CLEAN STREAMS PROGRAM

BRANCIFORTE CREEK WATERSHED
DRAFT
ANNUAL REPORT
JULY-DECEMBER 2003

Attn: Bernadette Ramer
Watershed Coordinator
Coastal Watershed Council
P.O. Box 1459
Santa Cruz, California 95061
Ph: (831) 464-9200 Fax: (831) 464-9214

COASTAL WATERSHED COUNCIL

BRANCIFORTE CREEK WATERSHED
Annual Report
July-December 2003

EXECUTIVE SUMMARY

Citizen water quality monitoring began in Branciforte Creek in September 1999 with one family monitoring Branciforte Creek behind their house. By June 2003, the group, now called "The Neighbors of Branciforte Creek", had grown to 10 volunteers monitoring six sites within the watershed.

The Coastal Watershed Council collaborated with the Neighbors of Branciforte Creek Watershed to continue monitoring and to support and inform ongoing watershed restoration action strategies. Through funding from the State Water Resources Control Board (SWRCB), the Clean Streams Program continues collecting data, following guidelines and recommendations. The intent of the current Clean Streams Monitoring Program encompasses four main water quality goals:

- To provide baseline and ongoing data where data are lacking or absent.
- To support and inform ongoing assessments and enhancement plan development and ultimately provide effectiveness monitoring for projects resulting from the assessment and enhancement plans.
- To support and inform ongoing watershed restoration action strategies.
- To develop and support stakeholder involvement in watershed initiatives and foster long-term watershed stewardship.

Clean Streams water quality monitoring in Branciforte Creek began in May 2003. The 2003 Monitoring Program focused on collecting water quality data three times per month and biannual water sampling for laboratory chemical analysis.

Water quality parameters measured include:

- Air and water temperature
- Dissolved oxygen
- Turbidity
- Conductivity
- pH

Twenty-four volunteers sampled six stations in the Branciforte Creek watershed between 13-15 times. Field measurements were taken between July and December 2003. Water quality measurements were taken three times per month. A water sampling collection for laboratory chemical analysis occurred on November 5, 2003.

Ninety-nine percent of the data collected was within water quality standards set by CCAMP. Approximately 10% of the dissolved oxygen values fell below the water quality standard of 7.0 m/l and about 2% of the water temperatures and pH values were outside the water quality standards.

The Branciforte/San Lorenzo River Confluence station had the highest number of values that exceeded the water quality standards for dissolved oxygen (2 exceedences), pH (1 exceedence), water temperature (2 exceedence). This area, which is at the outlet to the San Lorenzo River needs continued detailed monitoring.

Recommendations for 2004-2005 are to continue monitoring of basic water quality parameters and add detergent and ammonia-nitrogen testing at 434 Market Street and the Carbonera Creek station since these substances have been detected in prior monitoring. Nitrate and bacteria sampling will be done in the wet and dry season, with the addition of streamflow monitoring and benthic macroinvertebrate sampling. Continued recruitment and training of additional volunteers will enhance the educational benefit of the program to the community and maintain the volunteer base.

Ongoing monitoring of Branciforte Creek will provide information on seasonal variability in basic water quality parameters. Long term monitoring will also provide volunteers with hands-on knowledge of their local watershed and the corresponding educational benefits to the community.

Table of Contents

I. COASTAL WATERSHED COUNCIL'S MONITORING PROGRAM

The Coastal Watershed Council (CWC) is a nonprofit organization committed to the preservation and protection of coastal watersheds through citizen-based conservation, education and community outreach. Serving as watershed advocates, CWC promotes the health of these ecosystems through stewardship, advocacy and proper management practices. Founded in 1994, the Coastal Watershed Council was formed in response to the declining health of the watersheds of the Monterey Bay region.

The mission of the Coastal Watershed Council is to restore the watersheds of the Monterey Bay region and teach area residents how to become stewards of their local creeks and streams. CWC's program areas focus on:

- Watershed stewardship, research and restoration
- Watershed education and outreach through citizen monitoring programs
- Organizational support and training for other grassroots watershed groups

Clean Streams

The Clean Streams Program is managed by the CWC and provides water quality monitoring in 4 watersheds on the Central Coast. The goals of the monitoring are:

- To provide baseline data where data are lacking or absent.
- To support and inform ongoing assessments and enhancement plan development and ultimately provide effective monitoring for projects resulting from the assessment and enhancement plans.
- To support and inform ongoing watershed restoration action strategies.
- To develop and support stakeholder involvement in watershed initiatives and foster long- term watershed stewardship.

The four Central Coast streams in the 2003-4 program include: Aptos, Branciforte, Corralitos and Gazos Creeks. The Clean Streams Citizen Monitoring Program included recruitment, all aspects of training, scheduling and supervision of volunteers, data entry, and draft and final data report completion. Watershed Coordinators work under the supervision and direction of the CWC's Watershed Program Managers.

The Neighbors of Branciforte Creek Watershed began a volunteer monitoring program in September 1999 at a creek site behind the residence at 434 Market Street. The volunteers were Tina and Ken Slosberg, the owners of that residence. The program was expanded to include five more sites and additional volunteers and monitoring continued through June 2003. The water quality parameters tested were water and air temperature, dissolved oxygen, ammonia-nitrogen, detergents, pH and conductivity. The monitoring sites were Branciforte Creek at the San Lorenzo River, 434 Market Street, Carbonera Creek at Branciforte Creek, the Forty Thieves Picnic Area of Delaveaga Park, Happy Valley School and 4567 Branciforte Drive. The Clean Streams Program collaborated with the Neighbors of Branciforte Creek and continued water quality monitoring on the Branciforte Watershed. The stations included in the Clean Streams Program were those monitored previously with the exception of 4567 Branciforte, which was not monitored this season. In addition, a station along Granite Creek, a tributary of Branciforte Creek, was added.

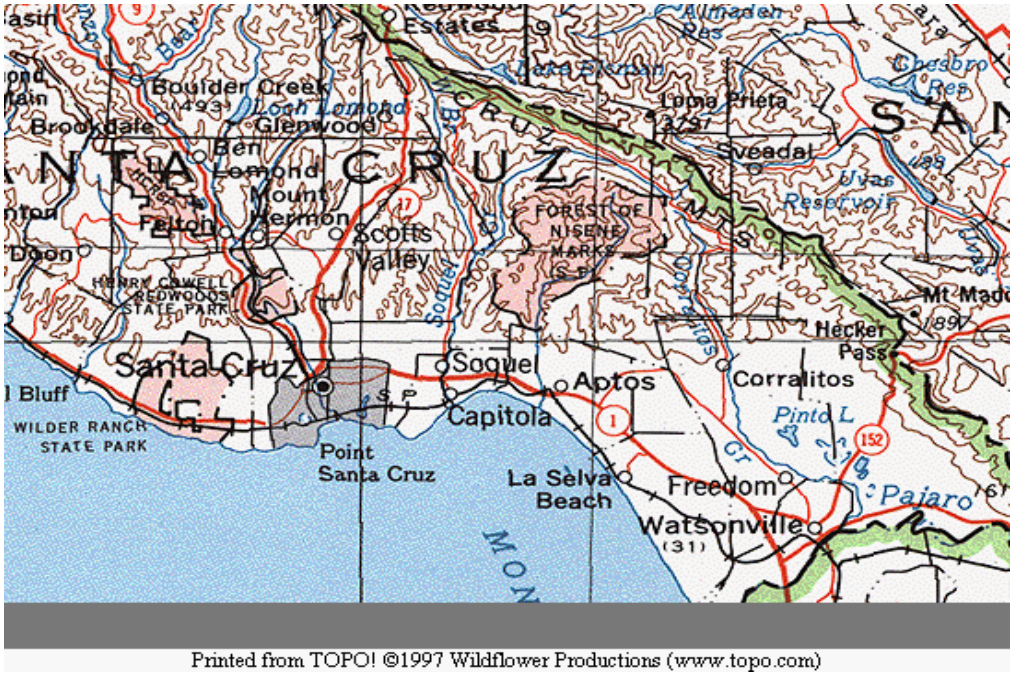

Figure 1. General location of Branciforte Creek Watershed.

Description of Branciforte Creek Watershed Monitoring Program

Branciforte Creek is the San Lorenzo River's largest tributary and flows into the San Lorenzo River in the city of Santa Cruz, California. The Branciforte Creek Watershed also includes the drainage of the Carbonera Creek. The final mile of Branciforte Creek is confined into a concrete culvert flood control channel. Upstream of the control channel, Branciforte Creek is a natural stream bordered by riparian vegetation.

Branciforte Creek is know to support steelhead trout, a federally threatened species. Recent studies by the California Department of Fish and Game (CDFG) have recommended sediment source studies for the creek as well as increasing woody cover in pools and other slow water habitats in addition to further analysis of creek temperature. A CDFG study completed in November 2001 found that steelhead downstream migration, low flows, high temperatures and lack of escape cover might impede passage. The same study found that upstream migration was complicated by high winter flows and lack of resting areas for steelhead. The San Lorenzo Urban River Plan (City of Santa Cruz, 2002) recommends continuing the volunteer water quality monitoring program for Branciforte Creek and expanding it to include monitoring stream flow in summer months.

Monitoring in the San Lorenzo River Watershed represents the water quality goal of supporting and informing ongoing watershed restoration action strategies. CWC also has an established history of data collection in the San Lorenzo River watershed. The target area for monitoring in the watershed is Branciforte Creek where citizens have contributed in the past by participating in a water quality monitoring program. Others areas within the San Lorenzo River Watershed are monitored through programs conducted by the City of Santa Cruz, Santa Cruz Country Environmental Health Department and other local agencies.

The Clean Streams Watershed Monitoring Program for Branciforte Creek began in May 2003. Volunteer outreach methods included flyers and posters, community outreach notices, press releases and public service announcements A two-hour informational public meeting was held on 9 July 2003 to provide information about the Coastal Watershed Council and the Clean Streams program, its goals and the volunteer time commitment required. This was followed by a two-hour Volunteer Monitoring Training Session on July 16, 2003.

The training provided creek side hands-on training conducting field water quality tests, paying particular attention to Standard Operating Procedures (SOP'S) and protocols for each parameter to be tested. Program Manager, Tamara Doan, and

Watershed Coordinator, Bernadette Ramer, conducted the training. Field monitoring teams were created at the training session and a schedule formed based on volunteer availability. Team leaders were chosen based on performance during field training, leadership, and willingness to commit to the additional volunteer time required for that position. . Team leaders were responsible for kit pickup and checkout before monitoring events and for communication between the Watershed Coordinator and members of the teams. Leaders ensured that team members were aware of the monitoring schedule and communicated any needs and irregularities to the Coordinator.

Twenty-four volunteers were split into six teams with three teams monitoring the lower Branciforte stations and three teams monitoring the upper Branciforte stations. Each station was monitored a minimum of three times per month between 3 August and 22 November 2003.

Figure 2 shows the six monitoring stations in the Branciforte Creek Watershed.
Lower Stations:

- Branciforte Creek/San Lorenzo River Confluence Station ID: 304-Branc-21
- 434 Market Street Station ID: 304-Branc-23
- Carbonera Creek/Branciforte Creek Confluence Station ID: 304-Carbo-21

Upper Stations:

- Forty Thieves Station ID: 304-Branc-22
- Happy Valley School Station ID: 304-Branc-24
- Granite Creek Station ID: 304-Grani-21

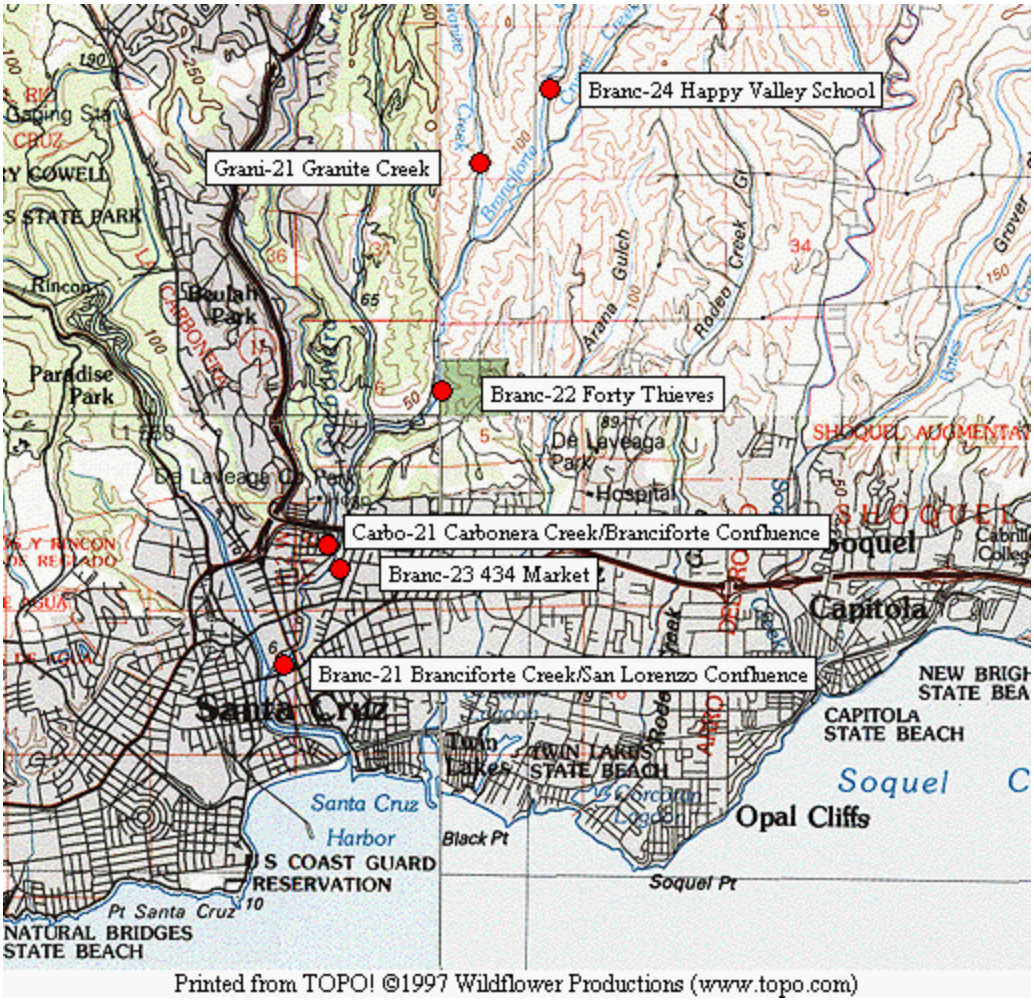

Figure 2. Branciforte Creek Watershed Stations

Four stations were chosen for nutrient and bacteria analysis on 5 November 2003: Branciforte Creek/San Lorenzo River Confluence, 434 Market Street, Carbonera Creek/Branciforte Creek Confluence and Forty Thieves.

Volunteer Participation

Hours spent by Branciforte Creek volunteers in the field, at the community meeting and in-field training came to a 219 total hours between 1 July 1 –22 November 2003, with most of the hours spent in the field.

A volunteer recognition party was held at Petroglyphs in Santa Cruz on December 3, 2003 for volunteers from all current CWC programs 9 of 23 Branciforte volunteers joined in the celebration that evening.

Participating volunteers during the 2003 season included:

Carolyn Allansmith
Eric Berg
Tammy Bowser
Tyson Coolman
Emily Corwin
Nora Grant
Breta Holgers
Carolyn Johnson
Mackenzie Manning
Eric Morgan
Bryn Morgan
Barbara Novelli
Fleur O'Neill
Alyssa Ramer
Bob Ramer
Ken Slosberg
Tina Slosberg
Joyce Smith
Jeremiah Sprague
Katharine Trombino
Iris Wallace
Nick Wallace
Ty Wallace

II. DATA QUALITY, METHODS AND EQUIPMENT

Coordinator Training

Watershed Coordinators received a two full day of classroom and in-field training. The training session was conducted by Program Managers Tamara Doan and Kaitilin Gaffney and assisted by Bridget Hoover (Monterey Bay Sanctuary Citizen Watershed Monitoring Network). The training topics covered were administration, quality assurance, the Monitoring Plan, parameters, volunteers, data and reporting.

Volunteer training

Volunteers received a full day of classroom and in-field training prior to monitoring and each team was accompanied by the coordinator on initial visits in the field. Program Manager, Tamara Doan, and Watershed Coordinator, Bernadette Ramer, conducted the training session. Training topics included: program purpose, safety, equipment orientation, in-field training on Standard Operating Procedures (SOP's), and quality assurance. The Coordinator continued to supervise each team during the monitoring season as necessary. Volunteer teams were provided with a monitoring manual which included descriptions of parameters to be tested, parameter fact sheets, general watershed ecology, SOP's, data recording sheets, volunteer schedule, maps and directions to stations, and a list of contact information for the coordinator and program volunteers.

Volunteers conducted water quality monitoring three times per month at the selected monitoring stations within the watershed. The specific parameters sampled and station locations for monitoring were developed as part of the community outreach portion of this program and added to the monitoring plan prior to commencement of volunteer monitoring. At each station, volunteers were trained to collect water samples according to the appropriate protocol and to measure air and water temperature, pH, turbidity, dissolved oxygen and conductivity.

The Clean Streams water quality monitoring included the testing equipment, paper towels, first aid kit, clipboard, and a Water Quality Monitoring manual. The Coordinator maintained the kit.

Standard Operating Procedure (SOP's)

A Standard Operating Procedure (SOP) is an approved methodology for conductivity, dissolved oxygen, pH, turbidity and water temperature provided by State Water Resources Control Board (SWRCB) Clean Water Team (Table 1). Volunteer monitoring was conducted following the Standard SOP's.

Table 1. SWRCB Clean Water Team Compendium Standard Operating Procedures

Parameter	Equipment	SWRCB SOP
Dissolved Oxygen	Winkler Model EDO Code: 7414	3.1.1.2
Water Temperature	Bulb Thermometer LaMotte Code 1066	3.1.2.1
Conductivity	ECTestr Oakton ISO 9001	3.1.3.1
pH	Non-bleeding pH strips Macherey-Nagel D-52348	3.1.4.2
Turbidity	Dual Cylinder turbidity kit Model TTM Code 7519	3.1.5.3

Data Quality Objectives (WQO)

This section identifies how sensitive and representative, precise, accurate, and complete measurements will be (Table 4). These Data Quality Objectives were derived by reviewing the QAPP and performance of other citizen monitoring organizations, by considering the specifications of the instruments and methods planned for use, and by considering how the data will be used.

Detection Limit and Sensitivity
The Method Detection Limit is the lowest possible concentration an instrument, or equipment, can detect. Sensitivity is the ability of the instrument to detect one concentration level from the next.

Precision
The precision objectives apply to replicate samples taken as part of a QC session or as part of periodic in-field QC checks. Precision describes how well repeated measurements agree. The evaluation of precision described here relates to repeated measurements taken by either different volunteers on the same sample (at quality control sessions) or the same volunteer analyzing replicate samples in the field. Sampling variability will not be covered in this section.

.

Accuracy
Accuracy describes how close a measurement is to its true value. Using standard solutions, accuracy measurements compare the results of a sample of known value to its measured value. Accuracy checks are conducted twice per year on conductivity, pH, and temperature.

Completeness
Completeness is the fraction of planned data that must be collected in order to fulfill the statistical criteria of the project. Volunteer data will not be used for legal or compliance uses. There are no statistical criteria that require a certain percentage of data. However, it is expected that 80% of all measurements would be taken when anticipated. This accounts for adverse weather conditions, safety concerns, and equipment problem.

Table 2 - Data Quality Objectives for Conventional Water Quality Parameters

Parameter	Method/range	Units	Detection Limit	Sensitivity	Precision	Accuracy	Complete-ness
Temperature	Thermometer (-5 to 50)	^{o} C	-5	0.5 ^{o} C	± 0.5 ^{o} C	± 0.5 ^{o} C	80%
Dissolved oxygen	Micro-Winkler Titration	mg/L	0.2 mg/L	0.2 mg/L	± 10%	± 10%	80%
pH	Non-bleeding Strips (range 4.5-10.0)	pH units	4.5	0.5 unit	± 0.5 units	± 0.5 units	80%
Conductivity	Conductivity Meter	µS/cm	10	10 µS/cm	± 10%	± 10%	80%
Turbidity	Dual Tube Optical	JTUs	5	5 JTUs	± 5 JTUs	NA	80%

NA: not applicable

- Note: Some test kits vary in sensitivity over the range of detection. The specific range of readings is noted in parentheses.
- DQO's are based on the manufacturer's enclosed accuracy information.

Quality Assurance
The following field measurement quality objectives were adopted to validate the quality of the data collected for the Clean Streams volunteer monitoring program:

1) Assure that each instrument had a unique identifying code (referred to as "Instrument ID") that was tracked with each measurement taken.
2) Assure that adjustable and non-adjustable-reading equipment provided was calibrated every 6 months using a certified state Standard to assess accuracy.
3) Assure accurate labeling of chemical reagents with expiration dates provided by LaMotte Chemical Company and that expired reagents were not used in the testing (dissolved oxygen and turbidity).
4) Assure that each instrument had at lease one "replicate" measurement on each field day for the purpose of calculating 'precision'.

5) Assure that in-field measurements were taken appropriately by providing adequate instruction and written procedures for volunteers.

Laboratory

Samples were sent to Santa Cruz County Environmental Health Department, under the supervision of Steve Peters for bacteria and nutrient analyses. It is assumed that each laboratory will act under the guidelines of its own QAPP and authorization to operate as a professional water quality laboratory in the State of California.

The laboratory quality assurance samples taken for this project were as follows:

- Field "Duplicates" (a second container filled at the same time in the same location) for both bacteria and nutrient samples were collected for laboratory analysis in one of the four station locations in the watershed.
- One "Field blank" (a sample container filled with distilled water while in the field) was collected for conducting bacteria analysis.
- A temperature blank was kept in each sample cooler. This was used to record the temperature of the samples until they were turned over to the lab.

Water Quality Objectives

A Water Quality Objective (WQO) is the acceptable range of values for a particular parameter, what constitutes *healthy* water quality. The Regional Water Quality Control Board (RWQCB) has created a Basin Plan to show how the quality of the surface and ground waters in the Central Coast Region should be managed to provide the highest water quality reasonably possible (Basin Plan).

The Central Coast RWQCB has established The Central Coast Ambient Monitoring Program (CCAMP), a regionally scaled water quality monitoring and assessment program whose purpose is to provide scientific information to Regional Board staff and the public, to protect, restore, and enhance the quality of the waters of central California (CCAMP, 2004). The CCAMP program has set "action levels" for the water quality parameters, which are specific to this geographic area. An action level is an indicator or flag assigned to the data indicating that it is above or below an acceptable range. The parameter may or may not have a regulatory limit associated with it. The Clean Streams program has adopted these action levels as our WQO for dissolved oxygen, pH and water temperature, as well as for bacteria (E. coli, total coliform) and nutrient (ortho-phosphate, nitrate-nitrogen and ammonia) analysis.

After the monitoring was completed, and the data verified, WQOs were then applied to the results. If a result at a particular station did not meet its WQO, it was identified as having 'exceeded' its criteria. The phrase "exceedence" was adopted to discuss the values that were out of the acceptable range for "good" water quality as defined by the WQO. Based on the WQO for an individual parameter, exceedence values can be either higher or lower than the WQO.

All of the parameters with WQO have a significant impact on water quality and habitat value for wildlife and fishes in coastal California, as well as indicate concerns for human health (Table 3).

Table 3. Water Quality Objectives

Parameter	Water Quality Objectives (WQO)	Source of Objective
Dissolved Oxygen (mg/l)	Not lower than 7	CCAMP Action Level
pH	Not <7.0 or > 8.5	CCAMP Action Level
Temperature (°C)	Not > 22 °C	CCAMP Action Level
Turbidity	Not >20 JTU	NA

DESCRIPTION OF PARAMETERS AND RELEVANCE TO WATER QUALITY AND HABITAT

Conductivity

Conductivity is a general measure of water's ability to conduct an electrical current. There are no water quality objectives for conductivity for water bodies in the Central Coast Region. Generally, potable water in the United States ranges between 30 to 1500 uS/cm and irrigation supply water ranges exceed 750 uS/cm (EPA 1994). Volunteers measure conductivity with a temperature-adjusted meter in the field.

Testing for conductivity provides ways to:

- identify different water sources (for example, rain water, agricultural runoff, municipal waste water)
- identify potential sources of pollution
- monitor seasonal changes in the water table
- monitor effects of salt water intrusion (salt water typically has higher conductivity than fresh water because of the presence of salts in the water)
- infer the local geology of the area (baseline conductivity varies depending upon which minerals are present as surface water flows over the local substrate)

Dissolved Oxygen

Dissolved oxygen (DO) refers to the amount of oxygen captured within the water column. Factors that affect the concentration of dissolved oxygen include temperature, DO sources (such as photosynthesis that adds oxygen to the water), DO sinks (such as respiration that consume oxygen), breakdown of organic material, sewage, yard waste, oil and grease, and salinity. Low dissolved oxygen levels usually result from water temperature increases, algal blooms, or the presence of human and animal waste.

Aquatic organisms, such as fish and amphibians, require adequate amounts of dissolved oxygen for their continued health and survival. Reduced dissolved oxygen levels in freshwater systems can cause problems with reproduction and incubation, egg or larval failure, retarded growth, and, in extreme cases, death in salmonids.

Anadromous fish require high DO levels (>9.0 mg/l) during their reproductive phases (San Francisco Estuary Institute 1997). During the juvenile growth period (in the summer and fall), DO levels must remain at 8.0 mg/l or higher to prevent impairment. DO levels fall to 6.5-7.0 mg/l, sharp decreases in performance have been observed. Embryos and larvae require even higher DO levels (State Water Resources Control Board 1996). The Water Quality Objective minimum for DO for supporting coldwater fish has been set at not less than 7.0 mg/l (Basin Plan).

pH

pH is a measure of how acidic or basic (alkaline) the water is. On a scale of 0-14, a pH value of 7 is said to be neutral, (neither acidic or basic). As the pH decreases, water becomes more acidic; as the pH increases, water becomes more basic. Changes in pH may also alter the concentrations of other substances in the water to a more toxic form. In freshwater systems, pH usually ranges between 6.5 and 8.5 (San Francisco Estuary Institute 1997). In fresh water, increasing temperature decreases pH. In the Central Coast Region for waters that are designated municipal and domestic water supply, water contact recreation, and non-contact water recreation, it is recommended that pH not fall below 6.5 or rise above 8.5 (Basin Plan).

Most fish species can tolerate pH values between 6.0 to 9.0. However, on the Central Coast, in streams that support salmon and steelhead, the pH values must fall between 7.0 and 8.5. Extreme pH values (<5 or >9) can be detrimental to fish survival and may cause physical damage to their gills, exoskeleton, and fins, and, in some cases, death (Basin Plan).

Temperature

Water temperature is one of the most important water quality parameters that has direct affects on water chemistry and the functions of aquatic organisms. Temperature influences the dissolved oxygen content of the water; conductivity and pH levels; the rate of photosynthesis by algae and other aquatic plants; the metabolic rates of organisms; the sensitivity of organisms to toxic wastes, parasites and diseases; and the timing of reproduction, migration and aestivation of aquatic organisms.

Factors that can affect water temperature include sunlight energy, seasonal and daily changes, shade, air temperature, streamflow, water depth, inflow of groundwater or surface water, and the color and turbidity (cloudiness) of the water. Other factors that can affect temperature include soil erosion, stormwater runoff, removal of riparian vegetation, water diversions, cooling water discharges from power plants, and alterations to stream morphology, substrate and flow. Water temperature is reported in degrees Celsius (°C).

Upstream migration of salmon and steelhead can occur when stream temperatures are between 3 °C and 20 °C; higher temperatures can inhibit migration, inducing salmonids to remain at sea until temperatures decrease (Reiser and Bjornn 1979). Water temperatures of 11.8-14.6 °C are optimal for coho salmon rearing; temperatures over 20 °C stop growth; and temperatures over 26 °C are lethal to coho salmon. Steelhead prefer lower temperatures of 7.3-14.6 °C for rearing; temperatures over 20 °C stops growth; and temperatures above 24 °C can result in mortality. Low water temperatures are imperative for successful salmonid reproduction and rearing.

Turbidity

Turbidity is a measure of the amount of suspended particles in the water. Watersheds have a natural turbidity level given the effects of natural erosion, organic decay and algae. There has been no determination of the natural turbidity level in most of the local watersheds within the Central California Coast. Turbidity can be an indicator of erosion, excessive nutrient loading and algal growth. Because of the number of suspended plants and animals (plankton) found within stream systems, turbid water can also be considered natural. The baseline level of turbidity will vary from stream to stream depending on the nutrient loading, geology and stream dynamics. Turbidity increases caused by discharge of sediment or nutrients should not exceed 10% of natural levels. In the absence of a numeric data quality objective, a turbidity level of >20 JTU (Jackson Turbidity Units) was adopted for this program.

Salmon and steelhead need clear-running streams with minimal sediment. High turbidity levels can indicate high sedimentation within the system. If a creek or river is heavily sedimented, spawning gravels and deep-water rearing habitat can become silted in. Also, highly turbid waters can increase the chance for redds (nests with egg sacks) to be washed away during storm events. Excessively turbid waters can also impair feeding. Coho salmon redds are highly susceptible to destruction caused by early storms (Smith 1998).

III. DATA RESULTS

From 26 July to 23 November 2003, 24 volunteers conducted between 13 to15 water quality field data monitoring trips in both the Upper and Lower Branciforte Watershed. The monitoring trips were conducted throughout the day (between 0730-1830 hours) with two to five volunteers working together. The basic water quality measurements taken were air and water temperature, dissolved oxygen, pH, turbidity and conductivity. In addition, nutrient and bacteria samples were obtained by Bernadette Ramer and Tina Slosberg on November 5, 2003 at four of six stations (Happy Valley School and Granite Creek site were excluded) and analyzed by the Santa Cruz Department of Environmental Health.

Table 4 summarizes the water quality data by parameter for all the six stations sampled within the Branciforte Creek watershed. It provide the Water Quality Objective, the total number of samples collected, and includes the number and percent exceedences, and the range and mean of each parameter. Tables 5 summarize the same information for each of the six stations.

Table 4. Branciforte Creek Watershed

Parameter	WQO	Number of Samples	Number of Exceedences	Percent Exceedences	Minimum Result	Maximum Result	Mean Result
Air Temp (°C)	none	87			4.5	29.5	16.9
Conductivity (uS)	none	84			310	10300	790
DO (mg/l)	not <7	85	9	10.5	4.8	16.2	8.0
pH	not < 7.0 or > 8.5	86	2	2.3	6.5	8.5	7.3
Turbidity (JTU)	Not > 20 JTU	84	1	1.2	5	80	
Water Temp (°C)	not > 22°C	87	2	2.2	5.5	27	14.2

Conductivity

The mean conductivity at all six stations was 790 uS with a range of 310 uS to 10,300 uS. The highest conductivity values were recorded at the Branciforte/San Lorenzo Station where the mean value was 1947 uS. The mean conductivity at the other five stations were: 591 uS at 434 Market, 431 uS at Carbonera Creek, 684 uS at Forty Thieves, 534 uS at Granite Creek, and 649 uS at Happy Valley School.

Dissolved Oxygen

The mean dissolved oxygen (DO) for the six stations was 8.0 mg/l with a range of 4.8 mg/l to 16.2 mg/l (Table_). The mean DO at each station was between 7.4-8.0 mg/l except at the Branciforte/San Lorenzo River Confluence station where the mean was 9.7mg/l. High DO values of over 12.0 mg/l were recorded at this station on 4 occasions. Dissolved oxygen levels below the accepted WQO of <7 mg/l were recorded on 9 of 85 occasions: 6.8mg/l twice at Carbonera Creek (304-Carbo-21); 5.8 mg/l and 6.0 mg/l at Branciforte/San Lorenzo River Confluence (304-Branc-21); 4.8 mg/l and 6.8 mg/l at 434 Market (304-Branc-23); 6.8 mg/l at Forty Thieves (304-Branc-22) and Happy Valley (304-Branc-24); and 6.0 mg/l at Granite Creek (304-Grani-21).

pH

The mean pH value at all six stations was 7.4 with a range of 6.5 to 8.5 (Table_). Of the 86 pH recorded at the six stations, two exceeded the WQO of not less than 7 or greater than 8.5. Both exceedences of pH 6.5 occurred on 16 November 2003; one at the Branciforte/San Lorenzo River Confluence and one at 434 Market Street.

Temperature

Air temperature The mean air temperature for all six stations was 16.9°C with values ranging from 4.5 to 29.5 °C (Table_). The lowest temperature was recorded at Forty Thieves (304-Branc-22) on 23 November at 0930 hours, and the highest temperature was recorded at Happy Valley School (304-Branc-24) on 26 October at 1115 hours.

Water temperature The mean water temperature for all six stations was 14.2°C with values ranging from 5.5 to 27.0 °C (Table_). The lowest temperature was recorded at Forty Thieves on 23 November at 0930 hours, and the highest temperature was recorded at the Branciforte/San Lorenzo River Confluence on 13 September at 1645 hours. Of the 87 temperatures recorded at the six stations, two exceeded the Water Quality Objective (WQO) of 22°C. Both exceedences (27°C on 13 September and 26°C on 17 September) were at the Branciforte/San Lorenzo River Confluence (304-Branc-21) where the river is confined by a concrete culvert.

Turbidity

Turbidity levels were within the acceptable range of not exceeding 20 JTU (State Water Quality Control Board 1994) throughout the July to November monitoring period except for a reading of 80 JTU's at Happy Valley School on 28 September 2003. The turbidity was less than or equal to 5 JTU in over 67% of the water samples tested.

Table 5.

Branciforte/San Lorenzo Confluence -Branc-21

Parameter	WQO	Number of Samples	Number of Exceedences	Percent of Exceedences	Minimum Result	Maximum Result	Mean Result
Air Temp (°C)	none	15			9.0	27	18.0
Conductivity (uS)	none	13			540	10300	1947
DO (mg/l)	not <7	14	2	14.2	5.6	16.2	9.7
pH	not < 7.0 or > 8.5	15	1	6.7	6.5	8.5	7.4
Turbidity (JTU)	Not > 20 JTU	14	0	0	5	20	
Water Temp (°C)	not > 22°C	15	2	13.3	10.0	27.0	16.3

Carbonera/Branciforte Confluence - Carbo-21

Parameter	WQO	Number of Samples	Number of Exceedences	Percent of Exceedences	Minimum Result	Maximum Result	Mean Result
Air Temp (°C)	none	14			9.0	22	16.3
Conductivity (uS)	none	14			310	510	431
DO (mg/l)	not <7	14	2	14.2	6.8	9.0	7.7
pH	not < 7.0 or > 8.5	14	0	0	7.0	8.0	7.2
Turbidity (JTU)	Not > 20 JTU	14	0	0	5	15	
Water Temp (°C)	not >22	14	0	0	8.5	19	14.1

434 Market -Branc-23

Parmeter	WQO	Number of Samples	Number of Exceedences	Percent of Exceedences	Minimum Result	Maximum Result	Mean Result
Air Temp (°C)	none	15			9.0	23.5	16.9
Conductivity (uS)	none	14			400	680	591
DO (mg/l)	not < 7	15	2	13.3	4.8	8.6	7.4
pH	not < 7.0 or > 8.5	14	1	7.1	6.5	7.5	7.0
Turbidity (JTU)	Not > 20 JTU	14	0	0	5	15	
Water Temp (°C)	not > 22°C	15	0	0	8.5	18.0	10.3

40 Thieves-Branc-22

Parameter	WQO	Number of Samples	Number of Exceedences	Percent of Exceedences	Minimum Result	Maximum Result	Mean Result
Air Temp (°C)	none	14			4.5	22.5	15.0
Conductivity (uS)	none	14			640	750	684
DO (mg/l)	not <7	14	1	7.1	6.8	9.8	8.0
pH	not <7.0,>8.5	14	0	0	7.0	7.5	7.3
Turbidity (JTU)	not > 20 JTU	14	0	0	5.0	15.0	
Water Temp (°C)	not >22	14	0	0	5.5	18.5	13.1

Happy Valley School-Branc-24							
Parameter	WQO	Number of Samples	Number of Exceedences	Percent of Exceedences	Minimum Result	Maximum Result	Mean Result
Air Temp (°C)	none	15			6.0	29.5	18.3
Conductivity (uS)	none	15			510	730	649
DO (mg/l)	not <7	14	1	7.1	6.8	9.8	7.7
pH	not <7.0,>8.5	15	0	0	7.0	7.5	7.0
Turbidity (JTU)	not > 20 JTU	14	1	7.1	5	80	
Water Temp (°C)	not >22	15	0	0	6.0	18.5	13.8

Granite Creek-Grani-21							
Parameter	WQO	Number of Samples	Number of Exceedences	Percent of Exceedences	Minimum Result	Maximum Result	Mean Result
Air Temp (°C)	none	14			6.0	22.5	16.8
Conductivity (uS)	none	14			410	590	534
DO (mg/l)	not <7	14	1	7.1	6.0	10.0	7.8
pH	not <7.0,>8.5	14	0	0	7.0	7.5	7.0
Turbidity (JTU)	not > 20 JTU	14	0	0	5.0	10.0	
Water Temp (°C)	not >22	14	0	0	6.5	18.0	13.8

Table 6. Results for Bacteria and Nutrients on 5 November 2003

Bacteria	**WQO**	**Branc-21**	**Branc-23**	**Carbo-21**	**Branc-22**
E. coli (MPN/100ml)	≤ 235	590	148	316	20
Total Coliform (MPN/100ml)	≤ 10000	14,540	3130	4196	398
Nutrients					
Ortho-Phosphate (ppm)	≤ 0.10	n.d.	0.288	n.d.	0.057
Nitrate-N (ppm)	≤	0.253	n.d.	0.614	0.082
Ammonia		n.d.	n.d.	n.d.	n.d.

Note: Highlighted numbers indicated values that exceeded Water Quality Objectives.
n.d. indicates no detection of the bacteria or nutrient in the sample.

IV. DISCUSSION

Over 99% of the total data collected met water quality standards set by CCAMP in the Branciforte Watershed from August through November 2003.

While almost 90% of the dissolved oxygen results collected met the water quality standards set by CCAMP of not less than 7.0 mg/l, every station sampled had one to two sample results below WQO standards. Four of these sample values were between 4.5-6.0 mg/l and five samples had a value of 6.8 mg/l, very close to the standard. Levels below 7mg/l are not optimal for salmonids and aquatic organism. Continued weekly monitoring of dissolved oxygen at all the stations will be important in determining where areas of concern are and what factors contribute to low dissolved oxygen values in these areas.

Turbidity values were within acceptable ranges except for a sample value of 80 JTU at Happy Valley School Station on 28 September 2003. The turbidity was 5 JTU on the following sampling date; 18 October 2003. It is unknown why the turbidity was so high on 28 September. In general, the creeks water at the sampling stations was clear and turbidity values low (between 5-20 JTU).

The Branciforte/San Lorenzo Confluence is an area of concern since dissolved oxygen fluctuates widely, pH can be as low as 6.5, and temperatures can increase to 27.0°C. At this station, water quality standards were exceeded for water temperatures, pH and dissolved oxygen. This area of the creek is within a concrete channel and has little or no vegetation that provides shade or cover. In addition, water levels, between the months of August and November, were very low especially at low tide contributing to higher water temperatures when air temperature is also high. Water temperature is an important factor for steelhead, which prefer water temperatures between 7.3-14.6°C, and may avoid areas of warm water above 18°C. Tidal waters also influence water quality at this station causing an increase in conductivity during high tide.

(TAMARA)Results from the water quality sampling on November 5, 2003 for bacteria and nutrients indicate

V. CLEAN STREAMS RECOMMENDATIONS

Recommendations for 2004-2005 are to continue monitoring of basic water quality parameters and add detergent and ammonia-nitrogen testing at 434 Market Street and the Carbonera Creek station since these substances have been detected in prior monitoring. Nitrate and bacteria sampling will be done in the wet and dry season, with the addition of streamflow monitoring and benthic macroinvertebrate sampling. Continued recruitment and training of additional volunteers will enhance the educational benefit of the program to the community and maintain the volunteer base.

Ongoing monitoring of Branciforte Creek will provide information on seasonal variability in basic water quality parameters. Long term monitoring will also provide volunteers with hands-on knowledge of their local watershed and the corresponding educational benefits to the community.

VI. REFERENCES

Central Coast Ambient Monitoring Program (CCAMP): January 30, 2004, Online. www.ccamp.org

California EPA Central Coast Regional Water Quality Control Board: Basin Plan, November 2003. Online. **http://www.swrcb.ca.gov/rwqcb3/BasinPlan/Index.htm**

California Regional Water Quality Control Board. 1994. Ammendment of the Central Coast Water Quality Control Plan. Resolution No. 94-01. Sacramento, California.

Reiser, D.W. and T.C. Bjornn. 1979. Habitat Requirements of Anadromous Salmonids in Influence of Forest and Rangeland Management on Anadromous Fish Habitat in the Western United States and Canada. Technical Report PNW-96. USDA Forest Service, Portland, Oregon.

San Francisco Estuary Institute. 1997. Volunteer Monitoring Protocols. Richmond, California. Produced under contract for the State Water Resources Control Board, Contract No. 4-126-250-0.

Smith, J. 1998. Steelhead and Coho Salmon Life Cycle and Habitat Requirements. (unpublished) Dept. of Biological Sciences, San Jose State University. San Jose, California.

State Water Resources Control Board and San Francisco Estuary Institute, *Volunteer Monitoring Protocols: A Reference Guide for Monitoring California's Rivers, Streams, and Watersheds*, 1996.

United States Environmental Protection Agency, Monitoring and Assessing Water Quality, *5.9 Conductivity*, 2003. January 29, 2004, Online. www.epa.gov/volunteer/stream/vms59.html

Quality Assurance Steps

See text provided from SSD to draw on for introducing this section.

Do this in 2 Paragraphs OR LESS-We'll go over this when we've got all the data summarized.

Accuracy-

Percent Accuracy is calculated from the drift (the difference between the post-event calibration reading and the value of the Standard), divided by the "true" value of the Standard, times 100. An acceptable value for percent accuracy is less than 10%.

The percent accuracy was calculated for both of the conductivity meters used in the Branciforte Watershed and found to be 1.41% and 5.0 %; both acceptable values. (need to do one more)

Two of the pH strips used, were not calibrated before beginning monitoring and one was not calibrated on the 20 November calibration event. (need to check 3 more pH)

Two of the temperature instruments used for Branciforte were not calibrated before beginning monitoring but were calibrated on 20 November 2003 and two other temperature instruments were calibrated in April 2003 at 17°C and on 20 November 2003 at 20°C.

Completeness

Twelve monitoring events (three trips to each station per month) were planned for the Branciforte Watershed. All of the planned trips were completed at each station. In addition, nutrient sampling was done at four stations on 5 November where water quality testing was also done. The coordinator conducted water quality sampling at Happy Valley School on 26 July and additional follow-up trips on 18 September at the Branciforte/San Lorenzo Confluence, 10 November at Happy Valley and 16 November at 434 Market St. Four sampling events were conducted at the Lower Branciforte Stations in October. From 14 to 15 monitoring events were conducted at each station. Water and air temperature was taken 87/87 (100%) of the time a trip was made, pH 86/87 (98%), dissolved oxygen and conductivity 85/87 (98%), and turbidity 84/87 (97%).

Precision

The percent precision was calculated using the formula: the absolute value of A minus B, divided by the average of A and B, times 100, where A equals the parameter result and B equals the replicate results. For both conductivity and dissolved oxygen samples (n=18), all the values were below the precision objective of 10%(a range of 0-8.7%). For temperature, pH and turbidity, the difference between the parameter result and its replicate were compared to the precision objective for each parameter. Two of the water temperature replicates (n=16) were more than $\pm$ 1.0 °C, above the $\pm$0.5 °C objective. All pH and turbidity replicates were within the objective values for their respective parameters.

Volunteer Participation

The volunteers in the Branciforte Watershed were very committed and worked together to schedule field visits in which at least two volunteers in the group could be present to conduct the water testing.

Twenty volunteers contributed 219 field hours. Fourteen people attended a two-hour public meeting for a total of 28 volunteer hours and 16 people attended the two-hour field training for a total of 32 volunteer hours. The total volunteers hours for the public meeting, field training and fieldwork was 279.

APPENDIX B - BRANCIFORTE CREEK WATERSHED DATA RESULTS

Station ID	Description	Date	Group	Time	Air Temp (°C)	Water Temp (°C)	pH	DO (mg/l)	Conductivity (uS)	Turbidity (JTU)
BRANC-21	B40/SLR	08/09/03	3	9:30	20.0	18.0	7.0	7.8		5
BRANC-21	B40/SLR	08/15/03	1	7:26	14.5	17.0	7.5	6.0	800	10
BRANC-21	B40/SLR	08/23/03	2	12:38	25.0	19.5	7.5	5.6	1300	5
BRANC-21	B40/SLR	09/06/03	3	8:32	16.0	16.5	7.5	7.2	1100	20
BRANC-21	B40/SLR	09/13/03	1	16:45	23.0	27.0	8.0	15.6	700	10
BRANC-21	B40/SLR	09/17/03	2	18:15	27.0	26.0	8.5	16.2	690	15
BRANC-21	B40/SLR	09/18/03	BR	11:30	24.0	18.5	8.5	13.4		
BRANC-21	B40/SLR	10/04/03	3	9:27	15.0	15.5	7.0	8.6	1520	5
BRANC-21	B40/SLR	10/11/03	1	9:05	12.0	11.0	7.0	9.2	840	10
BRANC-21	B40/SLR	10/12/03	2	14:35	22.5	17.0	7.5	12.6	700	10
BRANC-21	B40/SLR	10/26/03	3	9:08	18.5	14.5	7.0	7.2	10300	5
BRANC-21	B40/SLR	11/05/03	3	10:20	16.0	10.0	7.0	8.2	1120	5
BRANC-21	B40/SLR	11/08/03	1	9:05	14.0	13.0	7.0		1830	20
BRANC-21	B40/SLR	11/16/03	2	11:20	14.0	11.0	6.5	10.6	540	5
BRANC-21	B40/SLR	11/22/03	3	9:10	9.0	10.5	7.5	7.2	3900	10
BRANC-23	434 Market	08/09/03	3	10:55	23.5	17.0	7.0	7.0	530	10
BRANC-23	435 Market	08/15/03	1	9:05	16.5	16.0	7.5	6.8	630	10
BRANC-23	436 Market	08/23/03	2	10:40	19.5	16.0	7.5	7.0	600	5
BRANC-23	437 Market	09/06/03	3	10:05	16.0	14.5	7.0	7.8	600	15
BRANC-23	438 Market	09/13/03	1	17:25	19.0	18.0	7.5	7.0	600	5
BRANC-23	439 Market	09/17/03	2	18:50	22.5	18.0	7.5	7.8	600	15
BRANC-23	440 Market	10/04/03	3	10:30	15.0	14.0	7.5	7.6	680	5
BRANC-23	441 Market	10/09/03	1	9:25	15.0	14.0	7.5	7.4	620	10
BRANC-23	442 Market	10/12/03	2	15:15	22.0	14.5	7.0	8.6	650	5
BRANC-23	443 Market	10/26/03	3	10:52	22.0	13.5	7.0	7.6	660	5
BRANC-23	444 Market	11/05/03	BR, TS	9:25	11.0	9.0	7.0	8.2	600	5
BRANC-23	445 Market	11/08/03	1	10:00	13.0	11.0	7.5	4.8	400	5
BRANC-23	446 Market	11/16/03	2	12:00	16.0	11.0	6.5	8.4	500	5
BRANC-23	447 Market	11/16/03	BR, RR	16:00	14.0	12.0		7.4		
BRANC-23	448 Market	11/22/03	3	10:00	9.0	8.5	7.0	7.9	600	5
CARBO-21	Carbo/B40	08/09/03	3	10:35	22.0	17.0	7.0	7.4	410	5
CARBO-21	Carbo/B40	08/15/03	1	8:35	15.0	16.0	7.0	7.2	510	5
CARBO-21	Carbo/B40	08/23/03	2	11:45	21.0	16.0	8.0	7.4	400	5
CARBO-21	Carbo/B40	09/06/03	3	9:40	17.0	14.5	7.0	8.0	500	15
CARBO-21	Carbo/B40	09/13/03	1	18:00	18.0	19.0	7.0	7.4	400	5
CARBO-21	Carbo/B40	09/17/03	2	19:15	20.5	18.0	7.5	7.4	400	5
CARBO-21	Carbo/B40	10/04/03	3	10:05	15.5	14.0	8.0	7.6	510	5
CARBO-21	Carbo/B40	10/09/03	1	9:58	14.0	14.0	7.0	6.8	490	5
CARBO-21	Carbo/B40	10/12/03	2	15:37	22.0	15.0	7.0	8.8	470	5
CARBO-21	Carbo/B40	10/26/03	3	10:15	17.5	13.0	7.0	8.2	470	5
CARBO-21	Carbo/B40	11/05/03	BR, TS	8:48	9.0	9.0	7.0	8.0	420	5

CARBO-21	Carbo/B40	11/08/03	1	9:35	13.5	12.0	7.0	6.8	350	5
CARBO-21	Carbo/B40	11/16/03	2	12:30	13.5	11.0	7.0	9.0	310	10
CARBO-21	Carbo/B40	11/22/03	3	9:45	9.0	8.5	7.0	7.4	400	5
GRANI-21	Granite Ck	08/03/03	6	17:02	22.0	18.0	7.0	7.6	510	5
GRANI-21	Granite Ck	08/14/03	BR, DC	14:20	22.5	16.0	7.0	8.0	500	5
GRANI-21	Granite Ck	08/15/03	4	11:03	19.5	15.0	7.0	7.6	580	5
GRANI-21	Granite Ck	08/22/03	5	9:00	17.0	16.5	7.5	7.2	550	5
GRANI-21	Granite Ck	09/01/03	6	15:30	20.5	16.0	7.0	7.8	520	5
GRANI-21	Granite Ck	09/07/03	4	9:33	15.0	14.0	7.0	7.8	560	5
GRANI-21	Granite Ck	09/20/03	5	10:35	19.0	14.0	7.0	7.2	570	5
GRANI-21	Granite Ck	09/28/03	6	15:23	18.0	15.0	7.0	7.6	520	5
GRANI-21	Granite Ck	10/05/03	4	9:35	14.0	14.5	7.5	7.2	540	5
GRANI-21	Granite Ck	10/18/03	5	10:20	15.0	12.0	7.0	7.2	580	5
GRANI-21	Granite Ck	10/26/03	6	10:45	20.5	14.0	7.0	6.0	570	5
GRANI-21	Granite Ck	11/08/03	4	9:55	13.0	11.5	7.5	10.0	470	5
GRANI-21	Granite Ck	11/16/03	5	13:50	13.0	10.0	7.0	8.2	410	10
GRANI-21	Granite Ck	11/23/03	6	10:11	6.0	6.5	7.0	9.2	590	5
BRANC-24	Happy Valley	07/26/03	BR, RR	9:45	24.0	17.5	7.5	7.2	630	5
BRANC-24	Happy Valley	08/03/03	6	15:42	24.5	18.5	7.5	7.2	640	15
BRANC-24	Happy Valley	08/15/03	4	10:30	20.0	16.0	7.5	7.0	650	15
BRANC-24	Happy Valley	08/22/03	5	10:00	18.5	16.5	7.5	6.8	630	10
BRANC-24	Happy Valley	09/01/03	6	15:00	21.0	16.0	7.5	7.8	610	10
BRANC-24	Happy Valley	09/07/03	4	9:38	16.0	14.0	7.5	7.8	670	5
BRANC-24	Happy Valley	09/20/03	5	9:55	18.5	14.0	7.5	7.6	680	5
BRANC-24	Happy Valley	09/28/03	6	15:45	20.5	15.0	7.5	8.0	660	80
BRANC-24	Happy Valley	10/05/03	4	9:10	13.0	14.0	7.5	7.4	680	
BRANC-24	Happy Valley	10/18/03	5	10:58	19.0	12.0	7.0	7.8	680	5
BRANC-24	Happy Valley	10/26/03	6	11:15	29.5	12.0	7.5	8.2	690	10
BRANC-24	Happy Valley	11/08/03	4	9:25	14.5	12.0	7.5		630	10
BRANC-24	Happy Valley	11/10/03	BR	11:45	15.0	13.0	7.0	7.8	510	5
BRANC-24	Happy Valley	11/16/03	5	14:30	15.0	10.0	7.0	7.5	640	5
BRANC-24	Happy Valley	11/23/03	6	10:45	6.0	6.0	7.5	9.8	730	10
BRANC-22	Forty Thieves	08/03/03	6	14:35	22.5	18.5	7.5	8.6	640	15
BRANC-22	Forty Thieves	08/15/03	4	9:30	15.0	17.5	7.5	6.8	690	10
BRANC-22	Forty Thieves	08/22/03	5	11:00	19.0	17.0	7.5	7.2	670	5
BRANC-22	Forty Thieves	09/01/03	6	14:35	18.5	16.5	7.5	7.6	640	5
BRANC-22	Forty Thieves	09/07/03	4	10:05	16.5	14.0	7.0	7.6	690	5
BRANC-22	Forty Thieves	09/20/03	5	9:20	13.0	13.5	7.0	7.2	690	5
BRANC-22	Forty Thieves	09/28/03	6	15:00	18.5	15.0	7.5	8.2	670	5
BRANC-22	Forty Thieves	10/05/03	4	10:06	15.0	13.5	7.5	7.6	710	5
BRANC-22	Forty Thieves	10/18/03	5	9:25	11.0	10.5	7.0	8.0	720	5
BRANC-22	Forty Thieves	10/26/03	6	10:20	18.0	12.0	7.5	7.8	700	5
BRANC-22	Forty Thieves	11/05/03	BR	11:05	12.0	9.0	7.0	8.2	690	5
BRANC-22	Forty Thieves	11/08/03	4	10:15	14.0	11.5	7.5	8.0	670	5
BRANC-22	Forty Thieves	11/16/03	5	12:35	12.5	10.0	7.0	9.0	640	10
BRANC-22	Forty Thieves	11/23/03	6	9:30	4.5	5.5	7.5	9.8	750	5

APPENDIX C-PARTICIPATING AGENCIES, ORGANIZATIONS AND DONORS

City of Santa Cruz Parks and Recreation Department
Happy Valley School
Monterey Bay National Marine Sanctuary
Pacific Cookie Company
Santa Cruz County Environmental Health
Santa Cruz Harbor
Senior Citizens Opportunity, Santa Cruz
Staff of Life
State Water Resources Control Board Clean Water Team
Surfrider Foundation
The Ocean Conservancy