
- Step 6: Photo documentation.
  Stand in middle of channel at the HD starting point. Take photos of the stream channel; first looking downstream then upstream. Record photo numbers in your level notebook.
  > *Note: Photo documentation is repeated at all cross-sections and the end point (1000')*

Directions for Performing the Longitudinal Profile Survey

- Step 1: Setup the engineer's level.
  Setup the level at a location where both the benchmark and the downstream end of the study reach are visible. The line-of-sight of the level must be higher than the benchmark.
  Note: To set up the level follow the instructions in Surveying Basics in Appendix C. Choose the location to minimize the number of times the level will have to be moved. Moving the level adds time and potential error to the survey.
- Step 2: Surveying the benchmarks.
  1. Turn the telescope to view the primary benchmark. The rod person places the rod on top of the benchmark. The rod is held vertically by using a level.
     Note: Stand so that you can control the rod and see the level.
  2. The instrument person reads the elevation on the rod and records it as a backsight. After recording the backsight elevation, re-check the rod reading.
     Note: The elevation of the primary benchmark will be set at 100'. See Figure 6 in the Surveying Basics section.
  3. Calculate the instrument height by adding the elevation of the benchmark to the backsight (HI=Elev + BS).
  4. Turn the telescope to the secondary benchmarks and repeat the process.
     Note: Elevations of the secondary benchmarks are not recorded in the BS column but in the site description area.
- Step 3: Surveying the thalweg.
  1. The rod person stands at the HD starting point looking up-stream. Take the azimuth and distance (in this case the distance would be 0+00) of the first straight section of the HD tape. The instrument person records the azimuth in the AZM column at the distance the azimuth is taken.
     Note: The distance and the azimuth of the HD tape are always recorded at each angle change throughout the longitudinal profile.
  2. The rod person moves to the thalweg at the HD starting point, tells the instrument person the horizontal distance (in this case it would be 0+00) and then levels the rod.
  3. The instrument person always waits until the rod person says "level" then reads the elevation and records it as a foresight.
  4. The rod person then tells the instrument person the offset of the stadia rod from the tape.
     Note: The offset is rounded to the nearest foot and needs to be recorded as to which side of the HD tape; left or right bank.
  5. Calculate the elevation of the thalweg at the start point by subtracting the foresight from the instrument height (Elev=HI-FS).
  6. The rod person moves upstream to the next survey point in the thalweg.
     - First take the azimuth if the HD tape has changed angles.
     - Second take the horizontal distance
     - Third place and level the rod in the thalweg
     - Fourth take the elevation
     - Fifth take the offset

     Note: The most important thalweg features to measure are; riffle crests, breaks in slope, and the deep points of pools.
     Always measure the beginning, middle and end of any feature.

Measure the elevation whenever the channel bed changes slope. Where the slope is relatively uniform (e.g. a long run, riffle or pool) measurements can be farther apart but not more than 15'.

- Step 4: Follow the above procedure until the instrument person can no longer see the stadia rod. The line of sight may be blocked by vegetation or the stream may curve.
  Note: Vegetation can be moved by using bungee cords to tie it back.

Directions for Moving the Instrument (Turning Points)

- Step 1: Finding a stable foresight elevation.
  Pick a point for a foresight that is stable.
  Note: A boulder, a nail hammered into a piece of large wood or a stake are all good choices.
- Step 2: Recording a Turning Point (TP) foresight.
  In the HD column write TP1 instead of the horizontal distance. Record the elevation in the foresight (FS) column.
  Note: For accuracy, repeat the turning point foresight by removing the rod and then replace it in the same spot, verify elevation.
- Step 3: Moving the engineer's level.
  Setup the level at a location where both the TP and the thalweg of the study reach are visible. The line-of-sight of the level must be higher than the TP.
  Note: To set up the level follow the instructions in Surveying Basics in Appendix C. Choose the location to minimize the number of times the level will have to be moved. Moving the level adds time and potential error to the survey.
- Step 4: Recording a Turning Point (TP) backsight
  Place the rod in the exact spot the TP1 foresight was taken. In the HD column write TP1 instead of the horizontal distance. Record the elevation in the backsight (BS) column.
  Note: For accuracy, repeat the turning point backsight by removing the rod and then replace it in the same spot, verify elevation.
- Step 5: Continue surveying the thalweg along the horizontal distance tape.
  Note: Follow the above steps every time the engineer's level is moved.

Directions for Closing the Survey

- Step 1: Ending the thalweg survey.
  Always end the survey at the designated ending point. Continue surveying up to the end of the designated reach if your last tape lay was short of the ending point.
- Step 2: Differential Survey.
  After you have reached the end of the horizontal distance for the longitudinal survey, you must run a differential survey back to the benchmark. The elevation of the benchmark at the end of the survey is compared to its original value. This process is known as closing the survey. Closing the survey is accomplished by executing a number of turning points from the end of the longitudinal survey back to the primary benchmark. The difference between the calculated elevation of the benchmark and its original value is the error.
  Note: To close the survey you want to use the shortest way back to the beginning (primary benchmark). It is sometimes easiest to use a road or trail that parallels the stream.

For more information consult the Differential Level Survey section in Surveying Basics, Appendix C.

Clean-Up

Remove all the temporary stakes from the channel bed. Remove all the excess flagging. Wind up all of the tapes. Pick up any trash you may have dropped.

Cross-section Survey

Permanent cross-sections are essential for monitoring the stream channel. Additionally, the cross-sections sites provide established locations for pebble counts and photo surveys.
Each of our study reaches has three monumented cross-sections and they are surveyed in conjunction with the longitudinal survey. The cross-sections are placed at pool tail crests to document salmonid spawning habitat. Stakes are placed on opposite streambanks to mark each end of the cross-section. The line connecting the stakes should be at right angles to the stream flow. Distance along the cross-section is referenced to the stake on the left bank (facing downstream).

The rod is read on top of the left bank stake. The rod is then placed on the ground next to the stake and read. The rod person then places the rod on a series of points across the channel. The distance is recorded and the rod is read at every *break in slope*. A break in slope is the point where the angle of the ground surface changes (for example, at the top of a bank there is a distinct change in the slope of the ground surface).

The rod and distance should also be read at every significant channel feature such as the top of bank, bankfull indicators, bottom of the bank, edge of water and the thalweg (deepest point in channel).

Before starting to survey always review the material in Surveying Basics, Appendix C.

Directions for Performing a Cross-section Survey

- Step 1: Monument the cross-section.
  Install fence posts outside of bankfull on the left and right banks in a line that is perpendicular to the flow.
- Step 2: Delineate the cross-section data.
  In your level notebook draw a line below your last entry for the thalweg survey. Note that this is the start of a cross-section and the cross-section number.
- Step 3: Measuring the cross-section.
  Starting at left bank lay a tape between the fence posts. Stretch the tape from the left bank stake to the right bank stake. Read and record the horizontal distance between the stakes.
    Note: Leave the tape stretched to guide the rod person as she/he moves from point to point along the cross-section.
- Step 4: Surveying the cross-section.
    1. Start the survey at the left bank stake. Place the rod on top of the left bank stake and record the elevation as a foresight. The HD will be zero and under comments you will note that this elevation is at the top of the left bank stake.

2. Place the rod vertically on the ground next to the stake. Read the rod and record the value as a foresight. The cross-section distance of this elevation is also zero. Note in the comment section that this elevation is the base of the left bank stake. *Note: All elevations for the cross-section will be foresights unless you need to move the instrument.*
3. Then proceed to the next break in slope or the next channel feature, such as the bankfull stage or wetted width.
   Note: The elevations of all breaks in slope, bankfull stage, wetted width and the thalweg need to documented by identifying those elevations in the comment section.
   The maximum spacing between elevations cannot be greater than 5% of bankfull width.

- Step 5: Ending the cross-section survey.
  Continue shooting the elevation and recording the distance at each point along the cross-section. Finish the cross-section by taking the elevation at the base of the right bank stake and then on top of the right bank stake.
  Note: If the tape is too high for the rod person to read the instrument person can read the distance from the instrument to the rod using the stadia lines (see the Basic Surveying protocol). If the distance between the rod and the instrument is measured, make sure that it is recorded as such. It will be necessary to convert the distance from, "the distance from the instrument" to, "the distance from the left bank stake".
  Occasionally you will have to move the instrument to complete the cross-section survey. This may happen if an obstacle such as a large tree limb is blocking your line of sight. Do your turning points before and after you move the instrument. Follow the instructions in Surveying Basics, Appendix C.
- Step 6: Photo documentation.
  Stand in middle of channel at cross-section. Take photos of the stream channel; first looking downstream then upstream. Record photo numbers in your level notebook.
  Note: Photo documentation is repeated at all cross-sections and the start point (0+00') and end point (10+00')

Clean-Up

Remove all the temporary stakes from the channel bed. Remove all the excess flagging. Wind up all of the tapes. Pick up any trash you may have dropped.

References

Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy, (1994) *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, USFS General Technical Report RM-245.

Jackson, Dennis, Marcus, Laurel (1999) *Creating a Watershed Atlas and Monitoring Program, Watershed Stewardship Workbook.*

Leopold, Luna B., ***A View of the River***, 1994, Harvard University Press, Cambridge, MA.

GRWC Monitoring Equipment List

Station: ______________________ Date: _______________

Crew: ______________________

Equipment	Serial Number
Surveying Book	
200' Fiberglass Tape	
150' Fiberglass Tape	
Carpenters 25' Steel Tape	
Spencer Tape	
Metric Ruler	
Engineers Level	
Tripod for Engineer Level	
Bullet Level	
Stadia Rod	
Stadia Rod Level	
Compass	
Densiometer	
Clinometer	
Camera	
Fence Post Hammer	
Maul	
Electric Drill	
Ratchet	
Machete and/or Clippers	
Other:	

Appendix F
Pebble Counts

Introduction

The composition of the streambed (substrate) is an important factor in how streams behave. Observations tell us that steep mountain streams with beds of boulders and cobbles act differently from low gradient streams with beds of sand or silt. This difference can be documented with a quantitative description of bed material.

The most efficient basic technique is the Wolman Pebble Count (1954). Pebble counts can be made using grids, transects, or random step-toe procedure. We use a step-toe procedure here. Pebble counts are conducted at the three cross-sections in the study reach.

Starting at bankfull, the riffle is traversed and every three feet the surveyor randomly selects a pebble. The pebble is measured at the intermediate axis. It is important for the surveyor to avert their eyes and pick up the first particle touched by their index finger at the toe of your wader. This continues in a zigzag pattern transecting the stream until 100 pebbles are measured.

Pebble counts are easier if you have two surveyors. One to act as the observer who will wade the stream and measure the pebbles and the other as data recorder who remains on the bank.

Directions for Performing a Pebble Count

- Step 1: Start the transect.
  1. Select the closest riffle downstream from the cross-section.
  2. Record the Horizontal Distances (HD) of the downstream and upstream ends of the riffle.
  3. Select a random starting point (perhaps by tossing a pebble) at one of the bankfull elevations.
  4. Averting your gaze, pick up the first particle touched by the tip of your index finger at the toe of your wader.
- Step 2: Measure the intermediate axis (Figure F-1).
  Measure (with the metric ruler) the intermediate axis (neither the longest nor the shortest of the three mutually perpendicular sides of each particle picked up)
  Note: To measure embedded particles or those too large to be moved in place, measure the smaller of the two exposed axis.
- Step 3: Call out the measurement.

To make sure the recorder has heard the correct measurement have the note taker repeat back the information for confirmation.

- Step 4: Take one step across the channel in the direction of the opposite bank and repeat the process.
- Step 5: Traverse across the stream perpendicular to flow. Continue your traverse of the cross-section until you reach an indicator of bank-full stage on the opposite bank so that all areas between bank-full elevations are representatively sampled. Move up and down the stream in a zigzag fashion.
- Step 5: Continue to pick up particles until you have 100 measurements.

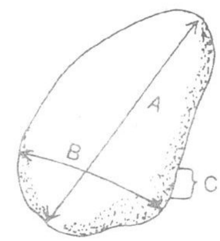


Figure F-1: Pebble Axis

Equipment and Forms List for 1,000 ft. Reach

- ❑ Clear plastic metric ruler (meters)
- ❑ 2 sheets of Pebble Count Forms (4 forms)
- ❑ Clipboard
- ❑ Pencils

Clean-Up

Remove all the temporary stakes from the channel bed. Remove all the excess flagging. Wind up all of the tapes. Pick up any trash you may have dropped.

References

Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy, (1994) *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, USFS General Technical Report RM-245.

Jackson, Dennis, Marcus, Laurel (1999) *Creating a Watershed Atlas and Monitoring Program, Watershed Stewardship Workbook.*

Leopold, Luna B., *A View of the River*, 1994, Harvard University Press, Cambridge, MA.

Data Field Form

To assist in the collection and organization of site-specific information, a field data form can be found below. Please photocopy the form onto Write-in-the-Rain paper for data collection activities. Please use a No. 2 pencil.

Station: ______________ Date: __________ Crew: __________

Distance: __________ Cross-section number: __________

Pebble Count

1 ______	26 ______	51 ______	76 ______
2 ______	27 ______	52 ______	77 ______
3 ______	28 ______	53 ______	78 ______
4 ______	29 ______	54 ______	79 ______
5 ______	30 ______	55 ______	80 ______
6 ______	31 ______	56 ______	81 ______
7 ______	32 ______	57 ______	82 ______
8 ______	33 ______	58 ______	83 ______
9 ______	34 ______	59 ______	84 ______
10 ______	35 ______	60 ______	85 ______
11 ______	36 ______	61 ______	86 ______
12 ______	37 ______	62 ______	87 ______
13 ______	38 ______	63 ______	88 ______
14 ______	39 ______	64 ______	89 ______
15 ______	40 ______	65 ______	90 ______
16 ______	41 ______	66 ______	91 ______
17 ______	42 ______	67 ______	92 ______
18 ______	43 ______	68 ______	93 ______
19 ______	44 ______	69 ______	94 ______
20 ______	45 ______	70 ______	95 ______
21 ______	46 ______	71 ______	96 ______
22 ______	47 ______	72 ______	97 ______
23 ______	48 ______	73 ______	98 ______
24 ______	49 ______	74 ______	99 ______
25 ______	50 ______	75 ______	100 ______

Station: ______________ Date: __________ Crew: __________

Distance: __________ Cross-section number: __________

Pebble Count

1 ______	26 ______	51 ______	76 ______
2 ______	27 ______	52 ______	77 ______
3 ______	28 ______	53 ______	78 ______
4 ______	29 ______	54 ______	79 ______
5 ______	30 ______	55 ______	80 ______
6 ______	31 ______	56 ______	81 ______
7 ______	32 ______	57 ______	82 ______
8 ______	33 ______	58 ______	83 ______
9 ______	34 ______	59 ______	84 ______
10 ______	35 ______	60 ______	85 ______
11 ______	36 ______	61 ______	86 ______
12 ______	37 ______	62 ______	87 ______
13 ______	38 ______	63 ______	88 ______
14 ______	39 ______	64 ______	89 ______
15 ______	40 ______	65 ______	90 ______
16 ______	41 ______	66 ______	91 ______
17 ______	42 ______	67 ______	92 ______
18 ______	43 ______	68 ______	93 ______
19 ______	44 ______	69 ______	94 ______
20 ______	45 ______	70 ______	95 ______
21 ______	46 ______	71 ______	96 ______
22 ______	47 ______	72 ______	97 ______
23 ______	48 ______	73 ______	98 ______
24 ______	49 ______	74 ______	99 ______
25 ______	50 ______	75 ______	100 ______

Appendix G
Large Woody Debris Survey

Introduction

Large Woody Debris (LWD) is known to be an important structural element of stream channels. It improves juvenile Coho salmon and steelhead trout summer rearing habitat by increasing the numbers and depths of pools. Large amounts of LWD also increase winter cover that is critical for salmonid protection from predation and high water velocity.

All wood pieces greater that 6" in diameter and 4' long that are within the stream channel or the pith breaks the bankfull plane are included in the survey. The thalweg tape layed for the longitudinal survey is used to record the horizontal distance of the pieces. As the team walks up the channel each piece is numbered and tagged for tracking purposes and the horizontal distances are recorded. The type of piece is determined as log or root wad and species is recorded. Total length and the length within bank-full are measured. Using a Spenser tape the team measures a number of different diameters including diameter at bankfull LWD must always be measured with a Spenser tape.

The LWD survey will always be conducted in 200' segments after each tape lay of the longitudinal survey has been completed. It is important to work as a team. One surveyor is the recorder and their duties consist of reading the horizontal distance, recording the measurement information and helping to take the physical measurements. The other surveyor is the LWD tagger and the primary measurement taker.

In small streams bankfull and the LWD is fairly evident from mid-channel so you can inventory both banks as you walk up the steam segment. In larger streams it may be necessary to survey the left and right banks separately.

Directions for Performing the LWD Survey

- Step 1: LWD form.
  Fill out the LWD form with all location, date and crew information.
- Step 2: Horizontal distance.
  Start at the beginning of your tape, which will be the downstream position of your segment.
  Note: If it is the start of the study reach then your starting point is 0+00'.
- Step 3: LWD size assessment.
  1. Determine if the piece is 6 inches in diameter for a length of 4 feet. If not, the piece is too small to include in the survey and is not considered to be LWD.

2. Next determine if the piece is in the bankfull channel. LWD that is partially within bankfull is included if the pith breaks the bankfull plane of the bankfull line.

- Step 4: LWD Horizontal Distance.
  If the piece is considered to be LWD then first determine and record the horizontal distance. The horizontal distance is always taken at the LWD downstream point of contact.
- Step 5: LWD Number.
  Tag and number the piece. Record the number on the form. Plastic tags with pre-determined numbers will be provided. In addition, with the landowner's permission, spray paint the number so it is visible from the survey channel.

  Note: Staple guns will be used to secure the tags. Try to attach tags in cavities or areas that are protected. Painting large numbers on the LWD will assist future survey crews.
- Step 6: LWD Species and Location.
  Determine the LWD Species and record the wood Location. If the pith of the LWD breaks the bankfull plane then the wood is not considered to be in bankfull but on the left or right bank.

  Note: Left and right bank are always determined by looking downstream.
- Step 7: LWD Quality.
  First decide if the piece is part or a logjam or possibly perched above the stream. If not, then decide if the piece is keyed in or mobile. Always envision the piece reacting to bankfull stage to make this determination.
- Step 8: LWD Source.
  To determine the source of the LWD first look to see if the wood is part of a restoration project. Wood that has been manually placed in the streams is usually marked. If you can't see markings you can sometimes see cables or bolts. If the wood does not appear to be part of a restoration project then try to determine how the piece entered the stream. Most pieces will be simply "unknown" which means the origin cannot be determined.
- Step 9: LWD Total Measurements.
  a. Length: If the LWD is a log measure the total length. If the LWD is a log with a root wad attached, measure only to 1 ft. above assumed ground level of the tree if it was upright.

  Note: The rootwad will be measured separately. Measurements for length are taken to the original LWD size parameter of 6" in diameter. Always stop your length measurement when the diameter of the LWD goes below 6".

  b. Diameters: First measure the large end of the log this is the D1. If the log has a root wad attached then measure the diameter at 1 ft. above assumed ground level. Second measure the small end this is the D2.

  Note: For diameter measurements make sure you use the appropriate side of the Spenser tape (the numbers are red). Remember, the small end diameter will never be less than 6".
- Step 10: LWD Bankfull measurements.

  Note: You will always measure the portion of the log that is within bankfull as if it is a separate log.

a. Length: If the LWD is a log measure the length of the log within bankfull. This means measure from the instream end of the log to where it breaks the bankfull line or plane. If the LWD is a log with a root wad attached, remember to measure only to 1 ft. above assumed ground level of the tree if it was upright. If the whole log is within bankfull then the Bankfull length is equal to the Total length.

   Note: The rootwad will be measured separately. Measurements for length are taken to the original LWD size parameter of 6" in diameter. Always stop your length measurement when the diameter of the LWD goes below 6".

b. Diameters: First measure the large end of the log this is the D1. Depending how the log is situated this measurement could be either the instream end of the log or the diameter of the log where it breaks the bankfull line or plane. If the whole log is within bankfull then the Bankfull diameters are equal to the Total diameters. If not, then measure the length of the log within bank-full and record as bankfull length. Second measure the small end this is the D2.

   Note: *For diameter measurements make sure you use the appropriate side of the Spenser tape (the numbers are red). Remember, the small end diameter will never be less than 6" and if the log has a root wad attached then measure the diameter at 1 ft. above assumed ground level.*

- Step 11: LWD Rootwad Measurements.
  Root wads are measured by first measuring the height of the wad. This is the distance from the roots to 1 ft. above ground level point. Next measure the width and then the depth.

Equipment & Forms List for 1,000 ft. Reach

- ❑ Installed Horizontal Distance Tape (200 ft.)
- ❑ Spenser Tape
- ❑ Large Wood Forms (5)
- ❑ Clipboard
- ❑ Pencils
- ❑ Paint
- ❑ Plastic Numbered Tags
- ❑ Aluminum Tags and Nails
- ❑ Hammer and Staple Gun

Clean-Up

Remove all the temporary stakes from the channel bed. Remove all the excess flagging. Wind up all of the tapes. Pick up any trash you may have dropped.

Data Field Form

To assist in the collection and organization of site-specific information, a field data form can be found attached. Please photocopy the form onto Write-in-the-Rain paper for data collection activities. Please use a No. 2 pencil.

References

Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy, (1994) *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, USFS General Technical Report RM-245.

Jackson, Dennis, Marcus, Laurel (1999) *Creating a Watershed Atlas and Monitoring Program, Watershed Stewardship Workbook.*

Leopold, Luna B., *A View of the River*, 1994, Harvard University Press, Cambridge, MA.

State of California Resources Agency, Department of Fish and Game (1998), *California Salmonid Stream Habitat Restoration Manual,* Third Edition.

Large Woody Debris Inventory Form

Modified on 03/10/03

		Species	Code	Location	Code	Quality	Code	Source	Code
Station ID:	________	Redwood	1	In Bankfull	2	Keyed	1.0	Unknown	1.0
		Douglas Fir	2	Left bank*	3	Digger wedged	1.2	Green Unknown	1.4
Date:	________	Pine	3	Right bank*	4	Digger cabled	1.3	Windthrow	5.0
		White Wood	4	Bank to bank	5	Buried	1.4	Green Windthrow	5.4
Crew:	________	Tanoak	5			Mobile	2.0	Undercut Bank	6.0
		Alder	6			Log Jam	5.0	Green UC Bank	6.4
Reach Length:	________	Maple	7			Perched	6.0	Landslide	7.0
		Willow	8					Green Landslide	7.4
		Other HW	9					Project	9.0

***Note:** To qualify as LWD a piece of wood must be at least 6" in diameter for 4' in length.*

Distance From 0' (Feet)	LWD#	Sp.	Loca-tion	Quality	Source	Log Total Length	Log Total D1 *Large End*	Log Total D2 *Small End*	Log Bankfull Length	Log Bankfull D1 *Large End*	Log Bankfull D2 *Small End*	Root Wad Size (Feet) A Axis Height	Root Wad Size (Feet) B Axis Width	Root Wad Size (Feet) C Axis Width

* Left bank and right bank determined by looking down stream.

Appendix H
Riparian Surveys

Introduction

Riparian surveys use a fixed 20th acre plot every 200' starting at the zero point along the steam monitoring reaches. The plots run perpendicular to the stream channel, are 21.8' wide and extend from a permanent point at bankfull to a permanent point 100' inland (adjusted for slope). All trees larger than 5.6" in diameter at breast height (DBH) are recorded as to size, species and placement within the plot. A sampling method for tree height allows for a statistical projection of tree height per acre. A smaller 100th acre lesser vegetation plot is established 15' inland from the bankfull point. The lesser vegetation survey records the number and the species of trees and brush less than 5.6" DBH plus the vegetation type and percent of ground cover.

Canopy density is measured by using a spherical densiometer. Measurements are taken in conjunction with the riparian surveys every 200 ft. starting at the zero point of the survey reach. The density is measured at center of channel, left and right bank and 50 ft. inland from bankfull.

The Riparian surveys need to be conducted by a survey team (2 or more) and are completed after the longitudinal profile and LWD surveys are finished. The start or zero points of the riparian plots are always the left and right bankfull sites that were flagged during the longitudinal survey.

Riparian surveys are not conducted where the slope is greater than 75%.

Before starting the riparian survey review the material in Field Equipment, Appendix D.

Directions for Performing the Riparian Survey

- Step 1: Riparian survey form.
  Fill out the top box of the riparian survey form. Include station (reach name & number), date, the form number in relationship to the total number of riparian forms for the study reach and crew names. For plot location always use the HD of the plot <u>along the study reach</u>. Make sure you designate left or right bank (i.e. 0+00RB).
  Note: Left and right bank are designated when looking downstream.
- Step 2: Laying out the riparian plot.
  1. Always start with the left bank plot. Place rebar at the bankfull point, paint for easier identification.
  2. Using your compass, stand perpendicular to the stream then sight on a feature approximately 100 ft. inland and record the azimuth on your plot form. Keep the bearing on your compass because this will be the lay line for your tape.

Note: The reciprocal bearing is the tape lay line for the right bank plot.

3. Attach the riparian plot lineal tape to the rebar. This will be your start point (zero).
   Note: This tape will be in feet and inches.
4. One team member stays at bankfull, the second team member starts to lay the tape 100 ft. inland using a compass and following the plot bearing.
5. As the second team member lays the tape they flag both the 15 ft. point and the 50 ft. point. This will be the center of the 100^{th} acre lesser vegetation plot (15 ft.) and where canopy density (50 ft.) is measured.

- Step 3: Determining slope.
  The horizontal distance of the plot is always adjusted to compensate for slope. A clinometer and the slope adjustment table are used to develop a specific horizontal distance for each riparian plot.
  1. Using a clinometer, the team member at bankfull sights on the team member at 100 ft.
     Note: To determine slope the person using the clinometer always sights on an object at eye level.
  2. Record the slope percent and using the slope adjustment chart (Table 2) determine and then record the true horizontal distance.
  3. The team member now adjusts the tape to the true horizontal distance and places and paints a piece of rebar. Flag above the rebar for easy identification.
- Step 4: Measuring tree diameters.
  Record the location and measure the diameter of all trees that are larger than 5.6" diameter at breast height (DBH) within 10', 10.7" of either side of the tape. In addition, record the distance and measure the diameter of any downed log at the point the tape transects the log.
  1. First determine if the tree is within the plot. If it is larger than 5.6" DBH and located within 10' 10.7" of either side of the tape then fill in the location number.
     Note: The location number is the distance the tree is from bankfull on the horizontal distance tape.
  2. Using the code tables attached to your Riparian Form fill in the codes for Tree Species (Table 2) and Group (Table 4).
  3. Using a Spenser tape measure the diameter and record.
  4. If a log transects the tape, is larger than 4 inches in diameter for 6 ft in length then record Location, Species and Group and measure the diameter at the point the log transects the horizontal distance tape.
     Note: Downed logs are only measured if they transect the horizontal distance tape.
  5. Continue until all trees are measured and recorded.
- Step 5: Measuring tree height.
  Measure the diameter, height and crown ratio of the first 3 conifers from bankfull in the riparian plot.
  1. After recording the Location, Species and Group of the first conifer from bankfull attach a Spenser tape to the tree. Walk 66 feet to an area where you can see the base and the top of the tree.
     Note: Although it is not always possible, the reading will be more accurate if you try to stay at the same elevation as the tree you're measuring.

2. Using a clinometer first site on the base of the tree, record. Make sure you record whether the number is negative or positive. Next site on the top of the tree, record reading in the Top column. Using the formula, add negative numbers and subtract positive numbers, record tree height in the Total column.
3. Next estimate the percent of live crown.
4. Measure the diameter, height and crown ratio of the next two conifers, for a total of 3 conifers.

- Step 6: 100th Acre Lesser Vegetation Plot.
  Lesser vegetation plots are fixed radius plots measured 11.78' from a point 15' inland from the bankfull rebar. Trees less than 5.6" DBH are recorded along with the percent of lesser vegetation ground cover.
  1. Stand at the 15' point along the horizontal distance tape. This will be the center of the fixed radius plot. Extend a tape out 11.78".
  2. Rotate the tape 360 degrees and record all trees less than 5.6" DBH as to Species, Group and Diameter that are within the circle.
     Note: Lesser vegetation trees may be grouped into size categories by species.
  3. Next within the same plot area, record the lesser vegetation using the codes listed in Table 3. Estimate the percent of area covered for each lesser vegetation species within the plot area and record in the % Cover column.
     Note: The total of the % Cover column for the lesser vegetation may be larger than 100% because of vegetation layers.
- Step 7: Canopy density.
  In the study reach canopy density is always surveyed in conjunction with the riparian plots. Density is measured using a spherical densiometer at the center of channel, left and right bank at bankfull and left and right at the 50' point in the riparian plots.
  1. Fill out canopy form with station (reach name & number), date and crew initials.
  2. Next fill out the plot location. This will be the horizontal distance of the riparian plot along the study reach.
  3. Measure the bankfull width by stretching a tape from the left bankfull rebar to the right bankfull rebar, record.
  4. Stand in the center of channel between the bankfull rebar facing upstream. Hold the densiometer 12-18 inches in front of your body and at elbow height, so that your head is not visible in the mirror. Make sure the level bubble is level.
  5. In each square of the grid, assume that there are four dots, representing the center of quarter-square subdivisions of each of the grids. Systematically count the number of dots NOT occupied by canopy.
  6. Multiply the total count by 1.04 to obtain the percent of overhead area not occupied by canopy,
  7. The difference between this and 100 is the canopy cover in percent. Record this number in Column 1. Make four readings per location – start by facing upstream then turn in a clockwise fashion taking a reading every 90 degrees – and average them to provide an estimate of canopy cover from that point.
  8. Repeat the above instructions at all canopy measurement sites.

Clean-Up

Wind up all of the tapes. Pick up any trash you may have dropped.

Equipment List for 1,000 ft. Reach

- ❑ Compass
- ❑ Clinometer
- ❑ Spherical Densiometer
- ❑ Calculator
- ❑ 200 ft. tape (tenths) for Bankfull Width
- ❑ 150 ft. tape (inches) for Riparian Plots
- ❑ Spenser tape
- ❑ 24 pieces of rebar
- ❑ Hammer
- ❑ Paint
- ❑ Flagging

Forms List for 1,000 ft. Reach

- ❑ 12 sheets of Riparian Survey Forms (24 forms)
- ❑ 1 Set of Riparian Tables (Tables 1-4)
- ❑ 1 Canopy Density Form
- ❑ Clipboard
- ❑ Pencils
- ❑ Permanent Marker (black)
- ❑ Study Reach Level Notebook

References

Dr. James D. Arney, Forest Biometrics, Forest Projection and Planning System (FPS)

State of California Resources Agency, Department of Fish and Game (1998), *California Salmonid Stream Habitat Restoration Manual,* Third Edition.

Riparian Survey Form

Station ID: ____________ **Date:** ____________ **Page:** ______ **Of:**____

Plot Location: ____________ **Fixed Plot:** 20th acre **Minimum DBH:** 5.6" **Vegetation Plot:** 100th Acre

Slope: ____________ **Azimuth:** ________ **Offset from HD tape:** 10’, 10.7”

20th Acre Plot								100th Acre Plot			
				Tree Height & % Crown							%
Location	Species	Group	DBH	Base	Top	Total	Crown	Species	Group	DBH	Cover

Riparian Survey Form

Station ID: ____________ **Date:** ____________ **Page:** ______ **Of:**____

Plot Location: ____________ **Fixed Plot:** 20th acre **Minimum DBH:** 5.6" **Vegetation Plot:** 100th Acre

Slope: ____________ **Azimuth:** ________ **Offset from HD tape:** 10’, 10.7”

20th Acre Plot								100th Acre Plot			
				Tree Height & % Crown							%
Location	Species	Group	DBH	Base	Top	Total	Crown	Species	Group	DBH	Cover

Riparian Survey Tables

Table 1 **Slope Adjustment Table**	
% Of Slope	**Horizontal Distance (feet)**
0	100'
5	100.12'
10	100.15'
15	101.12'
20	101.98'
25	103.08'
30	104.4'
35	105.95'
40	107.7'
45	109.66'
50	111.8'
55	114.13'
60	116.62'
65	119.27'
70	122.07'
75	125'

Table 2 **Tree Species**	
Survey Code	**Species**
BM	Big-leaf Maple
BP	Bishop Pine
BO	California Black Oak
LO	Canyon Live Oak
DF	Douglas Fir
GC	Golden Chinquapin
GF	Grand Fir
PM	Madrone
CX	Misc. Conifers
HX	Misc. Hardwoods
BL	Pepperwood (Bay)
PP	Ponderosa Pine
RA	Red Alder
RW	Redwood
SP	Sugar Pine
TO	Tanoak
MY	Wax Myrtle
WH	Western Hemlock
WI	Willows

Table 3 **Lesser Vegetation**	
Survey Code	**Species**
AZ	Azalea
BE	Berry, Sp.
BB	Blue Blossom
CE	Ceanothus, Sp.
CO	Coffee Berry
CB	Coyote Brush
OG	Dwarf Oregon Grape
EH	Evergreen Huckleberry
EQ	Equisetum Sp.
FN	Ferns Sp.
FW	Fireweed
FO	Forbes
GR	Grass
LU	Lupine
AR	Manzanita
PG	Pampas Grass
PO	Poison Oak
RH	Red Huckleberry
RD	Rhodendron
RO	Roses
SA	Salal
SB	Scotch Broom
TH	Thistle, Sp.

Table 4 **Group**	
Survey Code	**Description**
..	Green Trees
.D	Snag
DD	Down Log
LV	Lesser Vegetation
.P	Planted Tree
.C	Fresh Stump

Canopy Density Form

Station ID:	________________ Date: ______________ Crew: __________						
Plot			1	2	3	4	Avg.
Location:	________	Channel center					
		Bank full left					
BF Width:	________	50' left					
		Bank full right					
		50' right					
Plot			1	2	3	4	Avg.
Location:	________	Channel center					
		Bank full left					
BF Width:	________	50' left					
		Bank full right					
		50' right					
Plot			1	2	3	4	Avg.
Location:	________	Channel center					
		Bank full left					
BF Width:	________	50' left					
		Bank full right					
		50' right					
Plot			1	2	3	4	Avg.
Location:	________	Channel center					
		Bank full left					
BF Width:	________	50' left					
		Bank full right					
		50' right					
Plot			1	2	3	4	Avg.
Location:	________	Channel center					
		Bank full left					
BF Width:	________	50' left					
		Bank full right					
		50' right					
Plot			1	2	3	4	Avg.
Location:	________	Channel center					
		Bank full left					
BF Width:	________	50' left					
		Bank full right					
		50' right					

Appendix I
Stream Discharge, Turbidity, and Total Suspended Solids

Monitoring Objectives

1. Collect streamflow and water quality data during the rainy season at selected monitoring stations to establish baseline water quality conditions.
2. Monitor water quality and streamflow over several winters and attempt to establish trends in water quality conditions.
3. Develop a data set for water quality and streamflow in a Gualala River sub-watershed for future comparisons to other locations.

Monitoring Overview

Please refer to Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy, (1994) *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, USFS General Technical Report RM-245 for the specific procedures for measuring and monitoring stream discharge.

Establish Monitoring Stations

1. Install staff plate
2. Survey cross-section and staff plate elevation
3. Establish the "course" for observations of surface float velocity

Data Collection

1. Upon arrival at monitoring station, record the following
    a. Sample location (monitoring station name)
    b. Date and time
    c. Description of weather conditions and flow conditions
    d. Gage height of water surface
    e. Repeat gage height observation
2. Water quality sample collection
    a. Turbidity sample (grab sample from surface as near center of channel as possible for immediate processing using field turbidity meter)
    b. Suspended sediment sample (depth integrated using DH- 48 for laboratory analysis for Total Suspended Solids; remove a sample aliquot for turbidity measurement using field meter)
    c. Note approximate location of sample location in relation to staff plate and centerline of channel (e.g. "5 ft downstream of staff plate from surface 4 ft from left edge channel")

3. Discharge measurement using the current meter **AND/OR** float velocity observations (minimum of 6)
4. Repeat 2 above
5. Repeat 1-4 above at each sampling station
6. Perform turbidity measurements on samples immediately following completion of sampling circuit (process all samples at the same time, noting the time of sample processing)
7. Complete sample storage and chain of custody forms; shipment to laboratory to be arranged.
8. Photocopy data sheets and instrument logs; notify data coordinator regarding data collected.

Monitoring Procedures

- Step 1: Site Information.
  1. Fill in the appropriate station at which observations and samples are collected.
  2. Record initials of the individuals collecting observations and samples.
  3. Date and time of arrival at site.
- Step 2: Current weather.
  Circle one of the five choices that best describes the weather conditions at time of arrival at the site. If conditions change significantly, this can be noted in #7.
- Step 3: Flow conditions.
  This provides two descriptions of stream flow conditions described below.
  1. Circle one of the three choices that best describe the appearance of the water in the stream.
  2. Circle one of the four choices that best describe stream flow conditions regarding whether the stream is at or near a steady and low base flow, whether the stream is rising, falling or at or near a steady peak discharge.
  3. Water temperature measured in the field; circle F if Fahrenheit or C if Centigrade degrees (see Appendix B)
- Step 4: Previous weather.
  This provides two types of descriptions of recent weather affecting streamflow; it is possible that choices from 6a and 6b may apply. Note that this will be used as a supplemental description of rainfall records from rain gages in the watershed.
  1. Circle one of the two choices pertaining to preceding dry weather.
  2. Circle all of the four choices that apply pertaining to preceding rainy weather.
- Step 5: Comments.
  Note any additional information, problems or issues that may affect the data reported. If stream flow is very high and wading the stream is not safe, note that here.
- Step 6: Water surface elevation.
  Data collected pertain to the elevation of the stream observed at the staff plate (stream gage). Observations are made twice as described below.
  1. Time and elevation (staff plate reading) <u>before</u> discharge measurement (or float velocity).
  2. Time and elevation <u>after</u> discharge measurement (or float velocity).
- Step 7: Crest gage reading.

These measurements pertain to previous high water elevation recorded at the crest gage by water dissolving toothpaste smeared on a cedar grapestake fitted inside the PVC tube near the staff plate.

1. Measure and record the distance from the top of the grapestake to the end of the toothpaste remaining on the grapestake,
2. The adjustment factor needed to convert 9a to the equivalent water surface elevation on the staff plate; a value will be established for each station based on cross-section survey data.
3. Adjusted peak water surface elevation at the gage (staff plate).

- Step 8: Water quality samples.
  Three samples are collected: two grab samples and one depth-integrated sample using a DH-48 suspended load sampler (refer to DH-48 manufacturer's instructions or USGS Field Methods for additional details of sampling procedure). Grab samples are collected from the surface in a bottle as near to the thalweg (location of highest stream velocity) and are analyzed for turbidity at the end of the day. The DH-48 sample is sent to a contract laboratory for analysis of Total Suspended Solids (TSS); a small portion of this sample is used for turbidity analysis.
  1. Grab sample #1 is collected prior to discharge measurement.
  2. DH-48 depth integrated sample is collected in the thalweg (if possible) after the discharge measurement is completed.
  3. Grab sample #2 is collected immediately after the DH-48 sample.
  4. Date & time turbidity analysis is conducted, results of analysis, and the initials of the individual conducting the analysis.
  5. Remarks regarding any special circumstances or conditions affecting the timing, location or quality of water samples.
  6. Chain of custody information: Storage conditions for sample #2 for subsequent delivery to laboratory for analysis. Include location (address/residence), date & time, and storage conditions (ice chest, refrigerator, etc.)
- Step 9: Discharge measurement field observations.
  Refer to USGS instructional materials for detailed instructions at background on the technique. <u>Not to be performed by a novice.</u>
  1. Position on discharge measurement cross section measured with zero located on the left bank (facing downstream). This position defines the center of each discharge sub-cell for which a velocity measurement is obtained. LEW is the horizontal position of the left edge of water; REW is the horizontal position of the right edge of water facing downstream.
  2. Water depth at the velocity measurement position corresponding to location (a) above.
  3. Velocity measurement depth-point where velocity meter is positioned on the top set rod. The top set rod is designed to allow rapid positioning of velocity meter at above the bed equivalent to 0.4 times the water depth; this is equivalent to the position 0.6 times the depth below the water surface.
  4. Record the number of revolutions of the current meter as expressed by the number of audible "clicks" in the time interval selected (minimum 20 seconds or as specified by USGS guidance). For relatively low velocity flows, the sensor wire should be positioned to graze the single-revolution cam on the current meter axle. For high

velocity flows, the wire should be positioned to graze the five-revolution cam on the current meter axle. The selected cam for the discharge measurement is set at the beginning of the measurement and should not be changed after measurements begin.

5. Length of velocity measurement interval in seconds. This can vary for different locations in the cross-section, but should not be less than 20 seconds.
6. Mean water velocity computed from current meter rating table. This column is left blank in the field. Qualified personnel perform computations in the office.
7. Discharge of flow cell. This column is left blank in the field. Qualified personnel perform computations in the office. Discharge of the cell is calculated as the product of the width of the cell (horizontal distance between adjacent flow cells entered in column a), flow depth at the center of the cell (entered in column b), and the mean velocity of the cell (column g).
8. Total measured discharge. This column is left blank in the field. Qualified personnel perform computations in the office. Calculated as the sum of discharge cells (column g).
9. Name of operator of current meter.
10. Name of individual who computes discharge and date computed.

- Step 10: Float Velocity Data.
  These stream velocity data supplement current meter measurements and need not be collected in all cases. These data are most useful during periods of high stream discharge and should be collected after discharge measurements are completed at the same location. In some cases, stream discharge may be too high to safely measure by wading with the current meter, and the discharge is estimated from the velocity of surface floats. Over the course of the first sampling season, we would like to obtain paired data from current meter measurements and float velocity measurements to develop an adjustment factor between mean velocity (11f) and mean surface velocity. In the absence of site-specific data, the relationship is mean velocity = 0.85 x surface velocity. Refer to the appendix in the QAPP for technique of float measurements. Dried orange peels are an ideal float.
  1. Record the length of stream channel over which velocity is measured with floats.
  2. Location of float test in cross-section (left, center or right of channel surface); two float observation are required for each third of the channel width.
  3. Time in seconds for each float to travel the test length of stream surface.
  4. Raw float velocity (course distance divided by time of travel (12a divided by 12c). Computed in the office or in the field-may be left blank in the field.
  5. Adjusted float velocity (raw velocity x 0.85 <u>or</u> a site specific adjustment factor determined by qualified personnel)-may be left blank in the field.
  6. Measure mean channel width.

Equipment & Forms List

- ❑ Current meter
- ❑ Wading rod
- ❑ DH 48 suspended sediment sampler
- ❑ Sample bottles for DH 48
- ❑ Flexible nylon measuring tape (165 ft)
- ❑ Stop watch
- ❑ Steel tape measure (pocket size)
- ❑ Toothpaste (for crest gages)
- ❑ Thermometer
- ❑ Floats (dry orange peels)

Clean-Up

- Disassemble, dry and lubricate current meter
- Dry and secure turbidometer

Data Field Form

To assist in the collection and organization of site-specific information, a field data form can be found attached. Please photocopy the form onto Write-in-the-Rain paper for data collection activities. Please use a No. 2 pencil.

References

Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy, (1994) *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, USFS General Technical Report RM-245

Edwards, Thomas K. and Glysson, G. Douglas (no date), Field Methods for Measurement of Fluvial Sediment. U.S. Geological Survey, Techniques of Water-Resources Investigations, Book 3, Chapter C2

Instructions for Sampling with a US DH-48 Depth-Integrating Suspended Sediment Sampler (manufacturer's product)

Gualala River Watershed Council-Hydrologic and Water Quality Monitoring Form-Fuller Creek (3/2002)

1. Station: North Fork South Fork Mainstem Sullivan | **2. Observers:**

3. Date:__________ **Time:** _____ am pm | **4. Current Weather:** Clear Cloudy Showers Rain Heavy Rn.

5. Flow Conditions: **5a.** Clear / Turbid / Muddy

5b. Base Flow / Rising Flow / Peak Flow / Falling Flow | **5c.** Water Temp. ________ F / C

6. Previous Weather: **6a**. Dry: 1-3 days / 3+days | **6b.** Rain: Overnight / Yesterday / Past 2 days / 3+days

7. Comments on 1-6:____

____

____

8. Water Surface Elevation: **8a.** Time______ Elev. ______ ft | **8b.** Time______ Elev. ______ ft

9. Crest Gage Reading: **9a.** High Water Mark (Distance From Top of Wood Insert) __________ ft

9b. Adjustment to Gage Datum _________ft | **9c.** Crest Peak (Gage Equivalent) ______________ft

10. Water Quality Samples: ***Sample Labels Include Station, Date, and Sample #***

10a. Sample #1-Surface grab Location Time__________

10b. Sample #2-Depth integrated (DH-48) Location Interval Time Time__________

10c. Sample #3-Surface grab Location Time__________

10d. Turbidity Analytic Results Sample Turbidity Sample Processing by:________________

Sample #	Date Processed	Time Processed	NTU's
1			
2			
3			

10e. Comments on samples: ______________________________________

____

____

10f. Chain of Custody:

Sample for Laboratory Analysis (Sample #2) Stored At_____________________________

Date __________Time _________ Storage Conditions <

----

11. Discharge Measurement: ***Conduct "spin test" on current meter. Note wire on Cam 1x or 5x. Items f, g and h are not completed in the field.***

11a. Station (ft)	*11b. Depth (ft)*	*11c. Sample Depth (0.4 D) (ft)*	*11d. # of Revolutions*	*11e. Sample Duration (sec)*	*11f. Velocity (ft/s)*	*11g. Discharge (cfs)*
LEW						
REW						

				11h. Total Discharge=	

11i. Current meter operator:____

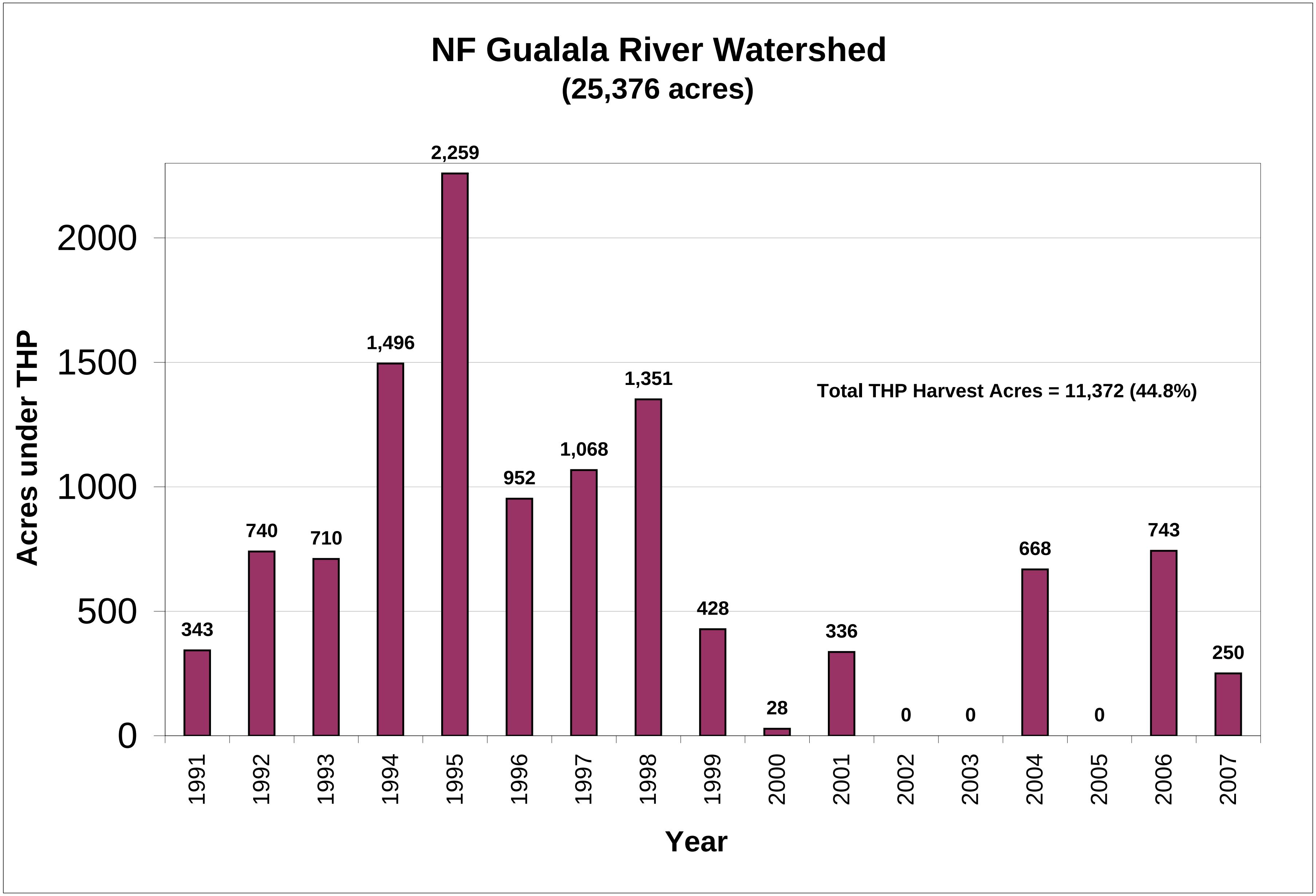
11j. Discharge computations by: ____________________________________Date____________

12. Float Velocity *(if performed)* 12a. **Float Course Distance (feet)**

12b. Observation # & Location	1-	2-	3-	4-	5-	6-
12c. Time for Float (seconds)						
12d. Raw Velocity (ft/s)						
12e. Adjusted Velocity (ft/s)						

12f. Mean Width of Water Surface (feet)

Discharge Measurement Notes & Comments:



Environmental Resource Solutions, Inc.

December 2010

Source of Data:
CAL FIRE Forest Practice GIS

North Fork Gualala

Reach Site #204

1999-2008

Prepared by:
The Gualala River Watershed Council

December, 2008

Table of Contents

North Fork Gualala - NFG3 #204

GUALALA RIVER WATERSHED

OVERVIEW

The Gualala River, located in Southern Mendocino and Northern Sonoma Counties, drains 685 miles of blue line streams. At 212,563 acres (342 mi^2) it is the largest watershed in the Mendocino Coast Hydrological Unit. The river enters the Pacific Ocean south of the town of Gualala, 114 miles north of San Francisco and 17 miles south of Point Arena. The Gualala River watershed is elongated, running over 32 miles long north-south, with an average width of 14 miles. The entire basin lies within 20 miles of the Pacific Ocean. Elevations vary from sea level to 2,602 feet at Gube Mountain and terrain is most mountainous in the northern and western parts of the basin.

A long history of movement along the San Andreas Fault and the Toombs Creek Fault has been a dominant force in the shaping of the basin. The sub-watersheds, largely fault controlled, flow through primarily steep valleys with little or narrow floodplains. The climate is influenced by fog near the coast with seasonal temperatures ranging between 40 to 60 degrees (F), with the interior basin ranging from below freezing to over 90 degrees (F) seasonally. Rainfall also varies by location within the basin with 33 inches falling on average near the town of Gualala and totals reaching over 63 inches in some areas within the interior.

The five principal Gualala sub-basins in order of size are the Wheatfield Fork (37% of drainage), South Fork and Gualala Mainstem (21%), North Fork (16%), Buckeye Creek (14%), and Rockpile Creek (12%). The mainstem Gualala extends only from the convergence of the North Fork and South Fork to the ocean, with much of this reach comprising the estuary or lagoon. This stretch of the Gualala River was designated "Wild & Scenic" by the State of California in 2003. Coastal conifer forests of redwood and Douglas fir occupy the northwestern, southwestern and central portions of the watershed while oak-woodland and grassland cover many slopes in the interior basin.

In 1993, the USEPA listed the Gualala River on its federal Clean Water Act list of impaired water bodies due to declines in anadromous salmonids from excessive sedimentation. The listing was updated in 2003 and water temperatures in the basin are now considered impaired as well. A Technical Support Document for the Total Maximum Daily Load for the Gualala was completed by the NCRWQCB in 2003.

The Gualala River lies within the Central California Coast Coho salmon Evolutionary Significant Unit (ESU), which is listed as endangered under the Endangered Species Act (NMFS 2005). Critical habitat includes all river reaches and estuarine areas accessible to Coho salmon within the ESU's geographic area (NMFS 1999). Winter run steelhead in the Gualala river basin are part of the Northern California steelhead Distinct Population Segment (DPS) and are listed as threatened under the Federal ESA (NMFS 2006).

Coho naturally inhabited the streams flowing from coniferous forest but were likely sub-dominant to steelhead in interior basin areas draining the mélange due to the more open nature of the channels, less suitable habitat, and naturally warmer stream temperatures. The interior basin is largely grassland with scattered oaks. Surface water in this area generally lack shade and is warmed with abundant sunshine.

The watershed has produced timber since before the turn of the last century and presently timber and ranching are still the main land use. In recent years timber land conversions to rural subdivisions and vineyards has increased in the Buckeye Creek, the Wheatfield Fork and the South Fork Super

Planning Watersheds. Aggregate mining occurs on the South Fork between the Wheatfield Fork and the North Fork.

NORTH FORK GUALALA

SUMMARY

The North Fork Subbasin (Calwater 2.2a 113.81, North Fork SPWS) encompasses 47.9 square miles of private land in the northern end of the Gualala River Watershed. The main channel has a zig-zag pattern in response to faulting. Two major faults have influenced channel formation in the North Fork SPWS. The Toombs Creek Fault bisects the headwater channels and the San Andreas Fault runs along the lower portion of the mainstem. There are 127 miles of "blue line" streams, and five major tributaries: Little North Fork, Robinson Creek, Dry Creek, Stewart Creek, and Billings Creek. Predominant land uses include timber production, grazing, small vineyards, and some 40-acre and larger subdivisions in the headwaters.

The North Fork sub-basin is extremely important to the Gualala River Watershed in two ways. First, it provides the highest quality salmonid refugia available in the watershed and is the only sub-basin to have remnant populations of Coho salmon. Coho salmon are still found in the Little North Fork, and its tributary Doty Creek, in McGann Gulch, and in Dry Creek. Second, the North Fork is an important source of base flows and cold water infusion to the lower Gualala during the late season periods when the estuary is prone to warmer temperatures and high salinity conditions. The North Fork contributes greater runoff per unit area than the other major tributaries feeding the lower river and estuary/lagoon in the summer months[1].

In 2007 John Bower, North Gualala Water Company (NGWC), hired the Gualala River Watershed Council (GRWC) to establish new temperature monitoring stations below, between and above the current NGWC well sites and re-survey the 2,000 ft. GRWC monitoring reach (NFG3 #204) in the North Fork of the Gualala River where the Water Company well sites are situated. Historically, the GRWC Monitoring Program has installed temperature monitoring equipment or has access to the data at various temperature sites in the North Fork since 1992 and at the reach site #204 since 1995. The monitoring reach #204 was surveyed in 1999, 2001 and in 2008.

NFG3 #204 reach data shows an increase in primary pool formation, maximum pool depth and a decrease in channel aggradation over the past 9 years (1999-2008). The channel degradation is consistent with overall watershed-wide findings. Channel degradation appears to confirm the premise that excess sediment loads are slowly transporting out of the watershed[2]. According to the NCWAP study, over a sixteen-year period (1984 to 2000) portions of channels having negative fluvial sediment conditions decreased within the watershed for an overall watershed reduction of forty 47% and a reduction of 40% in the North Fork SPWS. However, at other reaches within the watershed channel morphology has remained stable, increased pool production and depth has been limited to reaches included in in-stream restoration projects.

A Variation Index (VI) for the thalweg is developed for each monitoring site using a model designed by Mary Ann Madej (USGS and Redwood National Park). Simply stated, the VI measures the complexity of the channel bed; reduction of complexity occurs with excessive sediment introduction,

[1] Gualala Estuary and Lower River Enhancement Plan, ECORP Consulting, 2005
[2] Gualala River Watershed Assessment Report, North Coast Watershed Assessment Program (NCWAP), 2002

increased complexity indicates a recovery from such a condition. The formula used for analysis is: ([Variation Index 02]![SD]/[Variation Index 02]![GRWC BF Depth])*100.

The VI target for recovery is considered to be '20' (Madej, 1999) and channels with a VI index of $\geq$ 20 are believed to be in recovery from excessive sediment loads. NFG3 #204 shows a steady increase in the VI from 36.8 in 1999 to 48.9 in 2008.

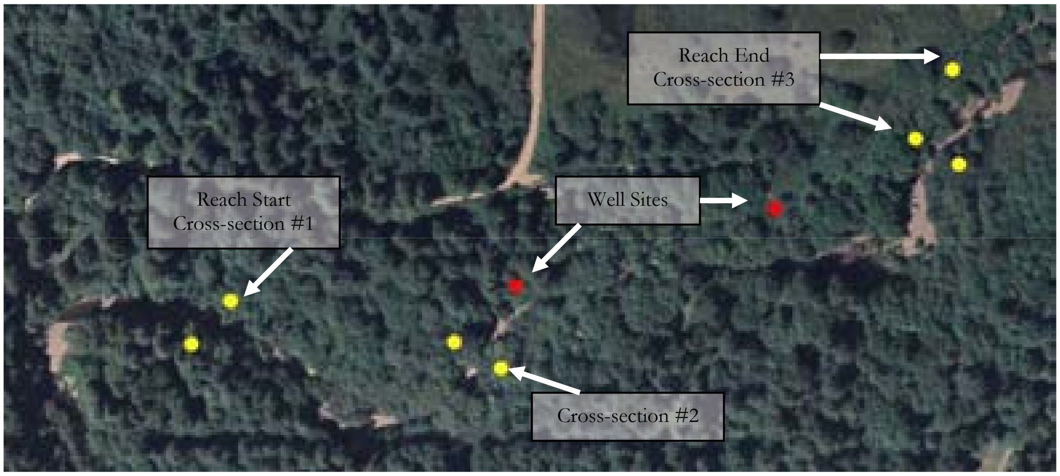
Temperatures for 2007 show a slight decrease in the Maximum Weekly Average Temperature (MWAT) and the Maximum Weekly Maximum Temperature (MWMT) since 1995. Reach water temperatures range from "somewhat suitable" to "moderately suitable" for summer rearing for salmonids. No recorded temperatures reached the maximum daily lethal temperature of 23.9° Celsius. In 2007 the highest daily recorded maximum was 19.65° Celsius.

Temperature monitoring data collected in 2007 are specific to both reach data and the NGWC well sites. Temperature loggers were placed specifically to monitor water temperature above, between and below the NGWC wells. No discernable difference in the MWAT or MWMT from site to site could be attributed to the wells. It is highly unlikely that further analysis of the temperature data such as comparing hourly temperatures and pumping times would show a relationship[3].

The GRWC monitoring reach data are not specific to the issue of impacts, if any, from the NGWC well sites. However, the trend in data does suggest that salmonid habitat enhancements are occurring naturally; over the past nine years the channel morphology appears to be steadily improving and favorably impacting salmonid summer rearing habitat, winter spawning gravels, and winter refugia[4].

[3] GRWC NFG3 #204 Temperature monitoring, 2007& 2008
[4] GRWC Thalweg and Stream Report, 2008

SITE DESCRIPTION



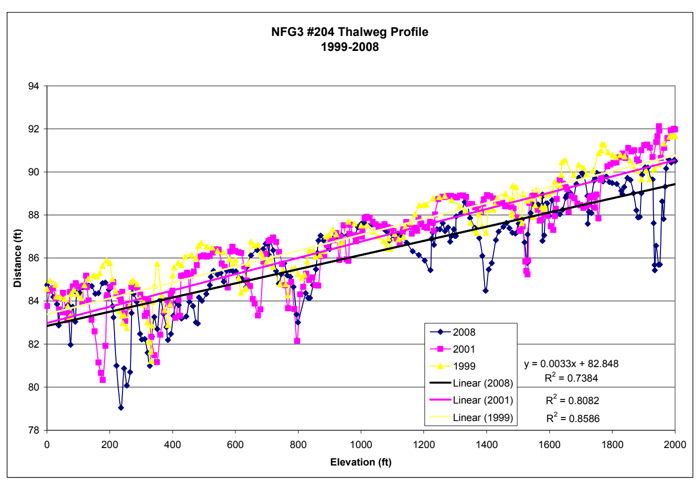
North Fork Gualala Reach Site #204

The North Fork's legal description at the confluence with the South Fork is T11N R15W S26. Its location is 38° 46.704' north latitude and 123° 29.939' west longitude. The North Fork is a 3rd order stream[5] and has approximately 127 miles of blue line stream. The North Fork does, and has historically, supported anadromous fish. The Department of Fish & Game 2001 habitat typing data lists the Rosgen channel types as B1 and F4; the average bank-full width is 50 feet. It drains a watershed of approximately 30,635 acres. Elevations range from about 140 feet at the mouth to 2,400 feet in the headwaters area according to the USGS Gualala and McGuire Ridge 7.5 minute quadrangles.

Site #204

The study site is a 2,000-foot long low gradient (.33%) study reach located in the lower reaches of the North Fork Gualala. The study reach is approximately 1.25 miles above the North Fork confluence with the South Fork and 400 ft. above the Little North Fork confluence with the North Fork (see map).

CHANNEL MORPHOLOGY

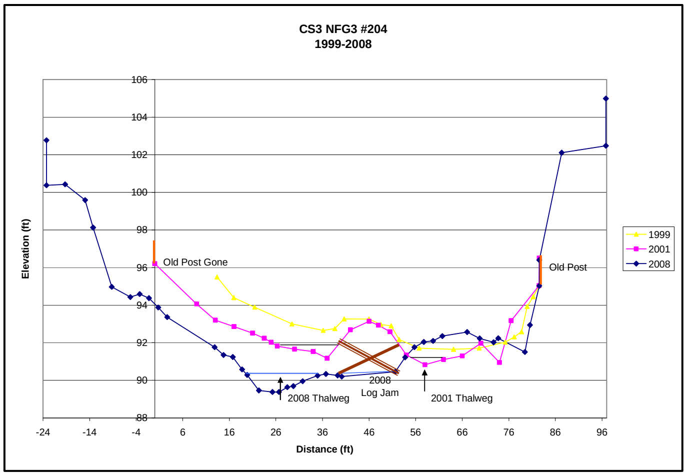


Thalweg surveys and cross-section surveys were completed in 2008. The watershed size above the monitoring site is 25,433 acres. The Rosgen channel type along the monitoring reach is F4 and the reach has an average bank-full width of 52 feet. The 2,000-foot long study reach has a low gradient of 0.33%. As demonstrated in the Thalweg graph, the survey results for the past 9 years show significant improvement in pool depth, pool formation, and pool frequency.

5 California Department of Fish and Game stream ranking

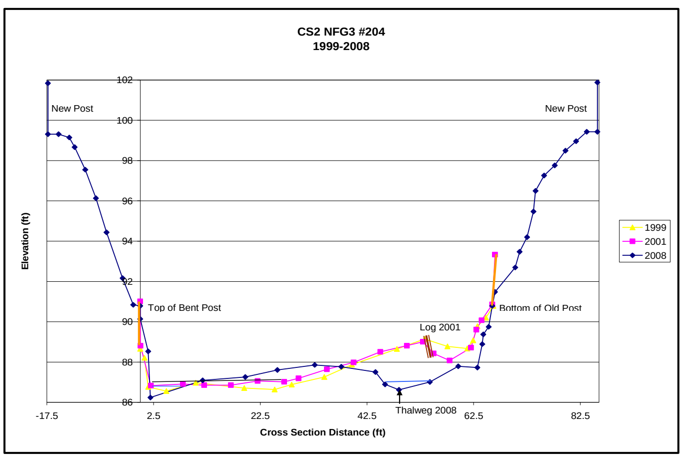
Primary pool frequency[6] has increased from 12% in 1999 to 40% in 2008, meeting the CDF&G target for suitable pool habitat. Maximum pool depth has increased over 1 ft. from 4.7' in 1999 to 5.8' in 2008. The longitudinal or linear square area of pools has increased by over 50% for the past 9 years. Compared to the base year of 1999, the reach thalweg has degraded by 1 ft.

The Variation Index of 42 is above the recovery index of 20 (Madej, 1999). This value has increased from the 1999 VI of 37.



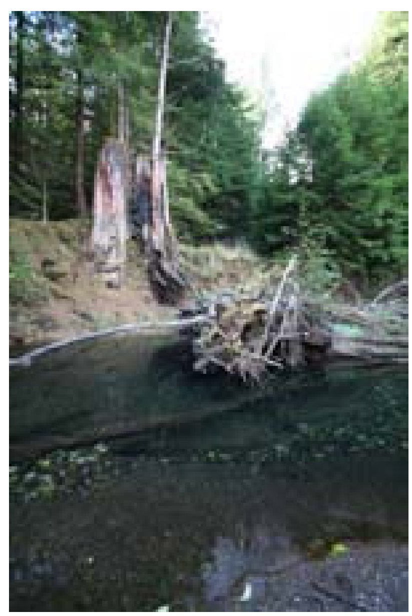
The cross-section graphs amplify the changes in this reach including shifting of the thalweg, increases and decreases in gravel bars, and the areas of instability of the stream banks.

In 2008 cross-section #1 was re-installed due to bank failure and is not comparable to past surveys. Graphs for cross-sections #2 and #3 show the thalweg degradation and demonstrate the change in channel morphology. Most changes appear to have occurred between 2001 and 2008.



The channel is well entrenched and bank instability is obvious along the lower third of the reach.

Erosion from bank instability does not appear to be hindering habitat enhancement in the reach. In fact, most erosion sites are benefiting from new large wood and root wad recruitment. Most of the erosion sites appear to have new in-channel and side channel pool formation.



Pebble counts are conducted at down-stream riffles at the 3 cross-sections sites and the reach end benchmark. In 1999 the average d50 for the reach showed a small gravel size (15mm); however there has been a steady increase in size since 1999. In 2008 the d50 was 28. As LWD increases and channel restoration continues, the d50 could continue to increase.

[6] California Department of Fish and Game pool habitat for 3rd order streams should be 40% of pools $\geq$ 3'.

LARGE WOOD

The 2008 survey results show the monitoring reach has a total of 63 pieces of LWD per 1,000 feet; the pieces represent a volume level of 3,003 ft^3. While the volume is up 38% from 1999, this is still below optimum levels. The GRWC is developing wood loading levels that will achieve pool formation and shelter rating targets in 1st to 3rd order streams. Literature suggests that volume levels > than 6,000 ft^3 and pieces >150 may achieve targets.

RIPARIAN

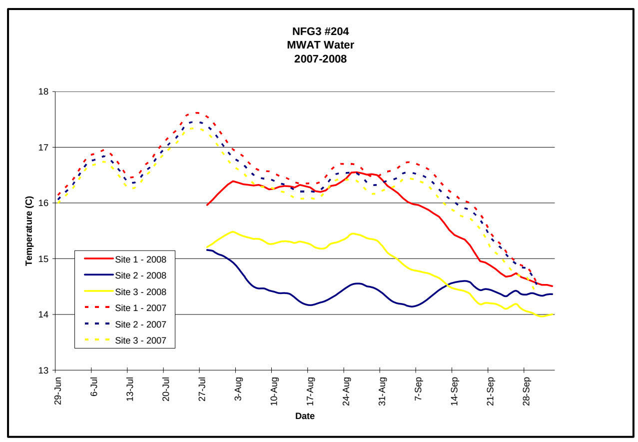
Average canopy density was very low along the study reach with 46% density at the center of the active channel and 64% density recorded 50 feet upslope from bank-full in 1999. Canopy density at bankfull and center of channel was surveyed again in 2008. The results show an increase at both center of channel and bankfull to 69% and 80% respectively.

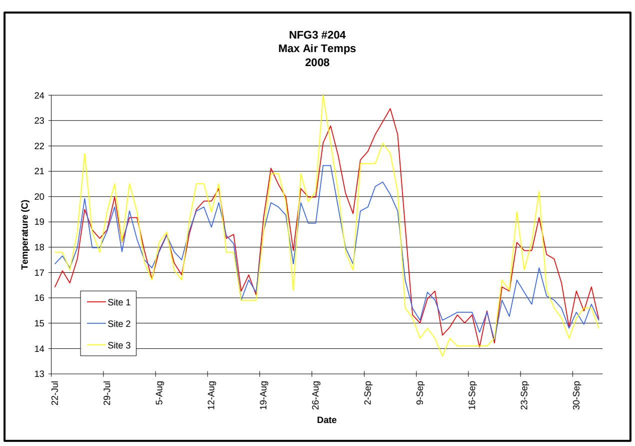
Riparian statistics were last collected in 1999. Canopy composition averages 55% conifer and 45% hardwood. The twelve riparian plots have an average basal area of 140 and an average tree height of 73 feet. The riparian survey is scheduled to be completed again in 2009.

TEMPERATURE

Yearly seasonal MWATs range between a high of 18.7° (in 1996) to a low of 17.6° Celsius (in 2007)[7]. Stream temperatures are above the NCWAP "fully suitable range" of 10° to 15.6° Celsius for salmonids, specifically Coho, but appear to be suitable for summer rearing for Steelhead Trout[8].

In 2007 the GRWC placed 12 temperature loggers, 3 air and 9 water at 3 sites, within the reach. Site #1 was 1000' above the Water Company pump-house and above the upper well site, site #2 was between the wells, and site #3 was 500' below the Water Company pump-house and below the lower well.





Significant variability was not evident between the 3 water temperature loggers placed at each site in 2007.

In 2007, water temperature at all three sites were within .50°c with the up-stream site #1 showing the warmest trend with a MWAT of 17.62°c and the downstream site #3 below the wells with the lowest temperature with a MWAT at 17.34°c.

As shown above more temperature variation was evident in the 2008 data. In 2008 site #1 (upstream site) continued to be the warmest of

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[7] 2008 temperature data should not be used for salmonid suitability factoring.
[8] Gualala River Watershed Technical Support Document for the Total Maximum Daily Load for Sediment, NCRWQCB, 2001.

the three sites, but site #2, between the well sites, had the lowest temperature. This change from the 2007 data could be attributed to the possibility of cold water infusion from underground springs near the hobo placement for site #2 in 2008. Lower temperatures at site #2 may also be a result of higher shade levels over the Hobo placement site. The air temperature graph on the previous page shows a more stable data set of max *air* temperatures for site #2. Site #2 air temperature varied by only 7° and remained below 21°C, while air temperatures from sites #1 and #3 range by 10°and 11°respectivly.

Due to late logger placement the 2008 data may not represent all peak temperatures. A peak temperature period from July 6th to July 11th is not represented and caution should be used when looking at the 2008 MWAT data and seasonal salmonid temperature suitability.

THALWEG REPORT

Stream	Station				Distance up Stream (Feet)	Drainage Area (Acres)	Slope	Streambed Aggradation Degradation (Feet)	Variation Index	Pools				Longitudinal Cross Sectional Area of Pools > 1' Deep
	Name	#	Visit ID	Year						>1' %	>2' %	>3' %	Max Depth (Feet)	
NF Gualala	NFG3	204	347	1999	6,600	25,433	37%		36.8	9 74%	3 32%	1 12%	4.7	645
NF Gualala	NFG3	204	495	2001	6,600	25,433	38%	-0.41	42.0	12 67%	4 38%	4 38%	4.9	770
NF Gualala	NFG3	204	898	2008	6,600	25,433	33%	-1.0	48.9	8 77%	8 77%	4 40%	5.8	972

STREAM MONITORING REPORT

Station		Miles	Year	Temperature		Large Wood		Substrate		Streambed			Riparian Zone				Fish per Mile	
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	<0.85mm	D50	Slope	VI	A/D	Canopy WLPZ	% Cr.	Basal Area	Tree Ht.	Coho	SH (1+)
204	NFG3	1.25	1995	20.6	17.5													
204	NFG3	1.25	1996	20.1	18.7													
204	NFG3	1.25	1997	19.4	18.2													
204	NFG3	1.25	1998	20.2	17.7													
204	NFG3	1.25	1999			2,186	39		19	0.37%	37		64%	46%	140	73	0	109
204	NFG3	1.25	2000	19.9	17												0	698
204	NFG3	1.25	2001	18.6	16.7	2,932	99		24	0.38%	42	-0.41					0	84
204	NFG3	1.25	2002														0	317
204	NFG3	1.25	2003	Stolen													0	255
204	NFG3	1.25	2006	Stolen														
204	NFG3	1.25	2007	18.8	17.3													
204	NFG3	1.25	2008			3,006	63		28	.33%	49	-1.00	80%	69%			0	79

TEMPERATURE

Yearly selection of sampling sites is based on the Goals and Objectives of the Temperature Monitoring Program. Primary site selection is within the study reach NFG3 #204. An automated data logger is placed in well mixed flowing areas at the upper, middle, and lower areas of the reach.

NFG #204: Hobo Site 3 - July 2008

Data Collection

Temperature loggers manufactured by Onset© Corp., was programmed to sample at least every 96-minutes. With 8K of internal memory, a full season of data can be collected. A season is May 1st to September 30th, the months of highest air and water temperatures each year. Additionally, the 96-minute sampling interval is the minimum specified in the cooperative effort developed by the Forest Science Project (FSP 1998) to detect daily maxima. Basic considerations for site selection are presented in the modified protocol. The primary use of the data at this point is for characterizing a stream reach, so placement is in a well mixed flowing section of the stream that is representative of a reach.

A thermal reach is a reach with similar (relatively homogenous) riparian and channel conditions for a sufficient distance to allow the stream to reach equilibrium with those conditions. The length of reach required to reach equilibrium will depend on stream size (especially water depth) and morphology (TFW, 1993). A deep, slow moving stream responds more slowly to heat inputs and requires a longer thermal reach, while a shallow, faster moving stream will generally respond faster to changing riparian conditions, indicating a shorter thermal reach. Generally, it takes about 1000 feet of similar riparian and channel conditions to establish equilibrium with those conditions in fish-bearing streams.

Data sheets for calibration, deployment, and site conditions accompany data for each deployment and are provided by the GRWC.

Data Analysis

Raw temperature data is processed according to the methods outlined in the FSP protocols. A core set of metrics are calculated from the data on a seasonal basis.

These include:

daily minimum
daily maximum
daily average
seven-day moving average of the daily mean
seven-day moving average of the daily maximum

Yearly summary statistics calculated from the daily and weekly data is produced for each site for each year. Yearly site-specific statistics of the seasonal maximum for the Maximum Weekly Average Temperature (MWAT) and the seasonal Maximum (Max) is produced in chart form for each Super Planning Watershed (NCWAP Synthesis Report,
2002).

LONGITUDINAL (THALWEG) PROFILES & BENCHMARKS

The amount of variability of the thalweg along a longitudinal axis in the stream is a good measure of complexity of the wetted stream channel. Pools, logs, boulders, riffles, etc. add complexity to the channel that affect sediment transport, channel form, and fish habitat. Changes in the thalweg profile reflect overall changes in the channel complexity, which are a result of channel-forming forces in the stream. Reduction of complexity occurs with excessive sediment introduction.
Increased complexity indicates a recovery from such a condition. Thalweg profiles provide information on existing conditions, but are useful in trend analysis over the long term.

Data Collection

Strictly implemented, a thalweg profile or survey, as mentioned above, measures the streambed elevation along the thalweg of the stream, taking particular care to measure all breaks-in-slope, riffle crests, maximum pool depths, and pool tail-outs. Concurrently, while the tapes, levels, etc., are set up for measuring thalweg profiles, the locations of transects for cross-sections are also usually documented and measured (Madej and Ozaki, 1996; Ramos, 1996). Since it is practically impossible to uniformly arrange the longitudinal tape exactly over the thalweg, measurements should be perpendicularly referenced to the centerline tape, and read to within one-tenth of a foot. Ramos suggests that as thalweg measurements intersect the point of a designated cross-section, the thalweg should be measured at the intersection first, next the cross-section is surveyed before proceeding upstream. In addition to the thalweg elevations, comments on local channel features such as pools, riffles, runs, and the presence or absence of large woody debris can also be recorded.

Data Analysis

Subsequent analysis of the profile allows the detection of changes in the vertical dimensions of channel features. A core set of metrics is calculated from the thalweg elevation data on an annual basis. These include:

channel slope
a thalweg profile chart to evaluate changes in gradient and pool formation
changes in channel elevation relative to base year elevation
variation index (Madej, 1999) – above 20, can show channel recovery

Summary statistics for slope, the thalweg profile and channel elevation are calculated by using an Excel database developed for Gualala Redwoods, Inc. The Variation Index is a way of quantifying channel roughness and is calculated as VI: ([Variation Index 02]![SD]/[Variation Index 02]![GRWC BF Depth])*100 by using the Longpro database (USGS and Redwood National Park).

CROSS-SECTIONS

Monitoring the long-term changes in cross-sectional data can provide insights into channel bed and bank stability, and relationships between sediment transport and discharge (Beschta and Platts 1986). Shifts, such as decreasing cross-sectional area, are often associated with decreasing thalweg depth, widening of the channel width, increasing bed elevations and overall streambed aggradation. Channel incision and down cutting may be indicative of a return to more "natural" conditions from previous management and/or natural catastrophically related impacts (McDonald, et al., 1991).

NFG #204: Cross-section #2 - 2008

Data Collection

Three cross-sections within the study reach are measured in conjunction with the thalweg profiles. A cross-sectional profile is developed by measuring points along a tape measure stretched across the stream and recording the distance, and streambed elevations at each specific point along the tape. Cross-section measurements always begin by measuring the elevation at the established benchmark, usually located on the left bank. Stream bed characteristics, such as changes in channel elevations, the position of the field estimated bank-full height, wetted width, breaks in slope, and the deepest points in the particular channel feature being measured are recorded. The end points of the cross-section need to extend above the estimated bank-full stage and sometimes above the flood prone zone.

Data Analysis

Analysis of the cross-sectional profile allows the detection of changes in streambed elevation, bank stability, bank-full width/depth ratio, and channel scour and/or fill (aggradation/degradation). A core set of metrics are calculated on an annual basis. These include:

bank-full width/depth ratio
a cross-sectional profile chart to evaluate changes in streambed elevation and bank stability.
changes in channel elevation relative to base year elevation
channel scour and/or fill (Madej, 1999)

Summary statistics for bank-full width/depth ratio are calculated by using the CDF&G protocol. The cross-sectional profile chart and the channel elevation change are calculated by using an Excel database developed by Gualala Redwoods, Inc. Channel scour and/or fill is calculated by using the Winscour database (USGS and Redwood National Park)

PEBBLE COUNTS

One of the most widely used methods of sampling grain size from a streambed is the pebble count technique (Wolman, 1954). It can be used as a simple and rapid stream assessment method that may help in determining if land use activities or natural land disturbances are introducing fine sediment into streams (Potyondy and Hardy, 1994). Pebble counts are routinely used by geomorphologists, hydrologists and others to characterize bed material particle size distributions of wadable, gravel bedded streams. The procedures have been adapted in fisheries studies as a preferred alternative to visually characterizing surface particle sizes commonly used during instream flow studies (Kondolf and Li, 1992). The methodology is best applied in gravel and cobble streams with a single channel and is not applicable to lower gradient, sand-bed dominated channels.

Data Collection

Pebble counts are conducted by randomly collecting, counting and measuring the intermediate diameter (b-axis) of 100 (Kappesser, 1993) particles from the surface of the streambed. Riffles deemed suitable for spawning salmonids are the preferred location for sampling efforts (Schuett Hames, et al., 1999). Four pebble counts are conducted per monitoring reach. Samples are collected at the cross-sections and end of the reach by walking the streambed in a zigzag pattern and picking up individual pebbles at the toe of a boot. Zigzag transects traverse the stream channel from left bank-full to right bank-full.

Data Analysis

It has been shown that shifts toward the lower end of the pebble count cumulative frequency curves may be indicative of significant increases in streambed fines from accelerated natural and or land-use disturbances. Conversely, a progressive coarsening of streambed surface particles may indicate improving conditions from past upstream and/or upslope disturbances. A core set of metrics are calculated on an annual basis. These include:

d50, median particle size, the diameter at which 50% of the particles are finer
d16, the diameter at which 16% of the particles are finer
d84, the diameter at which 84% of the particles are finer

Summary statistics for the particle size diameters were provided by individual sites and averaged by study reach. Other analyses that may be applied on a site-specific basis are the geometric mean diameter: dg = (D84 x D16)0.5 and the geometric sorting coefficient: sg = (D84/D16) 0.5 (Kondolf and Li, 1992).

LARGE WOODY DEBRIS

Large Woody Debris (LWD) is known to be an important structural element of stream channels. It improves juvenile Coho salmon and Steelhead trout summer rearing habitat by increasing the numbers and depths of pools. Large amounts of LWD also increase winter cover that is critical for salmonid protection from predation and the reduction of water velocity.

Data Collection

To monitor large woody debris we use an inventory method developed in partnership by GRI and the GRWC after reviewing other accepted techniques. It is designed to allow sorting and recompiling of data to answer different questions over time. LWD is measured in conjunction with the thalweg profiles. This allows the recording of LWD pieces by distance along the thalweg tape. Along with distance, placement (i.e. left or right bank) in the channel and percent within bank-full are recorded. Diameter and length measurements are taken of every piece that breaks the plane of the bank-full line and is at least 6" in diameter on the small end and 4' long.

NFG #204

Data Analysis

The North Coast Regional Water Quality Control Board concluded in its 2006 study that the target for healthy salmonid habitat for streams with bankfull widths of up to 98' is 192 pieces LWD/1000' of stream. Beechie and Sibley (1997) concluded that when the number of LWD pieces (>8 inches in diameter) reached about 122 pieces/1,000 Ft., pool formation is less sensitive to further increases in LWD loading. Similarly, Martin (1999) found that the effectiveness of LWD for forming pools in alluvial channels was diminished when the LWD load exceeded a threshold of approximately 137 pieces.

Calculating the size, position and number of LWD pieces within a survey reach will allow monitoring of natural LWD recruitment and assist in planning and monitoring future LWD restoration plans. A core set of metrics are calculated from the data on an annual basis. These include:

cubic feet of LWD per 1,000 feet
number of LWD pieces per 1,000 feet

Yearly summary statistics are reported by monitoring study reach.

RIPARIAN MEASUREMENTS AND CANOPY

Riparian, or streamside forest, provides habitat for many types of wildlife, shades the creek keeping water temperatures cool for salmon and trout, and protects creek banks. When a tree is undercut and falls into the creek it becomes the large wood, an essential element for fish habitat. There are several features of riparian forest that indicate its value as habitat and as part of the stream system: the density and diversity of plant species, the width of the riparian corridor beyond the edge of the creek scour channel, the size of the trees in the corridor and the occurrence of dead trees, vines, downed wood and other features. In addition to salmonids, these features also enhance habitat values for birds, mammals, reptiles and amphibians.

The density of the streamside tree canopy creating shade over the creek, and the availability of large trees along the banks to become wood in the stream are features of the riparian forest, which relate to salmon and trout habitat in the creek channel. The extent of creeks in the watershed with dense riparian corridor indicates where water temperatures are likely to be within NCWAP ranges for suitable habitat. By assessing the riparian area, the current conditions are documented and these current conditions can be compared throughout the watershed. The objective of the riparian

NFG #204

assessment is to understand and identify areas in need of restoration and enhancement.

Data Collection

The riparian surveys use the Forest Projection System (FPS) developed by Dr. Jim Arney of Forest Biometrics. Riparian forest stands are inventoried by identifying a sample of trees by species within 20th acre plots at 200 ft intervals along the established monitoring reaches. The 20th acre fixed plots are placed perpendicular to the stream. Measurements start at bank-full, extend to 100 feet and are 21.8' wide. Quantities and sizes of live trees, snags, downed-logs and under story vegetation are documented.
Canopy density is measured using a spherical densiometer to record the riparian vegetation shading the creek. The measurements are taken in conjunction with the riparian surveys. Measurements are taken at five points in the established riparian plot sites: center of channel, bank-full (right & left), and 50 ft. inland from the bank-full point. Four readings per location are made first facing upstream, left bank, downstream, and right bank then the results are averaged to provide an estimate of canopy cover for that point.

Data Analysis

Subsequent analysis of riparian data allows the calculation of the riparian habitat within the study reaches. A core set of metrics are calculated from the riparian surveys and canopy data on an annual basis. These include:

canopy density at center of channel, bank-full and 50' into the riparian zone
riparian composition
basal area
tree height

Summary statistics for canopy density, riparian composition and basal area are averaged for the study reach sites. Tree height is calculated by averaging the height of the 100 tallest trees per acre.

SNORKLE SURVEYS

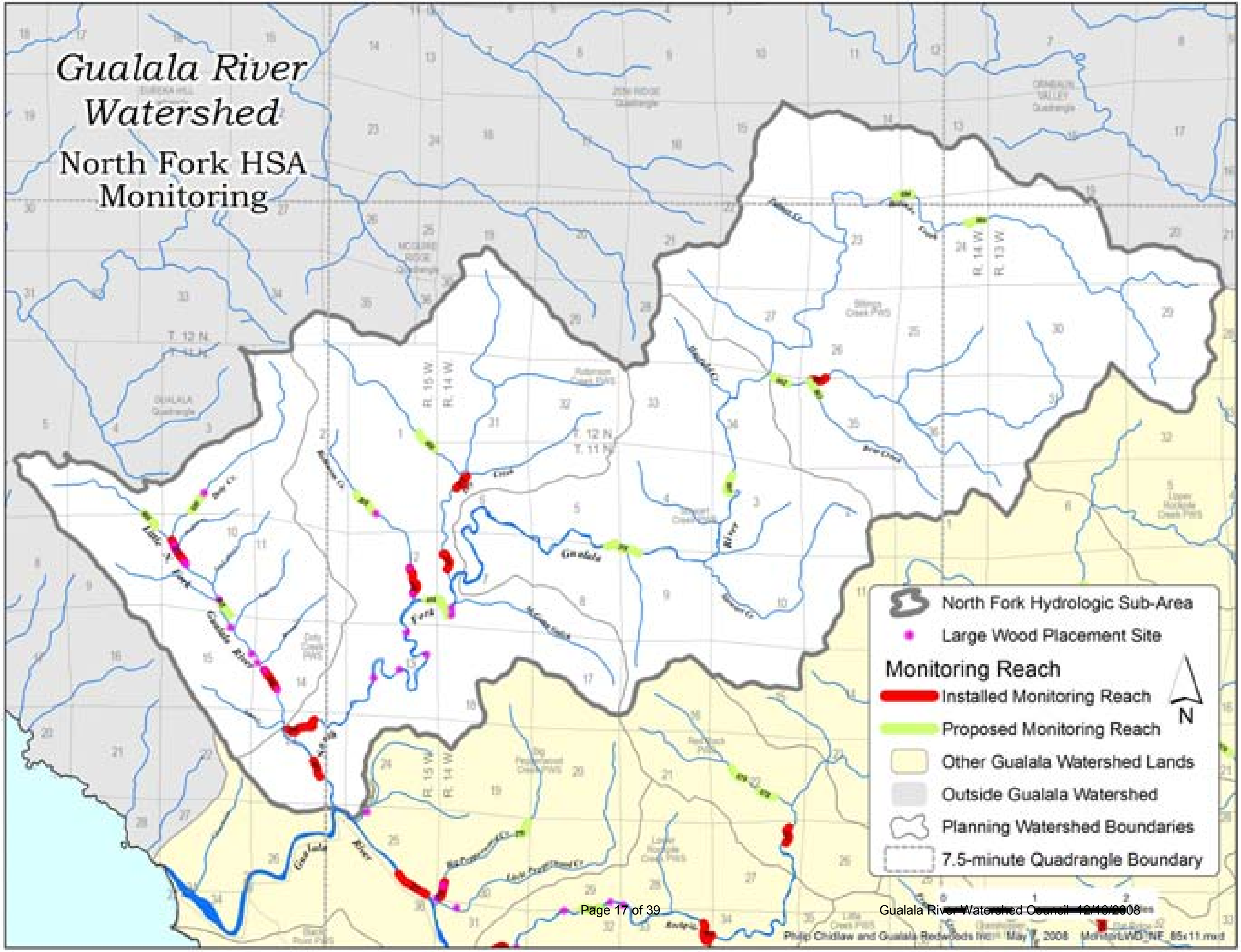
Snorkel surveys are conducted as benchmarks to compare with other streams in the greater watershed and establish presence or absence of specific salmonid species.

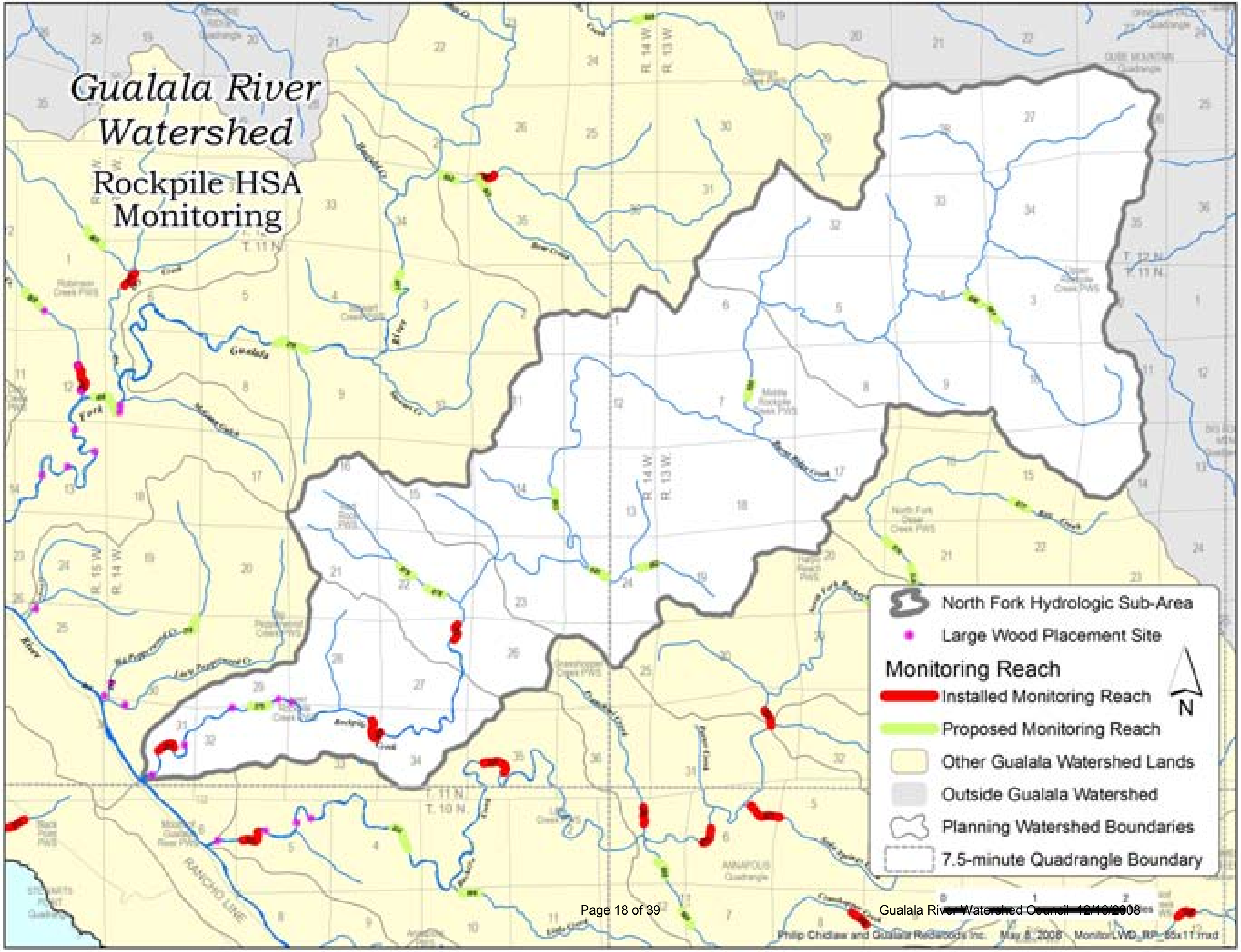
Data Collection

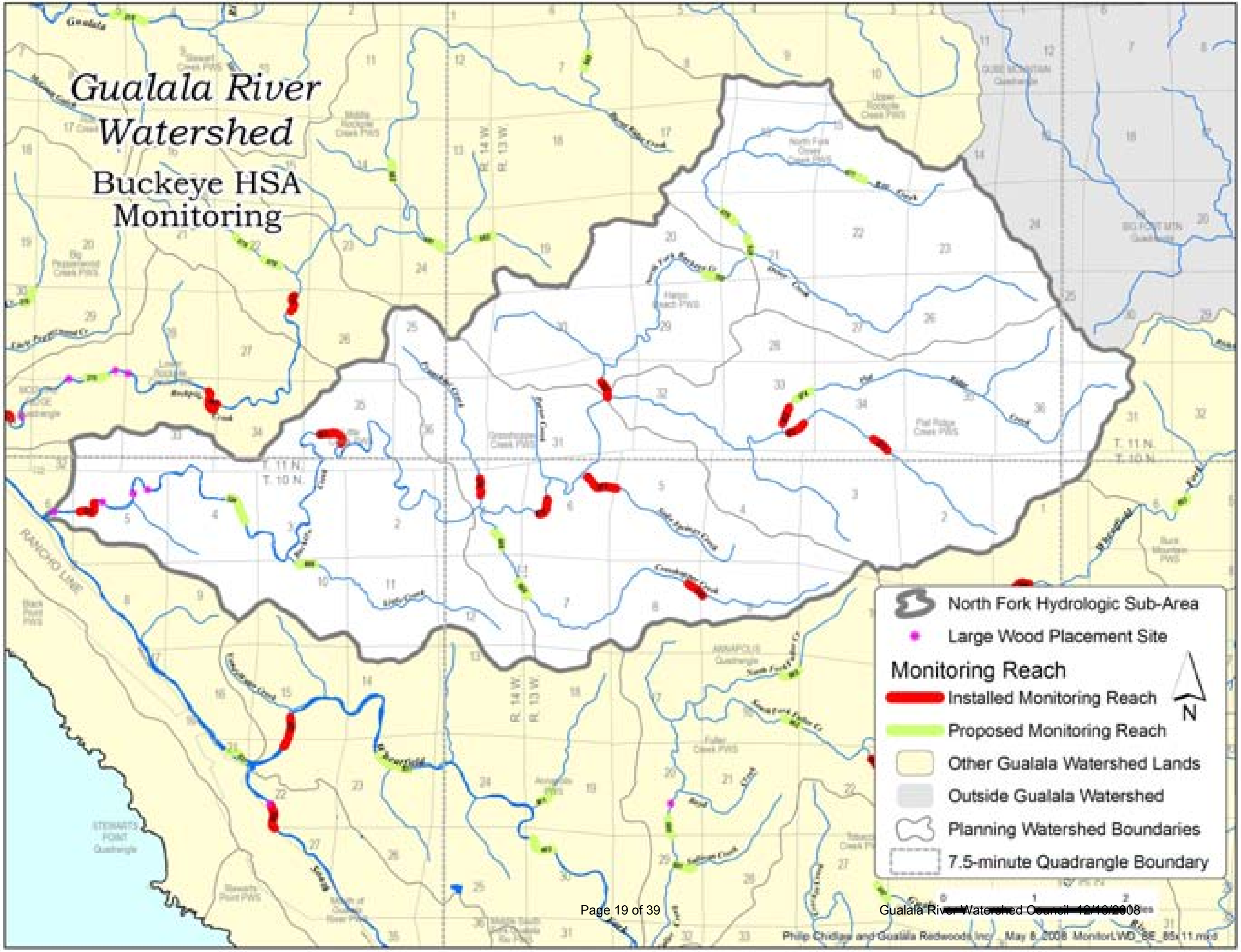
Snorkel surveys have been performed as per California Department of Fish and Game regulations since 1999. Quantities of Coho and Steelhead are classified by age as young of the year (yoy), 1+, 2+, or 3+.

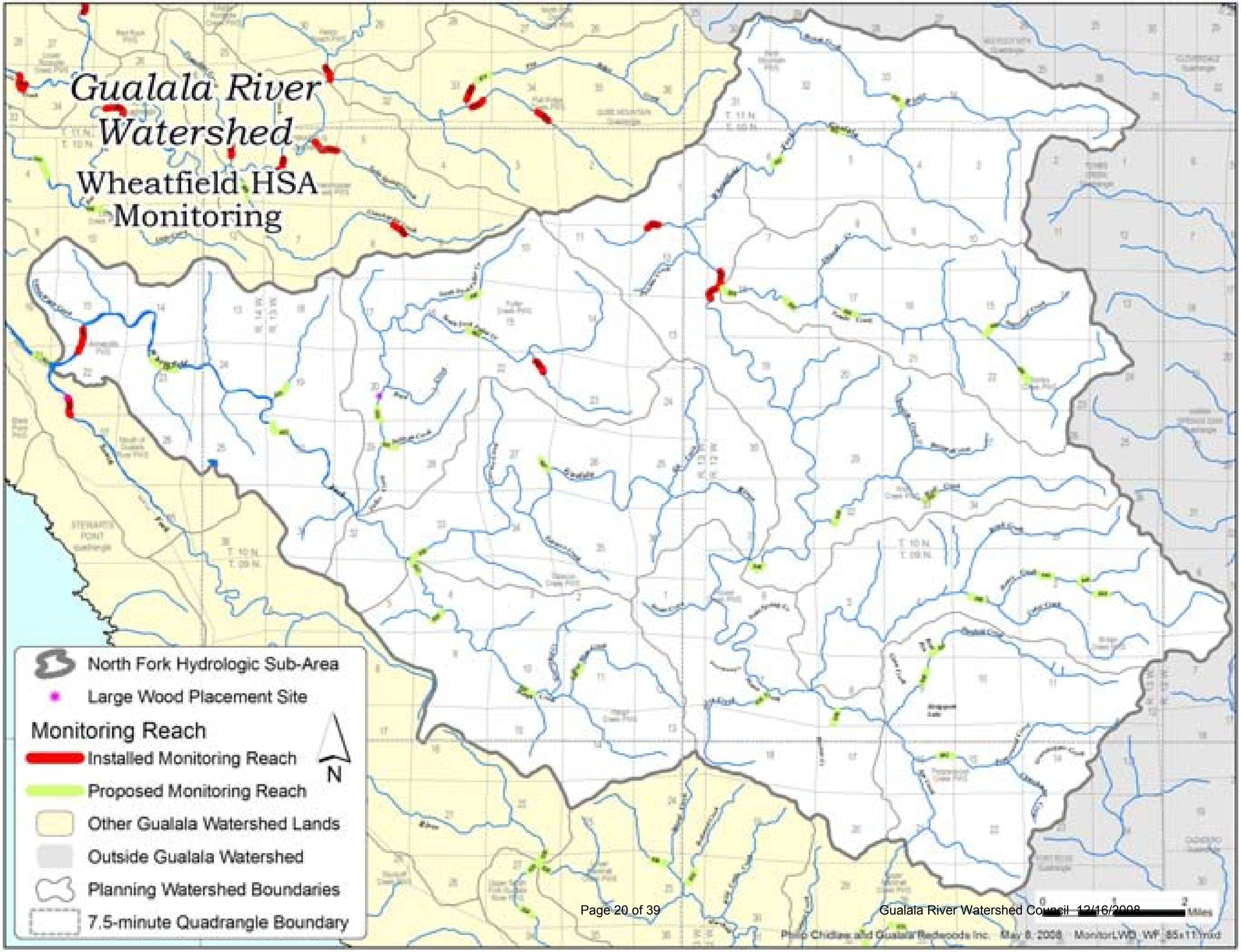
Data Analysis

A report is generated by the consulting biologist performing the survey. Data is added to the GRWC database and processed for the Stream Monitoring Report. Numbers of 1+ age Coho and Steelhead counted in the 2,000' reach are expanded to create a fish per mile statistic.

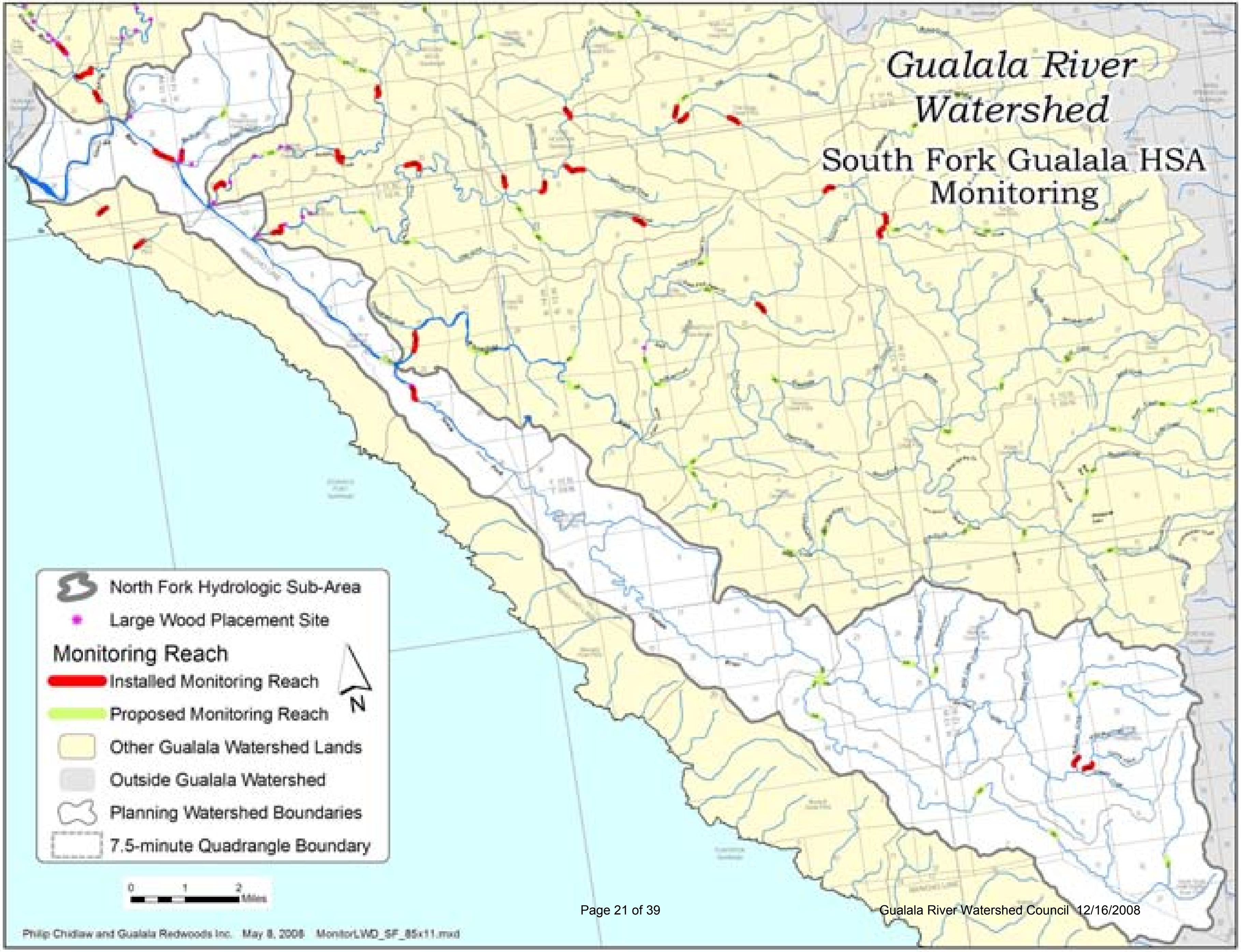

Gualala River Watershed
North Fork HSA Monitoring
North Fork Hydrologic Sub-Area
Large Wood Placement Site
Monitoring Reach
Installed Monitoring Reach
Proposed Monitoring Reach
Other Gualala Watershed Lands
Outside Gualala Watershed
Planning Watershed Boundaries
7.5-minute Quadrangle Boundary
N
Gualala River
Little North Fork
T. 12 N.
T. 11 N.
R. 15 W
R. 14 W
R. 13 W
Philip Chidlaw and Gualala Redwoods Inc. May 7, 2008 MonitorLWD_NF_85x11.mxd


Gualala River Watershed
Rockpile HSA Monitoring
North Fork Hydrologic Sub-Area
Large Wood Placement Site
Monitoring Reach
Installed Monitoring Reach
Proposed Monitoring Reach
Other Gualala Watershed Lands
Outside Gualala Watershed
Planning Watershed Boundaries
7.5-minute Quadrangle Boundary
N
T. 12 N.
T. 11 N.
T. 10 N.
R. 15 W.
R. 14 W.
R. 13 W.
RANCHO LINE
Philip Chidlaw and Gualala Redwoods Inc.   May 8, 2008   MonitorLWD_RP_85x11.mxd


Gualala River Watershed
Buckeye HSA Monitoring
North Fork Hydrologic Sub-Area
Large Wood Placement Site
Monitoring Reach
Installed Monitoring Reach
Proposed Monitoring Reach
Other Gualala Watershed Lands
Outside Gualala Watershed
Planning Watershed Boundaries
7.5-minute Quadrangle Boundary
N
RANCHO LINE
T. 11 N.
T. 10 N.
R. 14 W.
R. 13 W.
Philip Chidlaw and Gualala Redwoods, Inc. May 8, 2008 MonitorLWD_BE_85x11.mxd



Gualala River Watershed
Wheatfield HSA Monitoring
North Fork Hydrologic Sub-Area
Large Wood Placement Site
Monitoring Reach
Installed Monitoring Reach
Proposed Monitoring Reach
Other Gualala Watershed Lands
Outside Gualala Watershed
Planning Watershed Boundaries
7.5-minute Quadrangle Boundary
N
T. 11 N.
T. 10 N.
T. 10 N.
T. 09 N.
Miles
Philip Chidlaw and Gualala Redwoods Inc. May 8, 2008 MonitorLWD_WF_85x11.mxd


Gualala River Watershed
South Fork Gualala HSA Monitoring
North Fork Hydrologic Sub-Area
Large Wood Placement Site
Monitoring Reach
Installed Monitoring Reach
Proposed Monitoring Reach
Other Gualala Watershed Lands
Outside Gualala Watershed
Planning Watershed Boundaries
7.5-minute Quadrangle Boundary
N
0 1 2 Miles
Philip Chidlaw and Gualala Redwoods Inc. May 8, 2008 MonitorLWD_SF_85x11.mxd

Thalweg Report

Stream	Station Name	Station #	Station Visit ID	Station Year	Distance up Stream (Feet)	Drainage Area (Acres)	Slope	Streambed Aggridation Degradation (Feet)	Variation Index	Pools >1'	Pools %	Pools >2'	Pools %	Pools >3'	Pools %	Max Depth (Feet)	Longitudinal Cross Sectonal Area of Pools > 1' Deep (Sq Ft/1,000')
Watershed	Buckeye																
Buckeye Cr	Buc3	223	423	2000	1,800	25,588	0.32%		22.5	5	65%	2	25%	1	13%	4.1	563
Buckeye Cr	Buc3	223	897	2008	1,800	25,588											
Buckeye Cr	Buc1	231	34	1998	33,000	21,198	0.36%		27.0	8	68%	5	53%	3	35%	4.5	848
Buckeye Cr	Buc4	670	802	2006	59,000		0.58%		26.0	5	65%	1	27%	0	0%	2.6	504
Buckeye Cr	Buc8	672	695	2005	82,000		1.49%		68.8	11	51%	4	17%	2	9%	5.2	527
Buckeye Cr	Buc9	673	694	2005	87,000		1.64%		57.5	8	36%	3	17%	1	4%	3.4	365
Flat Ridge Cr	FLR2	602	692	2005	200		1.14%		88.6	9	50%	3	20%	1	11%	3.2	371
Franchini Cr	FRN1	667	803	2006	0		3.47%		30.6	14	33%	1	2%	1	2%	3.2	248
Grasshopper	GRS1	696	804	2006	14,000		2.22%		23.9	7	22%	2	4%	0	0%	2.4	148
NF Buckeye	NFB2	702	793	2005	100		0.62%		62.0	5	75%	2	44%	1	32%	3.1	769
Soda Springs	SSP1	671	792	2005	400		2.22%		68.3	8	24%	3	8%	1	1%	4.5	213
Watershed	Coastal Gualala																
Russian G	RuG1	471	421	2000	3,200		0.85%		37.7	6	43%	5	42%	0	0%	3.0	517
Salal Cr	Sal1	470	427	2000	4,000	259	4.69%		10.7	18	39%	4	10%	0	0%	2.2	303
School House	ScH	472	437	2000	1,400	347	5.86%		53.9	11	63%	0	0%	0	0%	1.8	459
Watershed	NF Gualala																
		690	899	2008	0												
Dry Cr	Dry3	211	302	1998	1,000	4,104	0.76%		22.2	7	45%	2	8%	2	8%	5.3	405
Dry Cr	Dry3	211	344	1999	1,000	4,104	0.72%	-0.10	20.2	8	42%	3	23%	1	8%	4.0	378
Dry Cr	Dry3	211	422	2000	1,000	4,104	0.74%	-0.07	20.6	8	41%	4	23%	1	4%	4.2	385
Dry Cr	Dry3	211	481	2001	1,000	4,104	0.69%	-0.10	19.5	7	47%	3	26%	1	5%	3.7	395
Dry Cr	Dry3	211	557	2002	1,000	4,104	0.70%	-0.39	17.5	6	43%	3	17%	1	7%	3.5	298
Dry Cr	Dry3	211	577	2003	1,000	4,104	0.74%	-0.33	22.1	6	56%	4	42%	2	26%	4.0	502
Dry Cr	Dry3	211	636	2004	1,000	4,104	0.77%	-0.27	29.4	5	41%	4	31%	2	13%	6.8	381
Dry Cr	Dry3	211	689	2005	1,000	4,104	0.75%	-0.22	29.1	4	34%	4	34%	2	16%	6.7	387
Dry Cr	Dry3	211	801	2006	1,000	4,104	0.80%	0.52	21.1	7	48%	5	37%	1	7%	3.0	393
Dry Cr	Dry3	211	874	2007	1,000	4,104	0.78%	0.54	19.9	6	33%	3	13%	2	9%	4.2	313
Dry Cr	Dry3	211	902	2008	1,000	4,104											
Dry Cr	Dry2	212	425	2000	6,800	3,756	1.82%		12.8	5	32%	0	0%	0	0%	2.0	267
Dry Cr	Dry2	212	945	2008	6,800	3,756											
LNF Gualala	LNF3	404	480	2001	2,400	4,217	0.57%		33.2	5	63%	4	53%	2	30%	3.5	577
LNF Gualala	LNF3	404	635	2004	2,400	4,217	0.79%	-0.61	56.8	9	77%	4	45%	2	27%	5.0	978

Stream	Station				Distance up Stream (Feet)	Drainage Area (Acres)	Slope	Streambed Aggridation Degradation (Feet)	Variation Index	Pools						Max Depth (Feet)	Longitudinal Cross Sectonal Area of Pools > 1' Deep (Sq Ft/1,000')
	Name	#	Visit ID	Year						>1'	%	>2'	%	>3'	%		
LNF Gualala	LNF1	203	33	1998	12,000	1,963	1.54%		23.3	8	35%	0	0%	0	0%	2.0	264
LNF Gualala	LNF1	203	342	1999	12,000	1,963	1.52%	-0.19	21.1	9	38%	0	0%	0	0%	2.0	275
LNF Gualala	LNF1	203	419	2000	12,000	1,963	1.49%	-0.08	21.1	7	23%	0	0%	0	0%	1.9	150
LNF Gualala	LNF1	203	491	2001	12,000	1,963	1.49%	-0.10	20.3	7	23%	2	7%	0	0%	2.1	161
LNF Gualala	LNF1	203	558	2002	12,000	1,963	1.41%	-0.26	28.2	12	42%	4	14%	1	4%	3.2	304
LNF Gualala	LNF1	203	574	2003	12,000	1,963	1.42%	-0.40	29.8	13	39%	4	16%	1	3%	3.2	363
LNF Gualala	LNF1	203	634	2004	12,000	1,963	1.54%	-0.73	32.4	13	47%	6	25%	1	4%	3.1	374
LNF Gualala	LNF1	203	685	2005	12,000	1,963	1.35%	-0.93	31.4	11	42%	5	20%	1	6%	3.0	386
LNF Gualala	LNF1	203	799	2006	12,000	1,963	1.46%	-1.08	28.1	15	57%	3	14%	0	0%	2.9	436
LNF Gualala	LNF1	203	872	2007	12,000	1,963	1.49%	-0.38	30.5	15	56%	4	18%	1	3%	4.4	452
LNF Gualala	LNF1	203	901	2008	12,000	1,963											
NF Gualala	NFG4	473	477	2001	2,300	30,600	0.26%		27.6	6	65%	2	17%	1	11%	4.4	556
NF Gualala	NFG3	204	347	1999	6,600	25,433	0.37%		36.8	9	74%	3	32%	1	12%	4.7	654
NF Gualala	NFG3	204	495	2001	6,600	25,433	0.38%	-0.41	42.0	12	67%	4	38%	4	38%	4.9	770
NF Gualala	NFG3	204	878	2007	6,600	25,433											
NF Gualala	NFG3	204	898	2008	6,600	25,433	0.33%	-1.00	48.9	8	77%	8	77%	4	40%	5.8	972
Robinson E	Rbn1	697	686	2004	0		0.59%		22.8	6	41%	2	16%	1	13%	3.1	325
Robinson W	Rob2	207	345	1999	600	1,068	1.39%		13.1	2	5%	0	0%	0	0%	1.2	25
Watershed	Rockpile																
Rockpile Cr	Roc3	221	304	1998	2,650	22,373	0.27%		16.9	5	78%	4	74%	2	47%	3.2	822
Rockpile Cr	Roc3	221	349	1999	2,650	22,373	0.31%	-0.21	10.5	7	59%	2	24%	0	0%	2.3	410
Rockpile Cr	Roc3	221	576	2003	2,650	22,373	0.27%	-0.40	12.8	12	64%	4	23%	0	0%	2.8	497
Rockpile Cr	Roc1	401	806	2006	18,800	20,000	0.16%		29.1	4	76%	3	61%	3	61%	3.8	973
Rockpile Cr	Roc4	701	807	2006	32,000		0.24%		52.4	4	73%	3	64%	2	58%	6.2	1,123
Rockpile Cr	Roc4	701	900	2008	32,000												
Watershed	Russian Estuary																
Jenner G	Jen1	407	303	1998	3,200	2,000	3.26%		40.0	7	19%	2	3%	0	0%	3.0	151
Watershed	SF Gualala																
Big Pepperwood	Ppw3	218	305	1998	800	1,825	1.37%		14.3	7	45%	3	20%	0	0%	2.9	352
Big Pepperwood	Ppw3	218	343	1999	800	1,825	1.46%	-0.31	12.7	8	50%	2	15%	0	0%	2.6	420
Big Pepperwood	Ppw3	218	569	2002	800	1,825	1.40%	-0.68	13.4	12	43%	2	5%	1	3%	3.1	316
Big Pepperwood	Ppw3	218	575	2003	800	1,825	1.40%	-1.16	16.4	11	50%	5	32%	1	6%	3.7	489
Big Pepperwood	Ppw3	218	637	2004	800	1,825	1.43%	-1.02	14.5	12	54%	5	22%	0	0%	2.5	430
Big Pepperwood	Ppw3	218	687	2005	800	1,825	1.43%	-1.11	16.7	13	54%	4	21%	3	15%	3.6	473
Big Pepperwood	Ppw3	218	800	2006	800	1,825	1.56%	-1.20	16.2	10	56%	7	40%	1	5%	3.1	519
Big Pepperwood	Ppw3	218	873	2007	800	1,825	1.50%	-1.13	15.3	9	41%	5	20%	2	7%	3.4	414
Big Pepperwood	Ppw3	218	904	2008	800	1,825											
Carson Cr	Car1	631	639	2004	0		1.45%		41.8	8	42%	2	12%	1	5%	4.3	393
McKenzie	McK1	615	638	2004	0		1.24%		26.8	6	55%	3	37%	1	6%	4.5	437

Stream	Station Name	#	Visit ID	Year	Distance up Stream (Feet)	Drainage Area (Acres)	Slope	Streambed Aggridation Degradation (Feet)	Variation Index	Pools >1'	%	>2'	%	>3'	%	Max Depth (Feet)	Longitudinal Cross Sectonal Area of Pools > 1' Deep (Sq Ft/1,000')
SF Gualala	Gua1	217	306	1998	5,200	157,415	0.11%		23.1	4	79%	2	58%	2	58%	5.0	1,050
SF Gualala	Gua1	217	420	2000	5,200	157,415	0.03%	-0.10	22.4	4	52%	3	84%	1	49%	5.2	1,300
SF Gualala	Gua1	217	492	2001	5,200	157,415	0.07%	0.19	20.0	3	78%	2	61%	2	61%	4.6	1,068
SF Gualala	Gua1	217	568	2002	5,200	157,415	0.10%	0.01	26.6	3	69%	2	59%	2	59%	4.7	1,099
SF Gualala	Gua1	217	578	2003	5,200	157,415	1.10%	0.10	21.7	5	76%	2	63%	2	63%	4.2	1,077
SF Gualala	Gua1	217	633	2004	5,200	157,415	0.09%	0.18	25.6	2	55%	2	55%	2	55%	4.9	1,079
SF Gualala	Gua1	217	810	2006	5,200	157,415											
SF Gualala	Gua1	217	877	2007	5,200	157,415	0.13%	-0.23	21.0	5	75%	2	55%	2	55%	4.4	1,100
SF Gualala	Gua1	217	903	2008	5,200	157,415											
SF Gualala	SFG	402	346	1999	41,000	31,081	0.33%		21.0	5	62%	2	23%	1	15%	4.9	579
SF Gualala	SFG	402	896	2008	41,000	31,081											
Watershed	Wheatfield																
Redwood Cr	Rdw1	704	805	2006	2,000		6.90%		19.9	11	24%	1	4%	1	4%	3.5	202
SF Fuller	SFu1	663	776	2005	14,000		2.05%		24.3	9	36%	0	0%	0	0%	1.5	216
Wheatfield	WFG6	651	809	2006	0		0.63%		38.2	4	63%	3	58%	1	31%	3.8	746
Wheatfield	WFG7	652	808	2006	0		0.55%		26.4	4	66%	2	41%	0	0%	2.2	500
Wheatfield	Wfg3	226	426	2000	2,200	71,409											
Wheatfield	Wfg3	226	579	2003	2,200	71,409	0.70%		20.5	3	82%	2	79%	2	79%	5.1	1,785
Wheatfield	Wfg3	226	895	2008	2,200	71,409											

Stream Monitoring Report

Station		Miles	Year	Temperature: Seasonal Maximum	Temperature: MWAT	Large Wood (>=8" Bank Full): CuFt/ 1000'	Large Wood (>=8" Bank Full): Pieces/ 1000'	Substrate: < 0.85 mm	Substrate: D50	Streambed: Slope	Streambed: VI	Streambed: A/D	Riparian Zone: Canopy % WLPZ	Riparian Zone: Canopy % Cr.	Riparian Zone: Basal Area	Riparian Zone: Tree Ht.	Fish per Mile: Coho	Fish per Mile: SH (1+)	Macroinvertebrates: Richness	Macroinvertebrates: Simpson	Macroinvertebrates: Hilsenhoff	Macroinvertebrates: Russian R Index	Macroinvertebrates: % Dominant
Hydrologic Unit			NF Gualala																				
Stream																							
690		0.00	2008																				
			Avg																				
Stream			**BILLINGS CR**																				
698	Bil	0.00	2004	25.2	21.6																		
			Avg	25.2	21.6																		
Stream			**Doty Creek**																				
256	Dot2	0.02	1993					16.2%															
256	Dot2	0.02	1994	14.1	12.9			11.4%															
256	Dot2	0.02	1995					16.9%															
256	Dot2	0.02	1996					16.9%															
256	Dot2	0.02	1997					17.0%															
281		0.02	1998	14.8	13.7																		
			Avg	14.4	13.3			15.7%															
Stream			**Dry Creek**																				
213		0.00	1995	17.0	16.0																		
213		0.00	1996	17.3	16.1																		
213		0.00	1997	17.8	16.4																		
211	Dry3	0.19	1995	17.7	15.7			16.8%															
211	Dry3	0.19	1996	17.7	15.9			14.7%															
211	Dry3	0.19	1997	16.9	15.2			11.6%															
211	Dry3	0.19	1998			3,138	56		48	0.76%	22						16						
211	Dry3	0.19	1999			2,822	56		58	0.72%	20	-0.10	86%	87%	210	89	0	148					
211	Dry3	0.19	2000	16.5	14.8	2,834	49		60	0.74%	21	-0.07	84%	77%			0	48	32	0.79	4.4	16	40
211	Dry3	0.19	2001	16.4	14.1	5,353	85		56	0.69%	19	-0.10					0	127					
211	Dry3	0.19	2002	15.6	14.0	6,149	91		62	0.70%	17	-0.39					11	143					
211	Dry3	0.19	2003	16.1	14.9	5,993	87		43	0.74%	22	-0.33					0	174					
211	Dry3	0.19	2004	14.8	13.7	5,580	85		38	0.77%	29	-0.27					23	175					
211	Dry3	0.19	2005	16.4	15.0	6,334	89		36	0.75%	29	-0.22											
211	Dry3	0.19	2006			6,706	85		29	0.80%	21	0.52											
211	Dry3	0.19	2007			6,665	87		26	0.78%	20	0.54											

Station		Miles	Year	Temperature		Large Wood (>=8" Bank Full)		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
211	Dry3	0.19	2008			7,037	105		21				93%	82%									
212	Dry2	1.29	1995	20.9	17.9																		
212	Dry2	1.29	1996	20.7	17.8																		
212	Dry2	1.29	1997	20.5	17.9																		
212	Dry2	1.29	1998	20.6	17.6																		
212	Dry2	1.29	2000			2,477	38			1.82%	13		76%	56%	81	60			41	0.92	4.5	22	19
212	Dry2	1.29	2004														0	500					
212	Dry2	1.29	2005	17.9	16.1																		
212	Dry2	1.29	2008			2,190	29		36				87%	85%									
			Avg	**17.7**	**15.8**	**4,867**	**72**	**14.2%**	**43**	**0.84%**	**21**	**-0.05**	**85%**	**77%**	**146**	**75**	**6**	**188**	**37**	**0.86**	**4.5**	**19**	**30**
Stream			**Little North Fork Gualala**																				
201	LNF5	0.02	1992					10.9%															
201	LNF5	0.02	1993					21.0%															
201	LNF5	0.02	1994	15.8	14.7			20.4%															
201	LNF5	0.02	1995	16.7	15.1			20.8%															
201	LNF5	0.02	1996	15.9	14.6			15.4%															
201	LNF5	0.02	1997	16.7	15.4			16.0%															
201	LNF5	0.02	1998	16.3	15.0																		
201	LNF5	0.02	2001	16.5	14.8																		
201	LNF5	0.02	2003	16.1	15.0																		
201	LNF5	0.02	2004	16.9	15.7																		
201	LNF5	0.02	2005	15.6	14.5																		
404	LNF3	0.45	1997																				
404	LNF3	0.45	1998														16						
404	LNF3	0.45	2001			5,250	83		34	0.57%	33		97%	96%	163	75							
404	LNF3	0.45	2003														0	589					
404	LNF3	0.45	2004			5,204	71		33	0.79%	57	-0.61					0	70					
202	LNF2	1.47	1993					11.5%															
202	LNF2	1.47	1994	16.4	14.6			14.6%															
202	LNF2	1.47	1995					18.8%															
202	LNF2	1.47	1996					17.2%															
202	LNF2	1.47	1997					21.6%															
202	LNF2	1.47	1998														32						
202	LNF2	1.47	2003														0	322					
202	LNF2	1.47	2004														0	391					

Station		Miles	Year	Temperature		Large Wood (>=8" Bank Full)		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
274	LNF8	1.68	1995	16.4	14.6																		
274	LNF8	1.68	1996	16.1	14.1																		
203	LNF1	2.27	1993					17.1%															
203	LNF1	2.27	1994	15.1	13.6			20.4%															
203	LNF1	2.27	1995	15.8	14.2			11.6%															
203	LNF1	2.27	1996	15.3	13.7			19.6%															
203	LNF1	2.27	1997	15.8	14.5			18.8%															
203	LNF1	2.27	1998	15.2	13.9	2,997	65		25	1.54%	23						0						
203	LNF1	2.27	1999	15.1	13.8	3,667	78		43	1.52%	21	-0.19	87%	89%	298	100	0	285					
203	LNF1	2.27	2000	15.3	13.9	3,792	75		46	1.49%	21	-0.08					0	143	31	0.85	4.5	19	30
203	LNF1	2.27	2001	15.2	13.5	4,854	130		42	1.49%	20	-0.10					0	148					
203	LNF1	2.27	2002	14.5	13.0	4,963	135		65	1.41%	28	-0.26					0	169					
203	LNF1	2.27	2003	15.2	14.0	4,840	141		60	1.42%	30	-0.40					0	235					
203	LNF1	2.27	2004	15.6	14.2	4,686	143		42	1.54%	32	-0.73					0	666					
203	LNF1	2.27	2005	14.9	13.6	5,803	136		40	1.35%	31	-0.93											
203	LNF1	2.27	2006			5,290	129		36	1.46%	28	-1.08											
203	LNF1	2.27	2007			5,438	129		31	1.49%	31	-0.38											
203	LNF1	2.27	2008			5,759	148		23				86%	88%	391	83		58					
408	LNF7	2.37	2005	14.9	13.7																		
255	LNF6	2.86	1993					19.4%															
255	LNF6	2.86	1994	15.9	14.3			17.2%															
255	LNF6	2.86	1995					11.9%															
255	LNF6	2.86	1996					24.4%															
255	LNF6	2.86	1997					27.8%															
			Avg	**15.7**	**14.3**	**4,811**	**113**	**17.8%**	**40**	**1.34%**	**30**	**-0.5**	**90%**	**91%**	**284**	**86**	**4**	**280**	**31**	**0.85**	**4.5**	**19**	**30**
Stream			**Lost Creek**																				
215		0.04	1995	16.4	15.3																		
215		0.04	1996	15.8	15.1																		
215		0.04	1998	17.0	15.9																		
			Avg	**16.4**	**15.4**																		
Stream			**McGann Gulch**																				
209	MGG2	0.08	1995	16.7	15.9			19.2%															
209	MGG2	0.08	1996	16.4	15.6			26.8%															
209	MGG2	0.08	1997	15.5	14.4			19.9%															
209	MGG2	0.08	2003														0	104					

Station		Miles	Year	Temperature		Large Wood (>=8" Bank Full)		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
210	MGG1	0.42	1995	20.4	16.4																		
210	MGG1	0.42	2002	14.2	13.9																		
210	MGG1	0.42	2003	14.8	14.6																		
210	MGG1	0.42	2004	14.9	14.5																		
			Avg	16.1	15.0			22.0%									0	104					
Stream			North Fork Gualala																				
251		0.06	1996	19.0	16.6																		
251		0.06	1997	19.3	17.5																		
251		0.06	2000	19.0	16.4																		
473	NFG4	0.44	2001	19.3	16.6	2,530	68		26	0.26%	28		93%	84%	148	72							
473	NFG4	0.44	2003														0	291					
204	NFG3	1.25	1995	20.6	17.5																		
204	NFG3	1.25	1996	20.1	18.7																		
204	NFG3	1.25	1997	19.4	18.2																		
204	NFG3	1.25	1998	20.2	17.7												0						
204	NFG3	1.25	1999			2,186	39		19	0.37%	37		64%	46%	140	73	0	109					
204	NFG3	1.25	2000	19.9	17.0												0	698					
204	NFG3	1.25	2001	18.6	16.7	2,932	99		24	0.38%	42	-0.41					0	84					
204	NFG3	1.25	2002														0	317					
204	NFG3	1.25	2003														0	255					
204	NFG3	1.25	2007			3,166	57		15														
204	NFG3	1.25	2008			3,006	63		28				80%	69%				79					
258		3.83	1994	24.5	19.3																		
205		4.94	1995	21.4	17.7																		
205		4.94	1996	20.4	17.8																		
205		4.94	1997	21.1	18.1																		
205		4.94	2001	19.3	17.0																		
406	NFG2	5.38	1997																				
406	NFG2	5.38	1998	21.4	18.6																		
406	NFG2	5.38	2004														0	303					
474	NFG	6.08	2001	22.4	18.4																		
474	NFG	6.08	2002	20.9	18.7																		
474	NFG	6.08	2003	22.1	19.3																		
474	NFG	6.08	2004	20.5	18.8																		
214		7.99	1995	23.9	21.0																		

Station		Miles	Year	Temperature: Seasonal Maximum	Temperature: MWAT	Large Wood (>=8" Bank Full): CuFt/ 1000'	Large Wood (>=8" Bank Full): Pieces/ 1000'	Substrate: < 0.85 mm	Substrate: D50	Streambed: Slope	Streambed: VI	Streambed: A/D	Riparian Zone: Canopy % WLPZ	Riparian Zone: Canopy % Cr.	Riparian Zone: Basal Area	Riparian Zone: Tree Ht.	Fish per Mile: Coho	Fish per Mile: SH (1+)	Macroinvertebrates: Richness	Macroinvertebrates: Simpson	Macroinvertebrates: Hilsenhoff	Macroinvertebrates: Russian R Index	Macroinvertebrates: % Dominant
214		7.99	1996	23.7	21.1																		
214		7.99	1997	24.0	21.2																		
214		7.99	1998	24.3	21.4																		
214		7.99	2004														0	1,081					
272		9.09	1994	24.5	21.4																		
272		9.09	2001	24.1	21.0																		
216	NFG1	9.85	1995	25.9	21.5																		
216	NFG1	9.85	1996	26.4	21.8																		
216	NFG1	9.85	1997	26.9	22.0																		
216	NFG1	9.85	2003														0	236					
691	NFG5	12.22	2004	24.4	21.0																		
			Avg	21.9	19.0	2,764	65		22	0.34%	35	-0.4	79%	66%	144	72	0	346					
Stream			**Peaches Creek**																				
269		0.30	1994	16.2	15.7																		
269		0.30	1998	17.5	16.0																		
			Avg	16.9	15.8																		
Stream			**Robinson Cr East**																				
697	Rbn1	0.00	2004			591	7		26	0.59%	23												
692	Rbn	0.00	2004	20.6	17.9																		
			Avg	20.6	17.9	591	7		26	0.59%	23												
Stream			**Robinson Cr West**																				
260	Rob	0.01	1994	14.6	13.8																		
206		0.04	1995	20.4	14.2																		
206		0.04	1996	16.9	14.2																		
206		0.04	1997	16.4	13.8																		
206		0.04	1998	16.5	14.4																		
206		0.04	2000	18.0	14.0																		
207	Rob2	0.11	1995	19.6	15.8			15.2%															
207	Rob2	0.11	1996	19.6	15.7			18.1%															
207	Rob2	0.11	1997	20.2	16.2			17.9%															
207	Rob2	0.11	1998	18.5	15.4												12						
207	Rob2	0.11	1999			1,643	49		36	1.39%	13		66%	74%	246	95	0	113					
207	Rob2	0.11	2000	17.2	14.7												0	422					
207	Rob2	0.11	2001														0	13					
207	Rob2	0.11	2003														0	100					

Station		Miles	Year	Temperature		Large Wood (>=8" Bank Full)		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
207	Rob2	0.11	2004															361					
207	Rob2	0.11	2005	14.8	14.1																		
207	Rob2	0.11	2008															21					
409	Rob	0.57	2005	16.0	14.6																		
263	Rob	0.78	1994	17.7	15.5																		
263	Rob	0.78	2003														0	101					
263	Rob	0.78	2004														0	317					
208	Rob1	1.29	1995	16.6	14.9																		
208	Rob1	1.29	1996	16.4	15.0																		
208	Rob1	1.29	1997	16.7	14.9																		
208	Rob1	1.29	1998	16.2	14.9																		
208	Rob1	1.29	2003														0	76					
			Avg	**17.3**	**14.8**	**1,643**	**49**	**17.1%**	**36**	**1.39%**	**13**		**66%**	**74%**	**246**	**95**	**1**	**169**					
Hydrologic Unit				Rockpile																			
Stream			**Dynamite Cr.**																				
478	Dyn1	0.00	2002	14.8	13.4																		
			Avg	**14.8**	**13.4**																		
Stream			**Emily Creek**																				
276	Emy	0.07	1997	15.2	14.1																		
276	Emy	0.07	1998	15.0	13.9																		
276	Emy	0.07	2002	14.3	13.3																		
			Avg	**14.8**	**13.8**																		
Stream			**Horsethief Canyon**																				
681	Hor1	0.00	2004	17.5	17.0																		
			Avg	**17.5**	**17.0**																		
Stream			**Rockpile Creek**																				
221	Roc3	0.50	1995	23.1	19.6																		
221	Roc3	0.50	1996	22.4	19.3																		
221	Roc3	0.50	1997	22.4	19.7																		
221	Roc3	0.50	1998	23.2	19.8	1,291	18		25	0.27%	17						0	677					
221	Roc3	0.50	1999			2,504	33		31	0.31%	10	-0.21	90%	37%	272	90	0	11					
221	Roc3	0.50	2000	22.7	18.8												0	169					
221	Roc3	0.50	2001	21.5	18.4												0	53					
221	Roc3	0.50	2002	22.7	17.5												0	48					
221	Roc3	0.50	2003	21.7	19.0	2,385	28		19	0.27%	13	-0.40					0	67					

Station		Miles	Year	Temperature: Seasonal Maximum	Temperature: MWAT	Large Wood (>=8" Bank Full): CuFt/ 1000'	Large Wood (>=8" Bank Full): Pieces/ 1000'	Substrate: < 0.85 mm	Substrate: D50	Streambed: Slope	Streambed: VI	Streambed: A/D	Riparian Zone: Canopy % WLPZ	Riparian Zone: Canopy % Cr.	Riparian Zone: Basal Area	Riparian Zone: Tree Ht.	Fish per Mile: Coho	Fish per Mile: SH (1+)	Macroinvertebrates: Richness	Macroinvertebrates: Simpson	Macroinvertebrates: Hilsenhoff	Macroinvertebrates: Russian R Index	Macroinvertebrates: % Dominant
221	Roc3	0.50	2004	21.7	18.6												0	20					
221	Roc3	0.50	2008															11					
275	Roc2	1.93	1997	20.1	19.5																		
275	Roc2	1.93	1998	23.9	20.2												0	508					
275	Roc2	1.93	2004	20.2	18.7																		
275	Roc2	1.93	2005	19.0	17.7																		
222		2.65	1994	21.9	19.4																		
222		2.65	1995	23.5	19.7																		
222		2.65	1997	22.4	19.8																		
401	Roc1	3.56	1998	23.7	20.8																		
401	Roc1	3.56	2006			5,424	57		24	0.16%	29		99%	58%	478	86							
701	Roc4	6.06	2006			2,961	36		34	0.24%	52		83%	60%	265	67							
701	Roc4	6.06	2008																				
680	Roc	7.77	2004	24.8	21.2																		
683	Roc5	8.71	2004	24.0	20.6																		
			Avg	**22.4**	**19.3**	**2,913**	**34**		**27**	**0.25%**	**24**	**-0.3**	**91%**	**52%**	**338**	**81**	**0**	**174**					

Hydrologic Unit Buckeye

Stream Buckeye Creek

Station		Miles	Year	Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
235	Buc	0.23	1994	21.1	18.3																		
223	Buc3	0.34	1996	21.4	18.8																		
223	Buc3	0.34	1997	22.4	19.5																		
223	Buc3	0.34	1998	22.7	19.7												0	459					
223	Buc3	0.34	1999	21.1	18.0												0	0					
223	Buc3	0.34	2000			2,977	57		33	0.32%	23		81%	56%	143	99	0	194	32	0.88	4.0	19	26
223	Buc3	0.34	2001	21.1	18.0												0	67					
223	Buc3	0.34	2002														0	137					
223	Buc3	0.34	2003														0	315					
223	Buc3	0.34	2004	21.3	17.9												0	46					
223	Buc3	0.34	2008			2,206	70		22				80%	54%				258					
224	Buc2	3.01	1995	23.9	19.9																		
224	Buc2	3.01	1996	22.1	19.3																		
224	Buc2	3.01	1997	22.7	19.8																		
224	Buc2	3.01	2000	20.9	18.1																		
224	Buc2	3.01	2003														0	287					
231	Buc1	6.25	1994	21.7	19.7																		

Station		Miles	Year	Temperature		Large Wood (>=8" Bank Full)		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
231	Buc1	6.25	1995	24.4	20.9																		
231	Buc1	6.25	1996	23.7	20.8																		
231	Buc1	6.25	1997	23.7	21.1																		
231	Buc1	6.25	1998	24.0	21.0	231	9		25	0.36%	27												
231	Buc1	6.25	2001	24.3	20.5																		
231	Buc1	6.25	2002	21.2	17.8																		
670	Buc4	11.17	2006	26.3	22.2	920	7		15	0.58%	26		100%	89%	323	64							
601	Buc7	12.31	2000	26.0	21.0																		
601	Buc7	12.31	2001	25.6	20.9																		
601	Buc7	12.31	2004	25.6	20.9																		
601	Buc7	12.31	2005	24.0	20.5																		
672	Buc8	15.53	2005	18.0	16.5	232	6		71	1.49%	69		33%	36%	76	84							
672	Buc8	15.53	2006	24.4	19.4																		
673	Buc9	16.48	2005			325	20		60	1.64%	58		28%	29%	106	82							
673	Buc9	16.48	2006	26.7	22.8																		
			Avg	**23.1**	**19.7**	**1,148**	**28**		**38**	**0.88%**	**40**		**64%**	**53%**	**162**	**82**	**0**	**196**	**32**	**0.88**	**4.0**	**19**	**26**
Stream			**Flat Ridge Creek**																				
602	FLR2	0.04	2000	25.6	20.9																		
602	FLR2	0.04	2001	25.2	20.5																		
602	FLR2	0.04	2005			1,193	20		47	1.14%	89		12%	11%	155	88							
602	FLR2	0.04	2006	25.8	22.6																		
674	FLT	0.38	2005	19.5	16.7																		
			Avg	**24.0**	**20.2**	**1,193**	**20**		**47**	**1.14%**	**89**		**12%**	**11%**	**155**	**88**							
Stream			**Franchini Creek**																				
667	FRN1	0.00	2005	16.5	14.9																		
667	FRN1	0.00	2006	18.7	16.4	4,633	151		32	3.47%	31		75%	97%	228	59							
			Avg	**17.6**	**15.6**	**4,633**	**151**		**32**	**3.47%**	**31**		**75%**	**97%**	**228**	**59**							
Stream			**Grasshopper Creek**																				
696	GRS1	2.65	2006			7,968	191		28	2.22%	24		82%	88%	406	65							
			Avg			**7,968**	**191**		**28**	**2.22%**	**24**		**82%**	**88%**	**406**	**65**							
Stream			**Meg Creek**																				
286		0.01	1998	15.1	14.3																		
286		0.01	2002	15.0	13.3																		
			Avg	**15.0**	**13.8**																		
Stream			**North Fork Buckeye Creek**																				

Station		Miles	Year	Temperature Seasonal Maximum	Temperature MWAT	Large Wood (>=8" Bank Full) CuFt/ 1000'	Large Wood (>=8" Bank Full) Pieces/ 1000'	Substrate < 0.85 mm	Substrate D50	Streambed Slope	Streambed VI	Streambed A/D	Riparian Zone Canopy % WLPZ	Riparian Zone Canopy % Cr.	Riparian Zone Basal Area	Riparian Zone Tree Ht.	Fish per Mile Coho	Fish per Mile SH (1+)	Macroinvertebrates Richness	Macroinvertebrates Simpson	Macroinvertebrates Hilsenhoff	Macroinvertebrates Russian R Index	Macroinvertebrates % Dominant
702	NFB2	0.02	2005			771	12		40	0.62%	62		96%	82%	318	59							
			Avg			771	12		40	0.62%	62		96%	82%	318	59							
Stream			Soda Springs Creek																				
671	SSP1	0.08	2005			1,303	85		66	2.22%	68		100%	94%	251	74							
671	SSP1	0.08	2006	19.7	17.9																		
			Avg	19.7	17.9	1,303	85		66	2.22%	68		100%	94%	251	74							
Hydrologic Unit						Wheatfield																	
Stream			Annapolis Falls Creek																				
901	97-3	0.08	1999	15.7	14.5																		
			Avg	15.7	14.5																		
Stream			Elk Creek																				
706	Elk	0.00	2005	18.4	16.3																		
706	Elk	0.00	2006	21.0	18.4																		
			Avg	19.7	17.4																		
Stream			Fuller Creek																				
902	Ful	0.06	1999	24.0	18.9																		
608	Ful1	0.38	2001	21.0	17.8																		
608	Ful1	0.38	2002	20.6	17.5																		
606	Ful	3.03	2001	23.2	18.5																		
606	Ful	3.03	2002	22.9	18.4																		
606	Ful	3.03	2004	21.7	18.2																		
606	Ful	3.03	2005	20.6	18.0																		
606	Ful	3.03	2006	23.6	19.8																		
			Avg	22.2	18.4																		
Stream			Jennifer Creek																				
228		0.19	1995	14.5	13.9																		
228		0.19	1996	14.0	13.4																		
228		0.19	1997	14.8	14.2																		
228		0.19	1998	14.1	13.6																		
228		0.19	2002	16.3	13.1																		
			Avg	14.7	13.6																		
Stream			North Fork Fuller Creek																				
619	NFU	0.02	2000	22.7	18.8																		
619	NFU	0.02	2001	22.7	18.3																		
619	NFU	0.02	2002	22.1	17.9																		

Station		Miles	Year	Temperature Seasonal Maximum	Temperature MWAT	Large Wood (>=8" Bank Full) CuFt/ 1000'	Large Wood (>=8" Bank Full) Pieces/ 1000'	Substrate < 0.85 mm	Substrate D50	Streambed Slope	Streambed VI	Streambed A/D	Riparian Zone Canopy % WLPZ	Riparian Zone Canopy % Cr.	Riparian Zone Basal Area	Riparian Zone Tree Ht.	Fish per Mile Coho	Fish per Mile SH (1+)	Macroinvertebrates Richness	Macroinvertebrates Simpson	Macroinvertebrates Hilsenhoff	Macroinvertebrates Russian R Index	Macroinvertebrates % Dominant
619	NFU	0.02	2004	20.3	17.4																		
619	NFU	0.02	2005	20.1	16.9																		
619	NFU	0.02	2006	23.2	19.6																		
665	NFu2	1.14	2004	18.1	16.3																		
			Avg	**21.3**	**17.9**																		
Stream			**Redwood Creek**																				
704	Rdw1	0.38	2006	20.6	19.7	4,774	148		26	6.90%	20		79%	97%	125	52							
			Avg	**20.6**	**19.7**	**4,774**	**148**		**26**	**6.90%**	**20**		**79%**	**97%**	**125**	**52**							
Stream			**South Fork Fuller Creek**																				
618	SFU	0.02	2000	22.5	19.1																		
618	SFU	0.02	2001	22.5	18.7																		
618	SFU	0.02	2002	22.1	18.2																		
618	SFU	0.02	2004	19.1	17.4																		
618	SFU	0.02	2005	21.0	18.3																		
618	SFU	0.02	2006	23.2	20.1																		
662	SFu2	1.52	2004	21.8	18.4																		
663	SFu1	2.65	2005			4,280	61		61	2.05%	24				129	44							
			Avg	**21.7**	**18.6**	**4,280**	**61**		**61**	**2.05%**	**24**				**129**	**44**							
Stream			**Wheatfield Fork Gualala River**																				
651	WFG6	0.00	2006	27.0	23.5	10	1		49	0.63%	38		66%	18%	82	40							
652	WFG7	0.00	2006	27.9	25.8	107	1		22	0.55%	26		87%	63%	188	44							
707	WFG	0.00	2006	24.4	22.0																		
708	WFG	0.00	2006	26.3	24.3																		
226	Wfg3	0.42	1995	25.5	20.9																		
226	Wfg3	0.42	1996	23.8	20.3																		
226	Wfg3	0.42	1997	23.1	21.9																		
226	Wfg3	0.42	1998	24.7	21.7												0	981					
226	Wfg3	0.42	2000			1,829	22		27				86%	40%	158	101			32	0.85	4.3	15	32
226	Wfg3	0.42	2001	23.2	20.0																		
226	Wfg3	0.42	2002														0	60					
226	Wfg3	0.42	2003			1,304	19		21	0.70%	21						0	182					
226	Wfg3	0.42	2008			1,632	30		16				81%	15%				137					
227	Wfg2	2.69	1996	24.0	21.2																		
227	Wfg2	2.69	1997	25.3	22.2																		
227	Wfg2	2.69	1998	24.3	21.5																		

Station		Miles	Year	Temperature Seasonal Maximum	MWAT	Large Wood (>=8" Bank Full) CuFt/ 1000'	Pieces/ 1000'	Substrate < 0.85 mm	D50	Streambed Slope	VI	A/D	Riparian Zone Canopy % WLPZ	Cr.	Basal Area	Tree Ht.	Fish per Mile Coho	SH (1+)	Macroinvertebrates Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
227	Wfg2	2.69	2000	25.3	21.2																		
227	Wfg2	2.69	2003														0	286					
403	WFG1	5.28	1997																				
403	WFG1	5.28	1998	26.4	22.9																		
403	WFG1	5.28	2000																				
273		5.45	1995	26.4	22.0																		
603	WFG	7.29	2001																				
603	WFG	7.29	2002	24.0	21.6																		
612	WFG	7.58	2001	25.6	22.4																		
612	WFG	7.58	2002	25.6	22.4																		
620	WFG4	8.90	2000	27.8	23.1																		
620	WFG4	8.90	2001	26.0	23.1																		
620	WFG4	8.90	2002	26.3	23.0																		
620	WFG4	8.90	2004	25.7	21.9																		
			Avg	25.4	22.2	976	15		27	0.63%	28		80%	34%	143	62	0	329	32	0.85	4.3	15	32

Hydrologic Unit SF Gualala

Stream Big Pepperwood

Station		Miles	Year	Temperature Seasonal Maximum	MWAT	Large Wood (>=8" Bank Full) CuFt/ 1000'	Pieces/ 1000'	Substrate < 0.85 mm	D50	Streambed Slope	VI	A/D	Riparian Zone Canopy % WLPZ	Cr.	Basal Area	Tree Ht.	Fish per Mile Coho	SH (1+)	Macroinvertebrates Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
218	Ppw3	0.15	1994	15.9	14.4																		
218	Ppw3	0.15	1995	16.5	15.0																		
218	Ppw3	0.15	1996	16.2	14.3																		
218	Ppw3	0.15	1997	17.3	15.6																		
218	Ppw3	0.15	1998	17.2	15.2	2,500	89		41	1.37%	14						0	153					
218	Ppw3	0.15	1999	15.9	14.4	2,310	80		30	1.46%	13	-0.31	90%	88%	348	87	0	132					
218	Ppw3	0.15	2000	16.2	14.5												0	21	32	0.79	4.7	15	39
218	Ppw3	0.15	2001														0	48					
218	Ppw3	0.15	2002	15.6	14.1	6,519	161		45	1.40%	13	-0.68	96%	87%	563	58	0	37					
218	Ppw3	0.15	2003	15.5	14.1	6,167	143		35	1.40%	16	-1.16											
218	Ppw3	0.15	2004	16.0	14.7	6,696	142		28	1.43%	15	-1.02					0	28					
218	Ppw3	0.15	2005	15.6	14.2	6,809	142		37	1.43%	17	-1.11											
218	Ppw3	0.15	2006			9,167	159		22	1.56%	16	-1.20											
218	Ppw3	0.15	2007			7,510	148		35	1.50%	15	-1.13											
218	Ppw3	0.15	2008			9,606	192		31				90%	87%				5					
219	Ppw2	1.29	1995	17.0	14.9																		
219	Ppw2	1.29	1996	16.7	14.7																		
219	Ppw2	1.29	1997	17.8	15.0																		

Station		Miles	Year	Temperature Seasonal Maximum	Temperature MWAT	Large Wood (>=8" Bank Full) CuFt/ 1000'	Large Wood (>=8" Bank Full) Pieces/ 1000'	Substrate < 0.85 mm	Substrate D50	Streambed Slope	Streambed VI	Streambed A/D	Riparian Zone Canopy % WLPZ	Riparian Zone Canopy % Cr.	Riparian Zone Basal Area	Riparian Zone Tree Ht.	Fish per Mile Coho	Fish per Mile SH (1+)	Macroinvertebrates Richness	Macroinvertebrates Simpson	Macroinvertebrates Hilsenhoff	Macroinvertebrates Russian R Index	Macroinvertebrates % Dominant
219	Ppw2	1.29	1998	17.3	14.9																		
248		1.33	1994	17.2	14.6																		
			Avg	**16.5**	**14.7**	**6,365**	**140**		**34**	**1.44%**	**15**	**-0.9**	**92%**	**87%**	**455**	**72**	**0**	**61**	**32**	**0.79**	**4.7**	**15**	**39**
Stream			**Camper Creek**																				
699	Cmp	0.00	2004	17.9	16.5																		
699	Cmp	0.00	2005	17.9	16.3																		
			Avg	**17.9**	**16.4**																		
Stream			**Carson Cr**																				
605	Car	0.00	2004	16.8	15.6																		
605	Car	0.00	2005	18.1	16.8																		
631	Car1	0.00	2004			2,724	39		39	1.45%	42		88%	98%	143	106							
			Avg	**17.4**	**16.2**	**2,724**	**39**		**39**	**1.45%**	**42**		**88%**	**98%**	**143**	**106**							
Stream			**Groshong Gulch**																				
250	Gros	0.05	1996	14.1	13.1																		
250	Gros	0.05	2002	16.2	13.3																		
277	GrG	0.27	1998	13.9	13.4																		
277	GrG	0.27	2000	17.8	14.5																		
			Avg	**15.5**	**13.6**																		
Stream			**Gualala River**																				
614	Gua8	0.00	2000	22.9	18.4																		
614	Gua8	0.00	2001																				
			Avg	**22.9**	**18.4**																		
Stream			**Little Pepperwood**																				
220	Lpw	0.11	1994	15.8	14.3																		
220	Lpw	0.11	1995	19.4	16.0																		
220	Lpw	0.11	1996	17.8	15.0																		
220	Lpw	0.11	1997	16.7	16.0																		
220	Lpw	0.11	1998	17.8	15.6																		
220	Lpw	0.11	2002	15.1	13.8																		
220	Lpw	0.11	2003	15.9	14.8												0	121					
220	Lpw	0.11	2004	14.8	14.3												0	8					
220	Lpw	0.11	2005	16.0	14.6																		
			Avg	**16.6**	**14.9**												**0**	**65**					
Stream			**Marshall Creek**																				
607	Mar	0.00	2004	22.5	19.7																		
			Avg	**22.5**	**19.7**																		

Station		Miles	Year	Temperature		Large Wood (>=8" Bank Full)		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
Stream			McKenzie Creek																				
615	McK1	0.00	2000	16.0	15.1																		
615	McK1	0.00	2001	20.6	17.5																		
615	McK1	0.00	2004	19.8	17.5	997	8		38	1.24%	27		95%	95%	262	133							
615	McK1	0.00	2005	20.2	17.8																		
617	McK1	0.00	2000	20.7	18.3																		
617	McK1	0.00	2001	20.2	17.5																		
617	McK1	0.00	2003	20.6	18.7																		
617	McK1	0.00	2004	18.7	17.2																		
617	McK1	0.00	2005	20.6	18.1																		
			Avg	**19.7**	**17.5**	**997**	**8**		**38**	**1.24%**	**27**		**95%**	**95%**	**262**	**133**							
Stream			Palmer Creek																				
621	Plm	0.00	2000	23.6	19.3																		
621	Plm	0.00	2001																				
621	Plm	0.00	2003	20.5	18.2																		
621	Plm	0.00	2004	20.6	17.5																		
621	Plm	0.00	2005	20.6	17.9																		
			Avg	**21.3**	**18.2**																		
Stream			South Fork Gualala River																				
217	Gua1	0.98	1994	22.7	19.2																		
217	Gua1	0.98	1995	25.3	20.6																		
217	Gua1	0.98	1996	24.4	20.1																		
217	Gua1	0.98	1997	24.6	22.4																		
217	Gua1	0.98	1998			943	18		24	0.11%	23		93%	16%									
217	Gua1	0.98	1999														0	32					
217	Gua1	0.98	2000	23.2	19.2	643	14		25	0.03%	22	-0.10	96%	17%	239	90	0	21	28	0.87	4.4	16	28
217	Gua1	0.98	2001	23.3	19.1	1,650	38		20	0.07%	20	0.19					0	11					
217	Gua1	0.98	2002			1,444	29		22	0.10%	27	0.01					0						
217	Gua1	0.98	2003			1,009	27		12	1.10%	22	0.10					0	149					
217	Gua1	0.98	2004	23.2	20.0	1,170	29		19	0.09%	26	0.18					0	97					
217	Gua1	0.98	2006			615	13		20														
217	Gua1	0.98	2007			595	16		15	0.13%	21	-0.23											
217	Gua1	0.98	2008			843	25		19									26					
225		4.36	1995	24.8	20.8																		
225		4.36	1997	22.1	20.6																		

Station		Miles	Year	Temperature		Large Wood (>=8" Bank Full)		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
229		7.39	1995	23.4	19.9																		
229		7.39	1996	22.1	19.0																		
229		7.39	1997	25.6	20.5																		
402	SFG	7.77	1998	22.1	19.7												0	961					
402	SFG	7.77	1999			1,459	33		18	0.33%	21		76%	26%	197	108	0	400					
402	SFG	7.77	2000	22.4	18.9												0	268					
402	SFG	7.77	2001														0	153					
402	SFG	7.77	2002														0	121					
402	SFG	7.77	2008															1,327					
230	SFG	9.32	1995	22.9	18.9																		
230	SFG	9.32	1996	21.8	18.4																		
230	SFG	9.32	1997	24.4	22.3																		
230	SFG	9.32	1998	22.6	19.5																		
616	SFG4	33.52	2000	19.4	16.7																		
616	SFG4	33.52	2001	19.8	16.4																		
616	SFG4	33.52	2003	19.5	17.4																		
616	SFG4	33.52	2004	18.7	16.7																		
616	SFG4	33.52	2005	19.0	17.2																		
			Avg	**22.5**	**19.3**	**1,037**	**24**		**19**	**0.25%**	**23**	**0.02**	**88%**	**20%**	**218**	**99**	**0**	**297**	**28**	**0.87**	**4.4**	**16**	**28**
Stream			**Wild Hog Creek**																				
604	Whg	0.00	2004	14.9	14.6																		
604	Whg	0.00	2005	17.9	17.2																		
			Avg	**16.4**	**15.9**																		

Hydrologic Unit Coastal Gualala

Station		Miles	Year	Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
Stream			**Russian Gulch**																				
471	RuG1	0.61	2000	17.5	14.9	8,596	169			0.85%	38		77%	40%	153	44			27	0.81	4.9	11	38
471	RuG1	0.61	2002	21.6	15.8																		
			Avg	**19.5**	**15.3**	**8,596**	**169**			**0.85%**	**38**		**77%**	**40%**	**153**	**44**			**27**	**0.81**	**4.9**	**11**	**38**
Stream			**Salal Creek**																				
470	Sal1	0.76	2000	15.3	13.5	2,053	129		9	4.69%	11		87%	89%	158	92			33	0.86	2.9	20	29
470	Sal1	0.76	2001	13.7	13.4																		
			Avg	**14.5**	**13.4**	**2,053**	**129**		**9**	**4.69%**	**11**		**87%**	**89%**	**158**	**92**			**33**	**0.86**	**2.9**	**20**	**29**
Stream			**School House Creek**																				
472	ScH	0.27	2000			829	66		0	5.86%	54		97%	97%	474	93							
			Avg			**829**	**66**		**0**	**5.86%**	**54**		**97%**	**97%**	**474**	**93**							

Station		Miles	Year	Temperature: Seasonal Maximum	Temperature: MWAT	Large Wood (>=8" Bank Full): CuFt/ 1000'	Large Wood: Pieces/ 1000'	Substrate: < 0.85 mm	Substrate: D50	Streambed: Slope	Streambed: VI	Streambed: A/D	Riparian Zone: Canopy % WLPZ	Riparian Zone: Canopy % Cr.	Riparian Zone: Basal Area	Riparian Zone: Tree Ht.	Fish per Mile: Coho	Fish per Mile: SH (1+)	Macroinvertebrates: Richness	Macroinvertebrates: Simpson	Macroinvertebrates: Hilsenhoff	Macroinvertebrates: Russian R Index	Macroinvertebrates: % Dominant
Hydrologic Unit				Russian Estuary																			
Stream			Jenner Gulch																				
407	Jen1	0.61	1998	15.6	14.4	2,124	71		20	3.26%	40		87%	88%									
407	Jen1	0.61	2000	18.0	14.4														40	0.90	4.2	22	26
407	Jen1	0.61	2001	15.1	13.5																		
			Avg	16.2	14.1	2,124	71		20	3.26%	40		87%	88%					40	0.90	4.2	22	26
			Avg	19.9	17.4	3,433	72	17.6%	33	1.22%	28	-0.4	82%	66%	233	78	1	226	33	0.85	4.3	18	31
			Min	13.7	12.9	10	1	4.5%	0	0.03%	10	-1.2	12%	11%	76	40	0	0	27	0.79	2.9	11	19
			Max	27.9	25.8	9,606	192	48.3%	71	6.90%	89	0.54	100%	98%	563	133	32	1,327	41	0.92	4.9	22	40
Old Growth Watersheds (HRSP)				18.5	16.6			21.6%	62										26.2	0.89			
Poor-Normal-Good											>20								26-35	.8-.89	4.6-3.1	12-17	39-15
NCWQCB Target				18.3	16.8			<14%															

Temperature

- Seasonal Maximum – The highest water temperature recorded during the summer.
- Maximum weekly average temperature (MWAT) - The highest average temperature for any seven day rolling average

Large Woody Debris (LWD)

- LWD must be at least 8 inches on the small end and longer than 4 feet.
- Cubic Feet per 1,000 feet – The cubic volume of LWD located between the bankfull lines.
- Pieces per 1,000' – The number of LWD pieces per 1000'

Stream Substrate

- <0.85mm – The percent fines less than 0.85 millimeters in a McNeal sample.
- D50- The pebble size of the median pebble of a 100 pebble sample. Three sample sites on each reach are averaged.

Fish Surveys

- Presence/absence snorkel surveys were conducted. Rough estimates were made of fish numbers per mile.
- Coho – Coho salmon any age.
- SH (1+) – Steelhead one year old or older.

Streambed (Thalweg) Survey

- Slope – the slope of the channel
- VI – The variation index is the [(SD of residual depth/bank full depth) *100]. This is a way of quantifying roughness and hence suitability for fish. Greater than 20 is a good indication of recovery.
- A/D – The change in elevation of the channel (aggradation or degradation) relative to the first year of measurement.

Riparian Condition

- Canopy Cover percent as measured with a spherical densiometer. Every 200', canopy percent is measured in the center of the channel. And at bank full and 50' into the riparian zone from bankfull on both sides of the channel. Four measurements are averaged at each point.
- WLPZ (Watercourse and Lake Protection Zone) – The average of all the measurements taken on either side of the channel 50' into the riparial zone.
- Cr. – The average of all the measurements taken in the center of the channel.
- Riparian inventory plots were locate both sides of the channel every 200'
- Basal Area – Is the average basal area in square feet of all the riparian plots
- Tree Ht. – Is the average height of the 100 tallest trees per acre.

Macroinvertebrates

- Richness – Total number of Genuses represented.
- Simpson Diversity Index – Measures the evenness of species diversity
- Hilsenhoff – This is a locally modified Hilsenhoff index. It indicates levels of organic pollution
- Russian River Index – A localized index that combines several standard metrics
- Percent Dominant Taxon – this is a species distribution index

Stream Monitoring Report

Station		Miles	Year	Temperature Seasonal Maximum	Temperature MWAT	LWD Bank Full (> 6 " > 4 ' or > 10 CuFt) CuFt/ 1000'	LWD Bank Full Pieces/ 1000'	Substrate < 0.85 mm	Substrate D50	Streambed Slope	Streambed VI	Streambed A/D	Riparian Zone Canopy % WLPZ	Riparian Zone Canopy % Cr.	Riparian Zone Basal Area	Riparian Zone Tree Ht.	Fish per Mile Coho	Fish per Mile SH (1+)	Macroinvertebrates Richness	Macroinvertebrates Simpson	Macroinvertebrates Hilsenhoff	Macroinvertebrates Russian R Index	Macroinvertebrates % Dominant
Hydrologic Unit			**NF Gualala**																				
Stream			**Abieta Springs**																				
752		0.09	2009	17.9	16.6																		
Abieta Springs			Avg	**17.9**	**16.6**																		
Stream			**Bear Creek**																				
693		0.57	2009	17.1	15.1																		
Bear Creek			Avg	**17.1**	**15.1**																		
Stream			**Billings Cr**																				
698	Bil	0.00	2004	25.2	21.6																		
698	Bil	0.00	2009	26.0	20.8																		
Billings Cr			Avg	**25.6**	**21.2**																		
Stream			**Doty Creek**																				
256	Dot2	0.02	1993					16.2%															
256	Dot2	0.02	1994	14.1	12.9			11.4%															
256	Dot2	0.02	1995					16.9%															
256	Dot2	0.02	1996					16.9%															
256	Dot2	0.02	1997					17.0%															
281	Dot1	0.02	1998	14.8	13.7																		
281	Dot1	0.02	2008	14.5	13.4																		
Doty Creek			Avg	**14.5**	**13.3**			**15.7%**															
Stream			**Dry Creek**																				
211	Dry3	0.19	1995	17.7	15.7			16.8%															
211	Dry3	0.19	1996	17.7	15.9			14.7%															
211	Dry3	0.19	1997	16.9	15.2			11.6%															
211	Dry3	0.19	1998			3,148	57		48	0.76%	22						16						
211	Dry3	0.19	1999			2,815	53		58	0.72%	20	-0.10	86%	87%	210	89	0	148					
211	Dry3	0.19	2000	16.5	14.8	2,834	49		60	0.74%	21	-0.07	84%	77%			0	48	32	0.79	4.4	16	40
211	Dry3	0.19	2001	16.4	14.1	5,375	85		56	0.69%	19	-0.10					0	127					
211	Dry3	0.19	2002	15.6	14.0	6,309	94		62	0.70%	17	-0.39					11	143					
211	Dry3	0.19	2003	16.1	14.9	7,205	91		43	0.74%	22	-0.33					0	174					
211	Dry3	0.19	2004	14.8	13.7	7,111	96		38	0.77%	29	-0.27					23	175					
211	Dry3	0.19	2005	16.4	15.0	7,040	92		36	0.75%	29	-0.22											

Station		Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
211	Dry3	0.19	2006			7,064	90		29	0.80%	21	0.52											
211	Dry3	0.19	2007			6,991	96		26	0.78%	20	0.54											
211	Dry3	0.19	2008	14.9	13.8	7,226	109		21	0.84%	21	0.42	93%	82%									
211	Dry3	0.19	2009	15.2	13.7	7,230	110		31	0.86%	23	0.42	88%	79%			0	407					
211	Dry3	0.19	2010	15.4	14.1	7,310	110		30	0.86%	21	0.56											
212	Dry2	1.29	1995	20.9	17.9																		
212	Dry2	1.29	1996	20.7	17.8																		
212	Dry2	1.29	1997	20.5	17.9																		
212	Dry2	1.29	1998	20.6	17.6																		
212	Dry2	1.29	2000			2,477	37			1.82%	13		76%	56%	81	60			41	0.92	4.5	22	19
212	Dry2	1.29	2004														0	500					
212	Dry2	1.29	2005	17.9	16.1																		
212	Dry2	1.29	2008	16.8	15.9	2,185	28		36	1.89%	14	-0.40	87%	85%									
212	Dry2	1.29	2009	16.8	15.7																		
753		1.61	2009	16.5	15.7																		
Dry Creek			Avg	17.2	15.5	5,488	80	14.2%	41	0.91%	21	0.04	86%	78%	146	75	5	215	37	0.86	4.5	19	30
Stream			Little North Fork Gualala																				
201	LNF5	0.02	1992					10.9%															
201	LNF5	0.02	1993					21.0%															
201	LNF5	0.02	1994	15.8	14.7			20.4%															
201	LNF5	0.02	1995	16.7	15.1			20.8%															
201	LNF5	0.02	1996	15.9	14.6			15.4%															
201	LNF5	0.02	1997	16.7	15.4			16.0%															
201	LNF5	0.02	1998	16.3	15.0																		
201	LNF5	0.02	2001	16.5	14.8																		
201	LNF5	0.02	2003	16.1	15.0																		
201	LNF5	0.02	2004	16.9	15.7																		
201	LNF5	0.02	2005	15.6	14.5																		
201	LNF5	0.02	2008	16.4	15.2																		
201	LNF5	0.02	2009	15.8	14.8																		
201	LNF5	0.02	2010	15.0	13.7																		
404	LNF3	0.45	1997																				
404	LNF3	0.45	1998														16						
404	LNF3	0.45	2001			5,250	83		34	0.57%	33		97%	96%	163	75							
404	LNF3	0.45	2003														0	589					

Station		Miles	Year	Temperature: Seasonal Maximum	Temperature: MWAT	LWD Bank Full (> 6 " > 4 ' or > 10 CuFt): CuFt/ 1000'	LWD Bank Full (> 6 " > 4 ' or > 10 CuFt): Pieces/ 1000'	Substrate: < 0.85 mm	Substrate: D50	Streambed: Slope	Streambed: VI	Streambed: A/D	Riparian Zone: Canopy % WLPZ	Riparian Zone: Canopy % Cr.	Riparian Zone: Basal Area	Riparian Zone: Tree Ht.	Fish per Mile: Coho	Fish per Mile: SH (1+)	Macroinvertebrates: Richness	Macroinvertebrates: Simpson	Macroinvertebrates: Hilsenhoff	Macroinvertebrates: Russian R Index	Macroinvertebrates: % Dominant
404	LNF3	0.45	2004			5,204	69		33	0.79%	57	-0.61					0	70					
202	LNF2	1.47	1993					11.5%															
202	LNF2	1.47	1994	16.4	14.6			14.6%															
202	LNF2	1.47	1995					18.8%															
202	LNF2	1.47	1996					17.2%															
202	LNF2	1.47	1997					21.6%															
202	LNF2	1.47	1998														32						
202	LNF2	1.47	2003														0	322					
202	LNF2	1.47	2004														0	391					
274	LNF8	1.68	1995	16.4	14.6																		
274	LNF8	1.68	1996	16.1	14.1																		
203	LNF1	2.27	1993					17.1%															
203	LNF1	2.27	1994	15.1	13.6			20.4%															
203	LNF1	2.27	1995	15.8	14.2			11.6%															
203	LNF1	2.27	1996	15.3	13.7			19.6%															
203	LNF1	2.27	1997	15.8	14.5			18.8%															
203	LNF1	2.27	1998	15.2	13.9	3,010	65		25	1.54%	23						0						
203	LNF1	2.27	1999	15.1	13.8	3,632	73		43	1.52%	21	-0.19	87%	89%	298	100	0	285					
203	LNF1	2.27	2000	15.3	13.9	3,766	71		46	1.49%	21	-0.08					0	143	31	0.85	4.5	19	30
203	LNF1	2.27	2001	15.2	13.5	4,798	119		42	1.49%	20	-0.10					0	148					
203	LNF1	2.27	2002	14.5	13.0	4,964	138		65	1.41%	28	-0.26					0	169					
203	LNF1	2.27	2003	15.2	14.0	5,069	140		60	1.42%	30	-0.40					0	235					
203	LNF1	2.27	2004	15.6	14.2	4,924	139		42	1.54%	32	-0.73					0	666					
203	LNF1	2.27	2005	14.9	13.6	5,358	136		40	1.35%	31	-0.93							30		4.6		41
203	LNF1	2.27	2006			5,468	132		36	1.46%	28	-1.08											
203	LNF1	2.27	2007			5,476	130		31	1.49%	31	-0.38											
203	LNF1	2.27	2008	15.3	13.9	5,937	147		23	1.43%	34	-0.72	86%	88%	391	83		58					
203	LNF1	2.27	2009	15.1	13.7	6,022	148		48	1.45%	34	-0.66	89%	91%			0	803					
203	LNF1	2.27	2010	14.5	13.1	6,409	148		42	1.45%	33	-0.62											
408	LNF7	2.37	2005	14.9	13.7																		
255	LNF6	2.86	1993					19.4%															
255	LNF6	2.86	1994	15.9	14.3			17.2%															
255	LNF6	2.86	1995					11.9%															
255	LNF6	2.86	1996					24.4%															
255	LNF6	2.86	1997					27.8%															

Station		Miles	Year	Temperature Seasonal Maximum	Temperature MWAT	LWD Bank Full (> 6 " > 4 ' or > 10 CuFt) CuFt/ 1000'	LWD Bank Full Pieces/ 1000'	Substrate < 0.85 mm	Substrate D50	Streambed Slope	Streambed VI	Streambed A/D	Riparian Zone Canopy % WLPZ	Riparian Zone Canopy % Cr.	Riparian Zone Basal Area	Riparian Zone Tree Ht.	Fish per Mile Coho	Fish per Mile SH (1+)	Macroinvertebrates Richness	Macroinvertebrates Simpson	Macroinvertebrates Hilsenhoff	Macroinvertebrates Russian R Index	Macroinvertebrates % Dominant
Little North Fork Gualala			**Avg**	**15.7**	**14.3**	**5,019**	**116**	**17.8%**	**41**	**1.36%**	**30**	**-0.5**	**90%**	**91%**	**284**	**86**	**3**	**323**	**30**	**0.85**	**4.5**	**19**	**35**
Stream		**Lost Creek**																					
215	LCr	0.04	1995	16.4	15.3																		
215	LCr	0.04	1996	15.8	15.1																		
215	LCr	0.04	1998	17.0	15.9																		
Lost Creek			**Avg**	**16.4**	**15.4**																		
Stream		**McGann Gulch**																					
209	MGG2	0.08	1995	16.7	15.9			19.2%															
209	MGG2	0.08	1996	16.4	15.6			26.8%															
209	MGG2	0.08	1997	15.5	14.4			19.9%															
209	MGG2	0.08	2003														0	104					
210	MGG1	0.42	1995	20.4	16.4																		
210	MGG1	0.42	2002	14.2	13.9																		
210	MGG1	0.42	2003	14.8	14.6																		
210	MGG1	0.42	2004	14.9	14.5																		
210	MGG1	0.42	2008	14.1	13.5																		
McGann Gulch			**Avg**	**15.9**	**14.8**			**22.0%**									**0**	**104**					
Stream		**North Fork Gualala**																					
251	NFG	0.06	1996	19.0	16.6																		
251	NFG	0.06	1997	19.3	17.5																		
251	NFG	0.06	2000	19.0	16.4																		
473	NFG4	0.44	2001	19.3	16.6	2,518	64		26	0.26%	28		93%	84%	148	72							
473	NFG4	0.44	2003														0	291					
473	NFG4	0.44	2009	17.9	15.7																		
204	NFG3	1.25	1995	20.6	17.5																		
204	NFG3	1.25	1996	20.1	18.7																		
204	NFG3	1.25	1997	19.4	18.2																		
204	NFG3	1.25	1998	20.2	17.7												0						
204	NFG3	1.25	1999			2,326	46		19	0.37%	23		64%	46%	140	73	0	109					
204	NFG3	1.25	2000	19.9	17.0												0	698					
204	NFG3	1.25	2001	18.6	16.7	2,922	97		24	0.38%	26	-0.41					0	84					
204	NFG3	1.25	2002														0	317					
204	NFG3	1.25	2003														0	255					
204	NFG3	1.25	2007			3,161	56		15														
204	NFG3	1.25	2008	16.8	15.5	2,981	60		28	0.33%	31	-1.00	80%	69%				79					

Station		Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
204	NFG3	1.25	2009	17.7	15.9												0	1,484					
204	NFG3	1.25	2010	17.4	15.9																		
258	NFG	3.83	1994	24.5	19.3																		
205	NFG	4.94	1995	21.4	17.7																		
205	NFG	4.94	1996	20.4	17.8																		
205	NFG	4.94	1997	21.1	18.1																		
205	NFG	4.94	2001	19.3	17.0																		
406	NFG2	5.38	1997																				
406	NFG2	5.38	1998	21.4	18.6																		
406	NFG2	5.38	2004														0	303					
474	NFG	6.08	2001	22.4	18.4																		
474	NFG	6.08	2002	20.9	18.7																		
474	NFG	6.08	2003	22.1	19.3																		
474	NFG	6.08	2004	20.5	18.8																		
474	NFG	6.08	2008	21.7	18.4																		
474	NFG	6.08	2010	20.3	17.6																		
214	NFG	7.99	1995	23.9	21.0																		
214	NFG	7.99	1996	23.7	21.1																		
214	NFG	7.99	1997	24.0	21.2																		
214	NFG	7.99	1998	24.3	21.4																		
214	NFG	7.99	2004														0	1,081					
272	NFG	9.09	1994	24.5	21.4																		
272	NFG	9.09	2001	24.1	21.0																		
272	NFG	9.09	2009	22.9	19.2																		
216	NFG1	9.85	1995	25.9	21.5																		
216	NFG1	9.85	1996	26.4	21.8																		
216	NFG1	9.85	1997	26.9	22.0																		
216	NFG1	9.85	2003														0	236					
691	NFG5	12.22	2004	24.4	21.0																		
691	NFG5	12.22	2009	23.2	19.5	227	4		20	0.32%	43		50%	43%									
North Fork Gualala			Avg	21.5	18.6	2,356	54		22	0.33%	30	-0.7	72%	61%	144	72	0	449					
Stream			Peaches Creek																				
269	Pea3	0.30	1994	16.2	15.7																		
269	Pea3	0.30	1998	17.5	16.0																		
269	Pea3	0.30	2008	16.8	15.5																		

Station		Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
269	Pea3	0.30	2009	16.2	15.2																		
213	Pea2	1.52	1995	17.0	16.0																		
213	Pea2	1.52	1996	17.3	16.1																		
213	Pea2	1.52	1997	17.8	16.4																		
Peaches Creek			Avg	17.0	15.9																		
Stream			Robinson Cr East																				
697	Rbn1	0.00	2004			622	7		26	0.59%	23												
697	Rbn1	0.00	2009	23.0	18.7	690	11		33	0.61%	35	-0.39											
692	Rbn2	0.00	2004	20.6	17.9																		
692	Rbn2	0.00	2009	21.0	18.2	153	8		44	1.64%	65		73%	77%									
Robinson Cr East			Avg	21.5	18.3	488	9		34	0.95%	41	-0.4	73%	77%									
Stream			Robinson Cr West																				
260	Rob	0.01	1994	14.6	13.8																		
207	Rob2	0.11	1995	19.6	15.8			15.2%															
207	Rob2	0.11	1996	19.6	15.7			18.1%															
207	Rob2	0.11	1997	20.2	16.2			17.9%															
207	Rob2	0.11	1998	18.5	15.4												12						
207	Rob2	0.11	1999			1,643	49		36	1.39%	13		66%	74%	246	95	0	113					
207	Rob2	0.11	2000	17.2	14.7												0	422					
207	Rob2	0.11	2001														0	13					
207	Rob2	0.11	2003														0	100					
207	Rob2	0.11	2004															361					
207	Rob2	0.11	2005	14.8	14.1																		
207	Rob2	0.11	2008	15.8	14.6													21					
207	Rob2	0.11	2009	15.6	14.5																		
207	Rob2	0.11	2010	14.7	13.6																		
409	Rob	0.57	2005	16.0	14.6																		
263	Rob	0.78	1994	17.7	15.5																		
263	Rob	0.78	2003														0	101					
263	Rob	0.78	2004														0	317					
208	Rob1	1.29	1995	16.6	14.9																		
208	Rob1	1.29	1996	16.4	15.0																		
208	Rob1	1.29	1997	16.7	14.9																		
208	Rob1	1.29	1998	16.2	14.9																		
208	Rob1	1.29	2003														0	76					

Station		Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
Robinson Cr West			Avg	16.9	14.9	1,643	49	17.1%	36	1.39%	13		66%	74%	246	95	1	169					
Stream		**Sosueme Cr**																					
206	Sosu	0.04	1995	20.4	14.2																		
206	Sosu	0.04	1996	16.9	14.2																		
206	Sosu	0.04	1997	16.4	13.8																		
206	Sosu	0.04	1998	16.5	14.4																		
206	Sosu	0.04	2000	18.0	14.0																		
Sosueme Cr			Avg	17.6	14.1																		
Hydrologic Unit NF Gualala			Avg	18.0	16.0	4,371	83	17.6%	37	1.03%	27	-0.3	81%	76%	210	81	3	297	33	0.85	4.5	19	33
Hydrologic Unit				**Rockpile**																			
Stream		**Dynamite Cr.**																					
478	Dyn1	0.00	2002	14.8	13.4																		
478	Dyn1	0.00	2009	13.7	13.2																		
Dynamite Cr.			Avg	14.3	13.3																		
Stream		**Emily Creek**																					
276	Emy	0.07	1997	15.2	14.1																		
276	Emy	0.07	1998	15.0	13.9																		
276	Emy	0.07	2002	14.3	13.3																		
Emily Creek			Avg	14.8	13.8																		
Stream		**Horsethief Canyon**																					
681	Hor1	0.00	2004	17.5	17.0																		
681	Hor1	0.00	2009	16.4	15.9																		
Horsethief Canyon			Avg	16.9	16.4																		
Stream		**Red Rock Creek**																					
678		0.19	2009	15.6	15.1																		
Red Rock Creek			Avg	15.6	15.1																		
Stream		**Rockpile Creek**																					
221	Roc3	0.50	1995	23.1	19.6																		
221	Roc3	0.50	1996	22.4	19.3																		
221	Roc3	0.50	1997	22.4	19.7																		
221	Roc3	0.50	1998	23.2	19.8	1,291	18		25	0.27%	17						0	677					
221	Roc3	0.50	1999			2,514	31		31	0.31%	10	-0.21	90%	37%	272	90	0	11					
221	Roc3	0.50	2000	22.7	18.8												0	169					
221	Roc3	0.50	2001	21.5	18.4												0	53					

Station		Miles	Year	Temperature: Seasonal Maximum	Temperature: MWAT	LWD Bank Full (> 6 " > 4 ' or > 10 CuFt): CuFt/ 1000'	LWD Bank Full: Pieces/ 1000'	Substrate: < 0.85 mm	Substrate: D50	Streambed: Slope	Streambed: VI	Streambed: A/D	Riparian Zone: Canopy % WLPZ	Riparian Zone: Canopy % Cr.	Riparian Zone: Basal Area	Riparian Zone: Tree Ht.	Fish per Mile: Coho	Fish per Mile: SH (1+)	Macroinvertebrates: Richness	Macroinvertebrates: Simpson	Macroinvertebrates: Hilsenhoff	Macroinvertebrates: Russian R Index	Macroinvertebrates: % Dominant
221	Roc3	0.50	2002	22.7	17.5												0	48					
221	Roc3	0.50	2003	21.7	19.0	2,382	27		19	0.27%	13	-0.40					0	67					
221	Roc3	0.50	2004	21.7	18.6												0	20					
221	Roc3	0.50	2008	20.1	18.1													11					
221	Roc3	0.50	2009	20.6	17.3												0	1,552					
221	Roc3	0.50	2010																				
275	Roc2	1.93	1997	20.1	19.5																		
275	Roc2	1.93	1998	23.9	20.2												0	508					
275	Roc2	1.93	2004	20.2	18.7																		
275	Roc2	1.93	2005	19.0	17.7																		
222	Roc	2.65	1994	21.9	19.4																		
222	Roc	2.65	1995	23.5	19.7																		
222	Roc	2.65	1997	22.4	19.8																		
401	Roc1	3.56	1998	23.7	20.8																		
401	Roc1	3.56	2005																26		2.9		29
401	Roc1	3.56	2006			5,416	56		24	0.16%	29		99%	58%	478	86							
401	Roc1	3.56	2008	20.6	19.1																		
401	Roc1	3.56	2009	19.8	17.8																		
701	Roc4	6.06	2005																26		3.0		39
701	Roc4	6.06	2006			2,961	36		34	0.24%	52		83%	60%	265	67							
701	Roc4	6.06	2008	21.3	19.5																		
701	Roc4	6.06	2009	21.3	18.6																		
680	Roc	7.77	2004	24.8	21.2																		
680	Roc	7.77	2009	23.6	19.5																		
683	Roc5	8.71	2004	24.0	20.6																		
683	Roc5	8.71	2009	23.2	19.1																		
Rockpile Creek			Avg	22.1	19.1	2,913	34		27	0.25%	24	-0.3	91%	52%	338	81	0	312	26		3.0		34
Hydrologic Unit Rockpile			Avg	20.6	18.1	2,913	34		27	0.25%	24	-0.3	91%	52%	338	81	0	312	26		3.0		34

Hydrologic Unit Buckeye

Stream Buckeye Creek

709	Buc	0.00	2008	23.6	20.3
235	Buc	0.23	1994	21.1	18.3
223	Buc3	0.34	1996	21.4	18.8

Station		Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
223	Buc3	0.34	1997	22.4	19.5																		
223	Buc3	0.34	1998	22.7	19.7												0	459					
223	Buc3	0.34	1999	21.1	18.0												0	0					
223	Buc3	0.34	2000			2,965	55		33	0.32%	46		81%	56%	143	99	0	194	32	0.88	4.0	19	26
223	Buc3	0.34	2001	21.1	18.0												0	67					
223	Buc3	0.34	2002														0	137					
223	Buc3	0.34	2003														0	315					
223	Buc3	0.34	2004	21.3	17.9												0	46					
223	Buc3	0.34	2008	20.6	17.0	2,195	69		22	0.20%	58	-0.73	80%	54%				258					
223	Buc3	0.34	2009	19.4	16.5																		
223	Buc3	0.34	2010	18.0	16.2																		
224	Buc2	3.01	1995	23.9	19.9																		
224	Buc2	3.01	1996	22.1	19.3																		
224	Buc2	3.01	1997	22.7	19.8																		
224	Buc2	3.01	2000	20.9	18.1																		
224	Buc2	3.01	2003														0	287					
231	Buc1	6.25	1994	21.7	19.7																		
231	Buc1	6.25	1995	24.4	20.9																		
231	Buc1	6.25	1996	23.7	20.8																		
231	Buc1	6.25	1997	23.7	21.1																		
231	Buc1	6.25	1998	24.0	21.0	273	11		25	0.36%	27												
231	Buc1	6.25	2001	24.3	20.5																		
231	Buc1	6.25	2002	21.2	17.8																		
670	Buc4	11.17	2005																27		4.6		38
670	Buc4	11.17	2006	26.3	22.2	944	8		15	0.58%	26		100%	89%	323	64							
670	Buc4	11.17	2008	20.2	18.6																		
670	Buc4	11.17	2009	21.3	17.9																		
601	Buc7	12.31	2000	26.0	21.0																		
601	Buc7	12.31	2001	25.6	20.9																		
601	Buc7	12.31	2004	25.6	20.9																		
601	Buc7	12.31	2005	24.0	20.5																		
672	Buc8	15.53	2005	18.0	16.5	232	6		71	1.49%	69		33%	36%	76	84			35		4.1		22
672	Buc8	15.53	2006	24.4	19.4																		
673	Buc9	16.48	2005			325	20		60	1.64%	58		28%	29%	106	82			38		3.6		18
673	Buc9	16.48	2006	26.7	22.8																		

Station		Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
Buckeye Creek			Avg	22.6	19.4	1,156	28		38	0.77%	47	-0.7	64%	53%	162	82	0	196	33	0.88	4.1	19	26
Stream		**Flat Ridge Creek**																					
602	FLR2	0.04	2000	25.6	20.9																		
602	FLR2	0.04	2001	25.2	20.5																		
602	FLR2	0.04	2005			1,181	17		47	1.14%	89		12%	11%	155	88			38		3.2		25
602	FLR2	0.04	2006	25.8	22.6																		
602	FLR2	0.04	2009	26.3	20.7																		
674	FLT	0.38	2005	19.5	16.7																		
Flat Ridge Creek			Avg	24.5	20.3	1,181	17		47	1.14%	89		12%	11%	155	88			38		3.2		25
Stream		**Franchini Creek**																					
667	FRN1	0.00	2005	16.5	14.9														29		4.2		31
667	FRN1	0.00	2006	18.7	16.4	4,627	150		32	3.47%	31		75%	97%	228	59							
667	FRN1	0.00	2008	14.9	14.5																		
667	FRN1	0.00	2009	14.2	14.0																		
667	FRN1	0.00	2010	14.2	13.9																		
Franchini Creek			Avg	15.7	14.7	4,627	150		32	3.47%	31		75%	97%	228	59			29		4.2		31
Stream		**Grasshopper Creek**																					
696	GRS1	2.65	2005																30		3.8		31
696	GRS1	2.65	2006			8,031	191		28	2.22%	24		82%	88%	406	65							
696	GRS1	2.65	2009	15.1	14.5																		
Grasshopper Creek			Avg	15.1	14.5	8,031	191		28	2.22%	24		82%	88%	406	65			30		3.8		31
Stream		**Little Creek**																					
666	LiCr	0.09	2009	13.7	12.9																		
666	LiCr	0.09	2010	13.7	13.0																		
Little Creek			Avg	13.7	12.9																		
Stream		**Meg Creek**																					
286	Meg	0.01	1998	15.1	14.3																		
286	Meg	0.01	2002	15.0	13.3																		
Meg Creek			Avg	15.0	13.8																		
Stream		**North Fork Buckeye Creek**																					
702	NFB2	0.02	2005			771	12		40	0.62%	62		96%	82%	318	59			31		3.9		27
702	NFB2	0.02	2008	21.0	18.6																		
702	NFB2	0.02	2009	19.5	17.3																		
North Fork Buckeye Creek			Avg	20.2	17.9	771	12		40	0.62%	62		96%	82%	318	59			31		3.9		27
Stream		**Soda Springs Creek**																					
671	SSP1	0.08	2005			1,303	56		66	2.22%	68		100%	94%	251	74			34		3.6		21

Station		Miles	Year		Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
					Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
671	SSP1	0.08	2006		19.7	17.9																		
671	SSP1	0.08	2010		16.5	15.1																		
Soda Springs Creek				Avg	18.1	16.5	1,303	56		66	2.22%	68		100%	94%	251	74			34		3.6		21
Hydrologic Unit Buckeye				Avg	21.0	18.3	2,077	54		40	1.30%	51	-0.7	68%	64%	223	75	0	196	33	0.88	3.9	19	27
Hydrologic Unit					**Wheatfield**																			
Stream			**Elk Creek**																					
706	Elk	0.00	2005		18.4	16.3																		
706	Elk	0.00	2006		21.0	18.4																		
706	Elk	0.00	2009		21.0	17.2																		
Elk Creek				Avg	20.1	17.3																		
Stream			**Fuller Creek**																					
902	Ful	0.06	1999		24.0	18.9																		
608	Ful1	0.38	2001		21.0	17.8																		
608	Ful1	0.38	2002		20.6	17.5																		
608	Ful1	0.38	2009		20.6	16.5																		
608	Ful1	0.38	2010		18.6	16.2																		
609	Ful3	2.31	2008		19.4	17.5																		
606	Ful	3.03	2001		23.2	18.5																		
606	Ful	3.03	2002		22.9	18.4																		
606	Ful	3.03	2004		21.7	18.2																		
606	Ful	3.03	2005		20.6	18.0																		
606	Ful	3.03	2006		23.6	19.8																		
606	Ful	3.03	2009		20.6	16.8																		
Fuller Creek				Avg	21.4	17.8																		
Stream			**Haupt Cr**																					
637		0.38	2009																					
Haupt Cr				Avg																				
Stream			**Jennifer Creek**																					
228	Jen	0.19	1995		14.5	13.9																		
228	Jen	0.19	1996		14.0	13.4																		
228	Jen	0.19	1997		14.8	14.2																		
228	Jen	0.19	1998		14.1	13.6																		
228	Jen	0.19	2002		16.3	13.1																		
Jennifer Creek				Avg	14.7	13.6																		

Station		Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
Stream			**North Fork Fuller Creek**																				
619	NFU	0.02	2000	22.7	18.8																		
619	NFU	0.02	2001	22.7	18.3																		
619	NFU	0.02	2002	22.1	17.9																		
619	NFU	0.02	2004	20.3	17.4																		
619	NFU	0.02	2005	20.1	16.9																		
619	NFU	0.02	2006	23.2	19.6																		
619	NFU	0.02	2009	21.0	16.6																		
665	NFu2	1.14	2004	18.1	16.3																		
North Fork Fuller Creek			Avg	21.3	17.7																		
Stream			**Palchett Creek**																				
901	97-3	0.08	1999	15.7	14.5																		
Palchett Creek			Avg	15.7	14.5																		
Stream			**Redwood Creek**																				
704	Rdw1	0.38	2005																30		4.2		25
704	Rdw1	0.38	2006	20.6	19.7	5,409	146		26	6.90%	20		79%	97%	125	52							
Redwood Creek			Avg	20.6	19.7	5,409	146		26	6.90%	20		79%	97%	125	52			30		4.2		25
Stream			**South Fork Fuller Creek**																				
618	SFU	0.02	2000	22.5	19.1																		
618	SFU	0.02	2001	22.5	18.7																		
618	SFU	0.02	2002	22.1	18.2																		
618	SFU	0.02	2004	19.1	17.4																		
618	SFU	0.02	2005	21.0	18.3																		
618	SFU	0.02	2006	23.2	20.1																		
618	SFU	0.02	2009	19.4	16.7																		
662	SFu2	1.52	2004	21.8	18.4																		
663	SFu1	2.65	2005			4,294	59		61	2.05%	24				129	44			32		3.2		26
663	SFu1	2.65	2009	15.2	14.2																		
South Fork Fuller Creek			Avg	20.8	17.9	4,294	59		61	2.05%	24				129	44			32		3.2		26
Stream			**Tombs Creek**																				
656		0.09	2009	26.0	20.4																		
Tombs Creek			Avg	26.0	20.4																		
Stream			**Wheatfield Fork Gualala River**																				
707	WFG	0.00	2006	24.4	22.0																		
707	WFG	0.00	2008	26.7	22.8																		
707	WFG	0.00	2009	28.7	23.4																		

Station		Miles	Year	Temperature Seasonal Maximum	Temperature MWAT	LWD Bank Full > 6 " > 4 ' or > 10 CuFt CuFt/ 1000'	LWD Pieces/ 1000'	Substrate < 0.85 mm	Substrate D50	Streambed Slope	Streambed VI	Streambed A/D	Riparian Zone Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Fish per Mile Coho	Fish per Mile SH (1+)	Macroinvertebrates Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
708	WFG	0.00	2006	26.3	24.3																		
708	WFG	0.00	2008	22.9	19.4																		
708	WFG	0.00	2009	29.5	23.4																		
226	Wfg3	0.42	1995	25.5	20.9																		
226	Wfg3	0.42	1996	23.8	20.3																		
226	Wfg3	0.42	1997	23.1	21.9																		
226	Wfg3	0.42	1998	24.7	21.7												0	981					
226	Wfg3	0.42	2000			1,828	22		27				86%	40%	158	101			32	0.85	4.3	15	32
226	Wfg3	0.42	2001	23.2	20.0																		
226	Wfg3	0.42	2002														0	60					
226	Wfg3	0.42	2003			1,310	18		21	0.07%	21						0	182					
226	Wfg3	0.42	2008	21.0	18.9	1,637	29		16	0.08%	29	0.05	81%	15%				137					
226	Wfg3	0.42	2009																				
226	Wfg3	0.42	2010	20.8	19.1																		
29	62	0.69	2009							0.15%	22												
32	WFGr	0.69	2009							0.15%	21												
30	70	0.99	2009							0.14%	19												
227	Wfg2	2.69	1996	24.0	21.2																		
227	Wfg2	2.69	1997	25.3	22.2																		
227	Wfg2	2.69	1998	24.3	21.5																		
227	Wfg2	2.69	2000	25.3	21.2																		
227	Wfg2	2.69	2003														0	286					
403	WFG1	5.28	1997																				
403	WFG1	5.28	1998	26.4	22.9																		
403	WFG1	5.28	2000																				
273	WFG	5.45	1995	26.4	22.0																		
603	WFG	7.29	2001																				
603	WFG	7.29	2002	24.0	21.6																		
612	WFG	7.58	2001	25.6	22.4																		
612	WFG	7.58	2002	25.6	22.4																		
620	WFG4	8.90	2000	27.8	23.1																		
620	WFG4	8.90	2001	26.0	23.1																		
620	WFG4	8.90	2002	26.3	23.0																		
620	WFG4	8.90	2004	25.7	21.9																		
620	WFG4	8.90	2008	26.3	21.8																		

Station		Miles	Year	Temperature Seasonal Maximum	Temperature MWAT	LWD Bank Full (> 6 " > 4 ' or > 10 CuFt) CuFt/ 1000'	LWD Bank Full Pieces/ 1000'	Substrate < 0.85 mm	Substrate D50	Streambed Slope	Streambed VI	Streambed A/D	Riparian Zone Canopy % WLPZ	Riparian Zone Canopy % Cr.	Riparian Zone Basal Area	Riparian Zone Tree Ht.	Fish per Mile Coho	Fish per Mile SH (1+)	Macroinvertebrates Richness	Macroinvertebrates Simpson	Macroinvertebrates Hilsenhoff	Macroinvertebrates Russian R Index	Macroinvertebrates % Dominant
651	WFG6	22.73	2005																24		4.0		20
651	WFG6	22.73	2006	27.0	23.5	10	1		49	0.63%	38		66%	18%	82	40							
651	WFG6	22.73	2009	21.8	19.9																		
652	WFG7	23.11	2005																29		3.7		24
652	WFG7	23.11	2006	27.9	25.8	107	1		22	0.55%	26		87%	63%	188	44							
652	WFG7	23.11	2009	25.2	20.9																		
Wheatfield Fork Gualala Rive Avg				25.2	21.9	979	14		27	0.25%	25	0.05	80%	34%	143	62	0	329	28	0.85	4.0	15	25
Hydrologic Unit Wheatfield Avg				22.4	19.3	2,085	39		32	1.19%	24	0.05	80%	46%	136	56	0	329	29	0.85	3.9	15	25
Hydrologic Unit				**SF Gualala**																			
Stream			**Big Pepperwood**																				
218	Ppw3	0.15	1994	15.9	14.4																		
218	Ppw3	0.15	1995	16.5	15.0																		
218	Ppw3	0.15	1996	16.2	14.3																		
218	Ppw3	0.15	1997	17.3	15.6																		
218	Ppw3	0.15	1998	17.2	15.2	2,490	88		41	1.37%	14						0	153					
218	Ppw3	0.15	1999	15.9	14.4	2,324	84		30	1.46%	13	-0.31	90%	88%	348	87	0	132					
218	Ppw3	0.15	2000	16.2	14.5												0	21	32	0.79	4.7	15	39
218	Ppw3	0.15	2001														0	48					
218	Ppw3	0.15	2002	15.6	14.1	6,534	150		45	1.40%	13	-0.68	96%	87%	563	58	0	37					
218	Ppw3	0.15	2003	15.5	14.1	7,303	152		35	1.40%	16	-1.16											
218	Ppw3	0.15	2004	16.0	14.7	8,150	151		28	1.43%	15	-1.02					0	28					
218	Ppw3	0.15	2005	15.6	14.2	8,104	148		37	1.43%	17	-1.11											
218	Ppw3	0.15	2006			10,206	176		22	1.56%	16	-1.20											
218	Ppw3	0.15	2007			10,238	181		35	1.50%	15	-1.13											
218	Ppw3	0.15	2008	15.9	14.8	10,185	194		31	1.52%	17	-1.27	90%	87%				5					
218	Ppw3	0.15	2009	15.4	14.3	10,564	200		38	1.52%	16	-1.12					0	84					
218	Ppw3	0.15	2010	14.6	13.2	10,735	206		33	1.53%	15	-1.13											
219	Ppw2	1.29	1995	17.0	14.9																		
219	Ppw2	1.29	1996	16.7	14.7																		
219	Ppw2	1.29	1997	17.8	15.0																		
219	Ppw2	1.29	1998	17.3	14.9																		
219	Ppw2	1.29	2009	14.3	13.5																		
248	PPW	1.33	1994	17.2	14.6																		

Station		Miles	Year		Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
					Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
Big Pepperwood				Avg	16.2	14.5	7,894	157		34	1.47%	15	-1.0	92%	87%	455	72	0	64	32	0.79	4.7	15	39
Stream			Camper Creek																					
699	Cmp	0.00	2004		17.9	16.5																		
699	Cmp	0.00	2005		17.9	16.3																		
Camper Creek				Avg	17.9	16.4																		
Stream			Carson Cr																					
605	Car	0.00	2004		16.8	15.6																		
605	Car	0.00	2005		18.1	16.8																		
631	Car1	0.00	2004				2,724	39		39	1.45%	42		88%	98%	143	106							
Carson Cr				Avg	17.4	16.2	2,724	39		39	1.45%	42		88%	98%	143	106							
Stream			Groshong Gulch																					
250	Gros	0.05	1996		14.1	13.1																		
250	Gros	0.05	2002		16.2	13.3																		
277	GrG	0.27	1998		13.9	13.4																		
277	GrG	0.27	2000		17.8	14.5																		
Groshong Gulch				Avg	15.5	13.6																		
Stream			Gualala River																					
614	Gua8	0.00	2000		22.9	18.4																		
614	Gua8	0.00	2001																					
614	Gua8	0.00	2009		21.7	18.1																		
750		1.19	2009		22.5	19.2																		
751		1.52	2009																					
Gualala River				Avg	22.3	18.6																		
Stream			Little Pepperwood																					
220	Lpw	0.11	1994		15.8	14.3																		
220	Lpw	0.11	1995		19.4	16.0																		
220	Lpw	0.11	1996		17.8	15.0																		
220	Lpw	0.11	1997		16.7	16.0																		
220	Lpw	0.11	1998		17.8	15.6																		
220	Lpw	0.11	2002		15.1	13.8																		
220	Lpw	0.11	2003		15.9	14.8												0	121					
220	Lpw	0.11	2004		14.8	14.3												0	8					
220	Lpw	0.11	2005		16.0	14.6																		
220	Lpw	0.11	2008		14.7	14.3																		
220	Lpw	0.11	2009		14.4	13.7																		
Little Pepperwood				Avg	16.2	14.8												0	65					

Station		Miles	Year	Temperature: Seasonal Maximum	Temperature: MWAT	LWD Bank Full (> 6 " > 4 ' or > 10 CuFt): CuFt/ 1000'	LWD Bank Full: Pieces/ 1000'	Substrate: < 0.85 mm	Substrate: D50	Streambed: Slope	Streambed: VI	Streambed: A/D	Riparian Zone: Canopy % WLPZ	Riparian Zone: Canopy % Cr.	Riparian Zone: Basal Area	Riparian Zone: Tree Ht.	Fish per Mile: Coho	Fish per Mile: SH (1+)	Macroinvertebrates: Richness	Macroinvertebrates: Simpson	Macroinvertebrates: Hilsenhoff	Macroinvertebrates: Russian R Index	Macroinvertebrates: % Dominant
Stream			**Marshall Creek**																				
607	Mar	0.00	2004	22.5	19.7																		
Marshall Creek			Avg	22.5	19.7																		
Stream			**McKenzie Creek**																				
615	McK1	0.00	2000	16.0	15.1																		
615	McK1	0.00	2001	20.6	17.5																		
615	McK1	0.00	2004	19.8	17.5	997	8		38	1.24%	27		95%	95%	262	133							
615	McK1	0.00	2005	20.2	17.8																		
617	McK1	0.00	2000	20.7	18.3																		
617	McK1	0.00	2001	20.2	17.5																		
617	McK1	0.00	2003	20.6	18.7																		
617	McK1	0.00	2004	18.7	17.2																		
617	McK1	0.00	2005	20.6	18.1																		
McKenzie Creek			Avg	19.7	17.5	997	8		38	1.24%	27		95%	95%	262	133							
Stream			**Palmer Creek**																				
621	Plm	0.00	2000	23.6	19.3																		
621	Plm	0.00	2001																				
621	Plm	0.00	2003	20.5	18.2																		
621	Plm	0.00	2004	20.6	17.5																		
621	Plm	0.00	2005	20.6	17.9																		
Palmer Creek			Avg	21.3	18.2																		
Stream			**South Fork Gualala River**																				
217	Gua1	0.98	1994	22.7	19.2																		
217	Gua1	0.98	1995	25.3	20.6																		
217	Gua1	0.98	1996	24.4	20.1																		
217	Gua1	0.98	1997	24.6	22.4																		
217	Gua1	0.98	1998			934	17		24	0.11%	23		93%	16%									
217	Gua1	0.98	1999														0	32					
217	Gua1	0.98	2000	23.2	19.2	804	15		25	0.03%	22	-0.10	96%	17%	239	90	0	21	28	0.87	4.4	16	28
217	Gua1	0.98	2001	23.3	19.1	1,639	34		20	0.07%	20	0.19					0	11					
217	Gua1	0.98	2002			1,479	28		22	0.10%	27	0.01					0						
217	Gua1	0.98	2003			1,084	24		12	0.11%	22	0.10					0	149					
217	Gua1	0.98	2004	23.2	20.0	1,254	27		19	0.09%	26	0.18					0	97					
217	Gua1	0.98	2006			1,016	20		20														
217	Gua1	0.98	2007			1,064	22		15	0.13%	21	-0.23											

Station		Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
217	Gua1	0.98	2008	24.5	19.8	1,110	29		19	0.10%	23	-0.24						26					
217	Gua1	0.98	2009	23.2	18.9	1,109	30		16	0.06%	22	-0.14					0	166					
217	Gua1	0.98	2010	22.4	18.3																		
225	SFG	4.36	1995	24.8	20.8																		
225	SFG	4.36	1997	22.1	20.6																		
16	280	5.13	2009							0.10%	22												
19	SFGr	5.13	2009							0.13%	28												
17	295	5.25	2009							0.18%	25												
18	310	5.67	2009							0.23%	32												
20	370	6.77	2009							0.31%	20												
229	SFG	7.39	1995	23.4	19.9																		
229	SFG	7.39	1996	22.1	19.0																		
229	SFG	7.39	1997	25.6	20.5																		
402	SFG	7.77	1998	22.1	19.7												0	961					
402	SFG	7.77	1999			1,473	33		18	0.33%	29		76%	26%	197	108	0	400					
402	SFG	7.77	2000	22.4	18.9												0	268					
402	SFG	7.77	2001														0	153					
402	SFG	7.77	2002														0	121					
402	SFG	7.77	2008			1,391	31		19	0.41%	31	-0.11						1,327					
230	SFG	9.32	1995	22.9	18.9																		
230	SFG	9.32	1996	21.8	18.4																		
230	SFG	9.32	1997	24.4	22.3																		
230	SFG	9.32	1998	22.6	19.5																		
230	SFG	9.32	2009	20.6	17.6																		
616	SFG4	33.52	2000	19.4	16.7																		
616	SFG4	33.52	2001	19.8	16.4																		
616	SFG4	33.52	2003	19.5	17.4																		
616	SFG4	33.52	2004	18.7	16.7																		
616	SFG4	33.52	2005	19.0	17.2																		
South Fork Gualala River			Avg	22.5	19.2	1,196	26		19	0.16%	25	-0.04	88%	20%	218	99	0	287	28	0.87	4.4	16	28
Stream			**Wild Hog Creek**																				
604	Whg	0.00	2004	14.9	14.6																		
604	Whg	0.00	2005	17.9	17.2																		
Wild Hog Creek			Avg	16.4	15.9																		

Station		Miles	Year		Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
					Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
Hydrologic Unit SF Gualala				Avg	19.2	16.8	4,196	83		27	0.73%	22	-0.6	90%	64%	292	97	0	190	30	0.83	4.6	16	33
Hydrologic Unit					**Coastal Gualala**																			
Stream			**Russian Gulch**																					
471	RuG1	0.61	2000		17.5	14.9	8,615	169			0.85%	38		77%	40%	153	44			27	0.81	4.9	11	38
471	RuG1	0.61	2002		21.6	15.8																		
Russian Gulch				Avg	19.5	15.3	8,615	169			0.85%	38		77%	40%	153	44			27	0.81	4.9	11	38
Stream			**Salal Creek**																					
470	Sal1	0.76	2000		15.3	13.5	2,048	127		9	4.69%	11		87%	89%	158	92			33	0.86	2.9	20	29
470	Sal1	0.76	2001		13.7	13.4																		
Salal Creek				Avg	14.5	13.4	2,048	127		9	4.69%	11		87%	89%	158	92			33	0.86	2.9	20	29
Stream			**School House Creek**																					
472	ScH	0.27	2000				829	66		0	5.86%	54		97%	97%	474	93							
School House Creek				Avg			829	66		0	5.86%	54		97%	97%	474	93							
Hydrologic Unit Coastal Gual				Avg	17.0	14.4	3,830	121		5	3.80%	34		87%	75%	261	76			30	0.83	3.9	16	33
Hydrologic Unit					**Russian Estuary**																			
Stream			**Jenner Gulch**																					
407	Jen1	0.61	1998		15.6	14.4	2,124	71		20	3.26%	40		87%	88%									
407	Jen1	0.61	2000		18.0	14.4														40	0.90	4.2	22	26
407	Jen1	0.61	2001		15.1	13.5																		
Jenner Gulch				Avg	16.2	14.1	2,124	71		20	3.26%	40		87%	88%					40	0.90	4.2	22	26
Hydrologic Unit Russian Estu				Avg	16.2	14.1	2,124	71		20	3.26%	40		87%	88%					40	0.90	4.2	22	26

Station	Miles	Year	Temperature: Seasonal Maximum	Temperature: MWAT	LWD Bank Full (> 6 " > 4 ' or > 10 CuFt): CuFt/ 1000'	LWD Bank Full: Pieces/ 1000'	Substrate: < 0.85 mm	Substrate: D50	Streambed: Slope	Streambed: VI	Streambed: A/D	Riparian Zone: Canopy % WLPZ	Riparian Zone: Canopy % Cr.	Riparian Zone: Basal Area	Riparian Zone: Tree Ht.	Fish per Mile: Coho	Fish per Mile: SH (1+)	Macroinvertebrates: Richness	Macroinvertebrates: Simpson	Macroinvertebrates: Hilsenhoff	Macroinvertebrates: Russian R Index	Macroinvertebrates: % Dominant
		Avg	19.7	17.2	3,754	75	17.6%	33	1.05%	28	-0.4	81%	67%	233	78	1	262	31	0.85	4.0	18	29
		Min	13.7	12.9	10	1	4.5%	0	0.03%	10	-1.3	12%	11%	76	40	0	0	24	0.79	2.9	11	18
		Max	29.5	25.8	10,735	206	48.3%	71	6.90%	89	0.56	100%	98%	563	133	32	1,552	41	0.92	4.9	22	41
Old Growth Watersheds (HRSP)			18.5	16.6			21.6%	62										26.2	0.89			
Poor-Normal-Good										>20								26-35	.8-.89	4.6-3.1	12-17	39-15
NCWQCB Target			18.3	16.8			<14%															

Temperature

- Seasonal Maximum – The highest water temperature recorded during the summer.
- Maximum weekly average temperature (MWAT) - The highest average temperature for any seven day rolling average

Large Woody Debris (LWD)

- LWD must be at least 6 inches on the small end and longer than 4 feet.
- Cubic Feet per 1,000 feet – The cubic volume of LWD located between the bankfull lines.
- Pieces per 1,000' – The number of LWD pieces per 1000'

Stream Substrate

- <0.85mm – The percent fines less than 0.85 millimeters in a McNeal sample.
- D50- The pebble size of the median pebble of a 100 pebble sample. Three sample sites on each reach are averaged.

Fish Surveys

- Presence/absence snorkel surveys were conducted. Rough estimates were made of fish numbers per mile.
- Coho – Coho salmon any age.
- SH (1+) – Steelhead one year old or older.

Streambed (Thalweg) Survey

- Slope – the slope of the channel
- VI – The variation index is the [(SD of residual depth/bank full depth) *100]. This is a way of quantifying roughness and hence suitability for fish. Greater than 20 is a good indication of recovery.
- A/D – The change in elevation of the channel (aggradation or degradation) relative to the first year of measurement.

Riparian Condition

- Canopy Cover percent as measured with a spherical densiometer. Every 200', canopy percent is measured in the center of the channel. And at bank full and 50' into the riparian zone from bankfull on both sides of the channel. Four measurements are averaged at each point.
- WLPZ (Watercourse and Lake Protection Zone) – The average of all the measurements taken on either side of the channel 50' into the riparial zone.
- Cr. – The average of all the measurements taken in the center of the channel.
- Riparian inventory plots were locate both sides of the channel every 200'
- Basal Area – Is the average basal area in square feet of all the riparian plots
- Tree Ht. – Is the average height of the 100 tallest trees per acre.

Macroinvertebrates

- Richness – Total number of Genuses represented.
- Simpson Diversity Index – Measures the evenness of species diversity
- Hilsenhoff – This is a locally modified Hilsenhoff index. It indicates levels of organic pollution
- Russian River Index – A localized index that combines several standard metrics
- Percent Dominant Taxon – this is a species distribution index

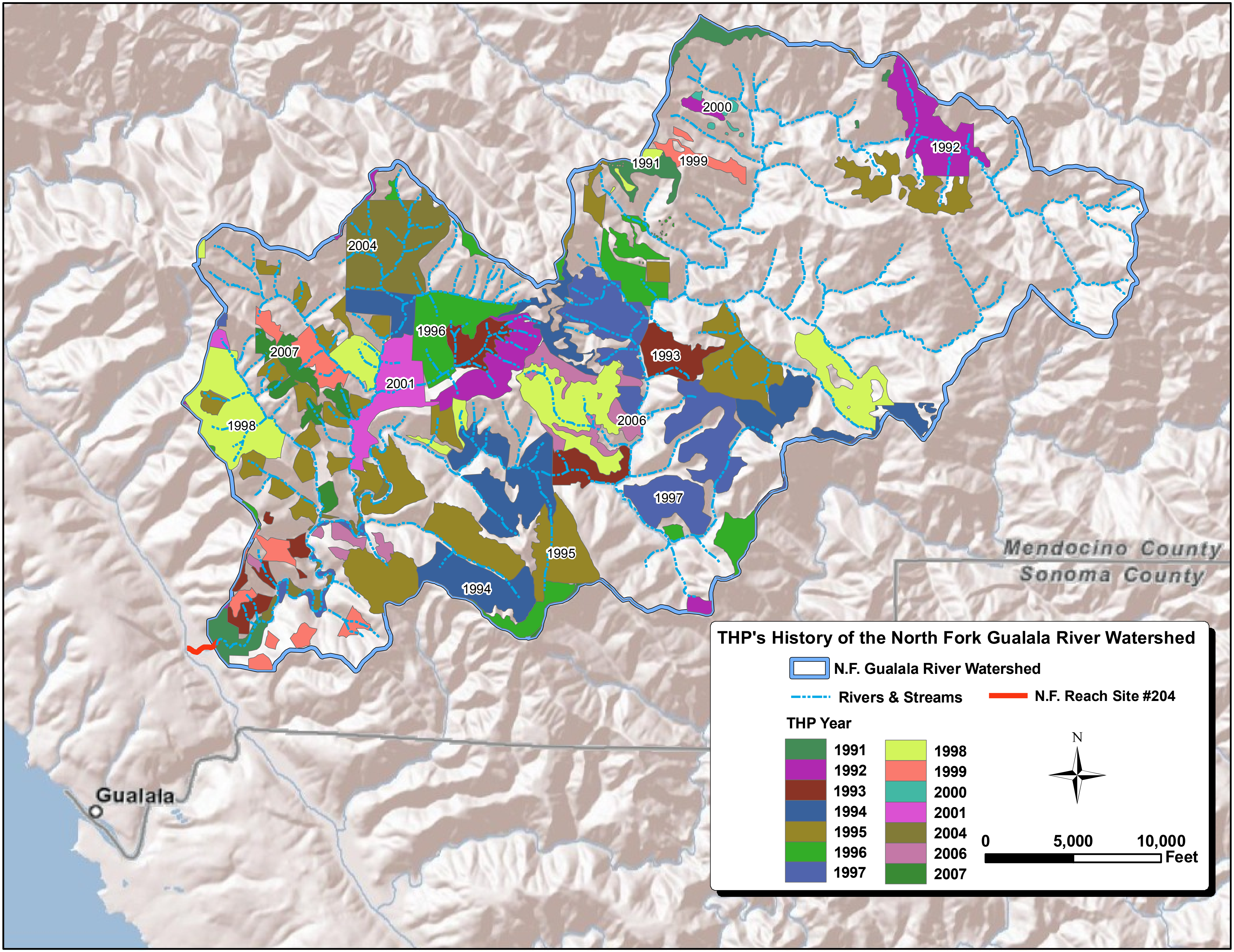
Thalweg Report

Stream	Station				Distance up Stream (Feet)	Drainage Area (Acres)	Slope	Streambed Agradation Degradation (Feet)	Variation Index	Pools							Longitudinal Cross Sectional Area of Pools > 1' Deep (Sq Ft/1,000')
	Name	#	Visit ID	Year						>1'	%	>2'	%	>3'	%	Max Depth (Feet)	
Watershed	Buckeye																
Buckeye Cr	Buc3	223	423	2000	1,800	25,588	0.32%		46.1	5	64%	2	24%	1	13%	4.1	568
Buckeye Cr	Buc3	223	897	2008	1,800	25,588	0.20%	-0.73	58.0	7	78%	6	72%	3	36%	5.4	971
Buckeye Cr	Buc1	231	34	1998	33,000	21,198	0.36%		27.0	8	68%	5	53%	3	35%	4.5	848
Buckeye Cr	Buc4	670	802	2006	59,000	16,331	0.58%		26.0	5	65%	1	27%	0	0%	2.6	504
Buckeye Cr	Buc8	672	695	2005	82,000	1,976	1.49%		68.8	11	51%	4	17%	2	9%	5.2	527
Buckeye Cr	Buc9	673	694	2005	87,000	1,511	1.64%		57.5	8	36%	3	17%	1	4%	3.4	365
Flat Ridge Cr	FLR2	602	692	2005	200	2,810	1.14%		88.6	9	50%	3	20%	1	11%	3.2	371
Franchini Cr	FRN1	667	803	2006	0	1,131	3.47%		30.6	14	33%	1	2%	1	2%	3.2	248
Grasshopper	GRS1	696	804	2006	14,000	689	2.22%		23.9	7	22%	2	4%	0	0%	2.4	148
NF Buckeye	NFB2	702	793	2005	100	7,617	0.62%		62.0	5	75%	2	44%	1	32%	3.1	769
Soda Springs	SSP1	671	792	2005	400	970	2.22%		68.3	8	24%	3	8%	1	1%	4.5	213
Watershed	Coastal Gualala																
Russian G	RuG1	471	421	2000	3,200		0.85%		37.7	6	43%	5	42%	0	0%	3.0	517
Salal Cr	Sal1	470	427	2000	4,000	259	4.69%		10.7	18	39%	4	10%	0	0%	2.2	303
School House	ScH	472	437	2000	1,400	347	5.86%		53.9	11	63%	0	0%	0	0%	1.8	459
Watershed	NF Gualala																
Dry Cr	Dry3	211	302	1998	1,000	4,104	0.76%		22.2	7	45%	2	8%	2	8%	5.3	405
Dry Cr	Dry3	211	344	1999	1,000	4,104	0.72%	-0.10	20.2	8	42%	3	23%	1	8%	4.0	378
Dry Cr	Dry3	211	422	2000	1,000	4,104	0.74%	-0.07	20.6	8	41%	4	23%	1	4%	4.2	385
Dry Cr	Dry3	211	481	2001	1,000	4,104	0.69%	-0.10	19.5	7	47%	3	26%	1	5%	3.7	395
Dry Cr	Dry3	211	557	2002	1,000	4,104	0.70%	-0.39	17.5	6	43%	3	17%	1	7%	3.5	298
Dry Cr	Dry3	211	577	2003	1,000	4,104	0.74%	-0.33	22.1	6	56%	4	42%	2	26%	4.0	502
Dry Cr	Dry3	211	636	2004	1,000	4,104	0.77%	-0.27	29.4	5	41%	4	31%	2	13%	6.8	381
Dry Cr	Dry3	211	689	2005	1,000	4,104	0.75%	-0.22	29.1	4	34%	4	34%	2	16%	6.7	387
Dry Cr	Dry3	211	801	2006	1,000	4,104	0.80%	0.52	21.1	7	48%	5	37%	1	7%	3.0	393
Dry Cr	Dry3	211	874	2007	1,000	4,104	0.78%	0.54	19.9	6	25%	3	13%	2	9%	4.2	279
Dry Cr	Dry3	211	902	2008	1,000	4,104	0.84%	0.42	21.3	8	47%	5	32%	1	8%	3.4	484
Dry Cr	Dry3	211	1182	2009	1,000	4,104	0.86%	0.42	23.1	10	48%	6	31%	1	4%	4.1	451
Dry Cr	Dry3	211	1235	2010	1,000	4,104	0.86%	0.56	21.1	5	35%	3	24%	2	13%	3.6	348
Dry Cr	Dry2	212	425	2000	6,800	3,756	1.82%		12.8	5	32%	0	0%	0	0%	2.0	267
Dry Cr	Dry2	212	945	2008	6,800	3,756	1.89%	-0.40	14.2	4	23%	1	13%	0	0%	2.1	231
LNF Gualala	LNF3	404	480	2001	2,400	4,217	0.57%		33.2	5	63%	4	53%	2	30%	3.5	577
LNF Gualala	LNF3	404	635	2004	2,400	4,217	0.79%	-0.61	56.8	9	77%	4	45%	2	27%	5.0	978

Stream	Station Name	Station #	Station Visit ID	Station Year	Distance up Stream (Feet)	Drainage Area (Acres)	Slope	Streambed Agradation Degradation (Feet)	Variation Index	Pools >1'	Pools %	Pools >2'	Pools %	Pools >3'	Pools %	Pools Max Depth (Feet)	Longitudinal Cross Sectional Area of Pools > 1' Deep (Sq Ft/1,000')
LNF Gualala	LNF1	203	33	1998	12,000	1,963	1.54%		23.3	8	35%	0	0%	0	0%	2.0	264
LNF Gualala	LNF1	203	342	1999	12,000	1,963	1.52%	-0.19	21.1	9	38%	0	0%	0	0%	2.0	275
LNF Gualala	LNF1	203	419	2000	12,000	1,963	1.49%	-0.08	21.1	7	23%	0	0%	0	0%	1.9	150
LNF Gualala	LNF1	203	491	2001	12,000	1,963	1.49%	-0.10	20.3	7	23%	2	7%	0	0%	2.1	161
LNF Gualala	LNF1	203	558	2002	12,000	1,963	1.41%	-0.26	28.2	12	42%	4	14%	1	4%	3.2	304
LNF Gualala	LNF1	203	574	2003	12,000	1,963	1.42%	-0.40	29.8	13	39%	4	16%	1	3%	3.2	363
LNF Gualala	LNF1	203	634	2004	12,000	1,963	1.54%	-0.73	32.4	13	47%	6	25%	1	4%	3.1	374
LNF Gualala	LNF1	203	685	2005	12,000	1,963	1.35%	-0.93	31.4	11	42%	5	20%	1	6%	3.0	386
LNF Gualala	LNF1	203	799	2006	12,000	1,963	1.46%	-1.08	28.1	15	57%	3	14%	0	0%	2.9	436
LNF Gualala	LNF1	203	872	2007	12,000	1,963	1.49%	-0.38	30.5	15	56%	4	18%	1	3%	4.4	452
LNF Gualala	LNF1	203	901	2008	12,000	1,963	1.43%	-0.72	33.8	14	61%	5	24%	1	3%	4.4	482
LNF Gualala	LNF1	203	1065	2009	12,000	1,963	1.45%	-0.66	34.1	14	49%	5	18%	1	2%	4.3	434
LNF Gualala	LNF1	203	1233	2010	12,000	1,963	1.45%	-0.62	32.6	14	53%	5	20%	1	4%	3.9	423
NF Gualala	NFG4	473	477	2001	2,300	30,600	0.26%		27.6	6	65%	2	17%	1	11%	4.4	556
NF Gualala	NFG3	204	347	1999	6,600	25,433	0.37%		23.0	9	74%	3	32%	1	12%	4.7	654
NF Gualala	NFG3	204	495	2001	6,600	25,433	0.38%	-0.41	26.3	12	67%	4	38%	4	38%	4.9	770
NF Gualala	NFG3	204	878	2007	6,600	25,433											
NF Gualala	NFG3	204	898	2008	6,600	25,433	0.33%	-1.00	30.6	8	77%	8	77%	4	40%	5.8	972
NF Gualala	NFG5	691	1194	2009	64,500	12,160	0.32%		43.5	3	49%	2	38%	1	19%	5.5	652
Robinson E	Rbn1	697	686	2004	0	3,022	0.59%		22.8	6	41%	2	16%	1	13%	3.1	325
Robinson E	Rbn1	697	1193	2009	0	3,022	0.61%	-0.39	35.0	6	52%	4	36%	2	17%	4.3	585
Robinson E	Rbn2	692	1192	2009	10	4,061	1.64%		65.3	11	56%	3	29%	2	19%	7.2	718
Robinson W	Rob2	207	345	1999	600	1,068	1.39%		13.1	2	5%	0	0%	0	0%	1.2	25
Watershed	Rockpile																
Rockpile Cr	Roc3	221	304	1998	2,650	22,373	0.27%		16.9	5	78%	4	74%	2	47%	3.2	822
Rockpile Cr	Roc3	221	349	1999	2,650	22,373	0.31%	-0.21	10.5	7	59%	2	24%	0	0%	2.3	410
Rockpile Cr	Roc3	221	576	2003	2,650	22,373	0.27%	-0.40	12.8	12	64%	4	23%	0	0%	2.8	497
Rockpile Cr	Roc1	401	806	2006	18,800	20,000	0.16%		29.1	4	76%	3	61%	3	61%	3.8	973
Rockpile Cr	Roc4	701	807	2006	32,000	18,925	0.24%		52.4	4	73%	3	64%	2	58%	6.2	1,123
Watershed	Russian Estuary																
Jenner G	Jen1	407	303	1998	3,200	2,000	3.26%		40.0	7	19%	2	3%	0	0%	3.0	151
Watershed	SF Gualala																
Big Pepperwoo	Ppw3	218	305	1998	800	1,825	1.37%		14.3	7	45%	3	20%	0	0%	2.9	352
Big Pepperwoo	Ppw3	218	343	1999	800	1,825	1.46%	-0.31	12.7	8	50%	2	15%	0	0%	2.6	420
Big Pepperwoo	Ppw3	218	569	2002	800	1,825	1.40%	-0.68	13.4	12	43%	2	5%	1	3%	3.1	316
Big Pepperwoo	Ppw3	218	575	2003	800	1,825	1.40%	-1.16	16.4	11	50%	5	32%	1	6%	3.7	489
Big Pepperwoo	Ppw3	218	637	2004	800	1,825	1.43%	-1.02	14.5	12	54%	5	22%	0	0%	2.5	430
Big Pepperwoo	Ppw3	218	687	2005	800	1,825	1.43%	-1.11	16.7	13	54%	4	21%	3	15%	3.6	473
Big Pepperwoo	Ppw3	218	800	2006	800	1,825	1.56%	-1.20	16.2	10	56%	7	40%	1	5%	3.1	519
Big Pepperwoo	Ppw3	218	873	2007	800	1,825	1.50%	-1.13	15.3	9	41%	5	20%	2	7%	3.4	414
Big Pepperwoo	Ppw3	218	904	2008	800	1,825	1.52%	-1.27	16.9	10	43%	4	15%	2	7%	3.7	394
Big Pepperwoo	Ppw3	218	1181	2009	800	1,825	1.52%	-1.12	16.5	9	42%	3	12%	1	6%	3.6	385
Big Pepperwoo	Ppw3	218	1234	2010	800	1,825	1.53%	-1.13	14.7	11	43%	4	16%	3	14%	3.2	323
Carson Cr	Car1	631	639	2004	0		1.45%		41.8	8	42%	2	12%	1	5%	4.3	393
McKenzie	McK1	615	638	2004	0	2,620	1.24%		26.8	6	55%	3	37%	1	6%	4.5	437

Stream	Station Name	#	Visit ID	Year	Distance up Stream (Feet)	Drainage Area (Acres)	Slope	Streambed Agradation Degradation (Feet)	Variation Index	Pools >1'	%	>2'	%	>3'	%	Max Depth (Feet)	Longitudinal Cross Sectional Area of Pools > 1' Deep (Sq Ft/1,000')
SF Gualala	Gua1	217	306	1998	5,200	157,415	0.11%		23.1	4	79%	2	58%	2	58%	5.0	1,050
SF Gualala	Gua1	217	420	2000	5,200	157,415	0.03%	-0.10	22.4	4	52%	3	84%	1	49%	5.2	1,300
SF Gualala	Gua1	217	492	2001	5,200	157,415	0.07%	0.19	20.0	3	78%	2	61%	2	61%	4.6	1,068
SF Gualala	Gua1	217	568	2002	5,200	157,415	0.10%	0.01	26.6	3	69%	2	59%	2	59%	4.7	1,099
SF Gualala	Gua1	217	578	2003	5,200	157,415	0.11%	0.10	21.7	5	76%	2	63%	2	63%	4.2	1,077
SF Gualala	Gua1	217	633	2004	5,200	157,415	0.09%	0.18	25.6	2	55%	2	55%	2	55%	4.9	1,079
SF Gualala	Gua1	217	810	2006	5,200	157,415											
SF Gualala	Gua1	217	877	2007	5,200	157,415	0.13%	-0.23	21.0	5	75%	2	55%	2	55%	4.4	1,100
SF Gualala	Gua1	217	903	2008	5,200	157,415	0.10%	-0.24	23.2	4	81%	2	61%	2	61%	4.2	1,165
SF Gualala	Gua1	217	1191	2009	5,200	157,415	0.06%	-0.14	22.1	3	75%	2	67%	2	67%	5.0	1,167
SF Gualala	SFG	402	346	1999	41,000	31,081	0.33%		29.1	5	62%	2	23%	1	15%	4.9	579
SF Gualala	SFG	402	896	2008	41,000	31,081	0.41%	-0.11	30.8	6	76%	5	74%	2	20%	6.8	788
Watershed	Wheatfield																
Redwood Cr	Rdw1	704	805	2006	2,000	703	6.90%		19.9	11	24%	1	4%	1	4%	3.5	202
SF Fuller	SFu1	663	776	2005	14,000	1,065	2.05%		24.3	9	36%	0	0%	0	0%	1.5	216
Wheatfield	Wfg3	226	426	2000	2,200	71,409											
Wheatfield	Wfg3	226	579	2003	2,200	71,409	0.07%		20.5	3	82%	2	79%	2	79%	5.1	1,785
Wheatfield	Wfg3	226	895	2008	2,200	71,409	0.08%	0.05	29.0	3	87%	3	87%	3	87%	6.3	2,076
Wheatfield	WFG6	651	809	2006	120,000	16,864	0.63%		38.2	4	63%	3	58%	1	31%	3.8	746
Wheatfield	WFG7	652	808	2006	122,000	10,620	0.55%		26.4	4	66%	2	41%	0	0%	2.2	500

Total Station Visits: 92


THP's History of the North Fork Gualala River Watershed
N.F. Gualala River Watershed
Rivers & Streams
N.F. Reach Site #204
THP Year
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2004
2006
2007
N
0
5,000
10,000
Feet
Mendocino County
Sonoma County
Gualala
2000
1992
1991
1999
2004
1996
2007
2001
1993
1998
2006
1997
1995
1994