PROJECT CLEAN WATER
County of Santa Barbara

Rain Year 2001/2002

Water Quality Analysis Report

County of Santa Barbara, California
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Public Health Department

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Storm water sampling takes a great deal of commitment and energy in order to respond efficiently to the many false alarms, the many late nights, and the many unexpected storm events. The County is grateful to the many volunteers and staff that participated in the efforts or who made themselves available on a stand-by basis. In particular, we would like to thank the work done by the Public Health Laboratory.

Table of Contents

Appendices

1.0 INTRODUCTION

Project Clean Water, initiated in the fall of 1998, is Santa Barbara County's programmatic effort to improve the water quality in local creeks and in the ocean. The program is primarily implemented by staff from the Public Works Department and the Public Health Department. Project Clean Water is driven by public concern over numerous beach advisories and historic closures due to elevated levels of bacteria, as well as community interest to improve the "health" of local creeks. Bacteria levels at local beaches are measured using weekly ocean-water sampling near the creek outfalls at 20 popular local beaches. Creeks and storm-drain outfalls appear to be the major source of bacteria in the nearshore environment. The sampling is conducted year-round by the Ocean Water Monitoring Program of the County Public Health Department.

As an initial investigation, the South Coast Watershed Characterization Study was conducted in 1998 by Project Clean Water staff to characterize the water quality of four South Coast streams (URS Greiner Woodward Clyde 1999). This study marked the first major local effort at evaluating baseline water quality conditions and water quality impacts from storm water runoff and wet weather conditions. Both dry and wet weather sampling occurred within the watersheds of Arroyo Burro, Mission, Carpinteria, and Rincon Creeks. The most significant water quality parameter that was consistently high was the indicator bacteria (total coliform, fecal coliform, and enterococcus groups).

In order to gain a better understanding of the types and extent of pollutants contributed by storm water and low flow runoff, as well as to address future regulatory requirements (see Section 2.0, Regulatory Setting), Project Clean Water staff designed an expanded program of dry and wet weather sampling for the 1999-2000 season. The sampling program significantly broadened the previous year's study by adding many more creek sites and water quality parameter measurements, such as volatile organic compounds (VOCs) and various pesticides. In addition, the 1999-2000 storm water sampling program focused heavily on collecting samples during the "first flush" of each storm event, i.e., during increasing flow due to initial runoff.

The purpose of this sampling effort was to conduct a broad screening of water quality in local creeks in order to ascertain which contaminants are present at significant levels, and which watersheds exhibit consistently higher levels of contaminants. Once this is determined, a more informed approach can be made in identifying geographic areas (and their associated problematic contaminants) in need of treatment or source control "Best Management Practices."

The 2000-01 and 2001-02 water quality sampling programs were a continuation of the effort begun during the 1999-2000 season. Project Clean Water Staff believe that the information collected will complement our existing data and make statistical evaluation of the results more robust.

A description of the methods used and results are presented in this report along with a discussion of the findings and recommendations for further study.

2.0 REGULATORY SETTING

There are two main regulatory programs under which the County must address the quality of surface water. These are the National Pollutant Discharge Elimination System (NPDES), and Total Maximum Daily Loads (TMDLs). Under the Federal Clean Water Act both of these programs are enforced through regulations promulgated by the U.S. Environmental Protection Agency (EPA), and both programs have been delegated to the California State Water Resources Control Board and Regional Water Quality Control Boards.

2.1 NPDES

One of the programs under the federal NPDES regulations addresses storm water "non-point source" discharges (Clean Water Act §402(p)). The storm water program is divided into two phases. The first phase was promulgated in 1987 and regulated certain industry and municipalities with populations greater than 100,000 people. Storm water permits for these medium to large municipalities, such as the counties of Ventura, Los Angeles, and San Diego, were submitted to their respective Regional Water Quality Control Boards in the early 1990s.

Those portions of Santa Barbara County with an urban population of at least 10,000 and a population density of at least 1,000 per square mile fall under the definition of small municipality. Under Phase II of the NPDES regulations, owners and operators of small Municipal Separate Storm Sewer Systems ("MS4s") must obtain a permit for discharges into surface waters and must develop a program to reduce pollutant runoff to the maximum extent practicable. The application for this permit, which must include Best Management Practices to reduce pollutant runoff into the storm sewer system, is due to the Regional Water Quality Control Board on March 10, 2003. Additional requirements may, at the discretion of the State Board, be applied to those areas with at least 10,000 and a population density of at least 1,000 per square mile.

There are some differences between the EPA regulations for Phase I and the Phase II programs, notably the requirement for storm water monitoring. Phase I communities are required to conduct storm water monitoring; Phase II communities (at least in the first five years) currently are not. Although storm water monitoring is not a requirement under NPDES Phase II regulations, the information presented in this report and from previous sampling years is used to develop the County's Storm Water Management Program by generally defining storm water pollution types and sources, guiding development of Best Management Practices, and establishing baseline conditions to possibly gage the long-term success of Project Clean Water.

Initially, the unincorporated areas of the Carpinteria Valley, Montecito, Goleta and Orcutt were believed to comprise the area subject to NPDES Phase II regulations, based on 1990 and 2000 census data. In August 20002, the Regional Water Quality Control Board proposed to include the communities of Vandenberg Village, Mission Hills and Santa Ynez. Water quality sampling was not performed in these latter areas because the Regional Water Quality Control Board provided no prior indication of its intent to regulate these areas.

2.2 TMDLs

TMDL regulations are contained in Section 303(d) of the Clean Water Act. TMDLs are designated for water bodies of the state that show signs of being impaired or impacted for beneficial uses. The State Water Resources Control Board (SWRCB) with concurrence of the EPA and the Regional Water Quality Control Boards establishes a list of all 303(d) impaired water bodies. This list is updated every two years. The most recent update to the listing was in 2001.

This listing is prioritized based upon known and/or perceived adverse impacts to the beneficial uses of these waterbodies. Santa Barbara County currently has eight listed water bodies for specific pollutants of concern, which are listed in Table 2-1 below.

Table 2-1. Santa Barbara County Section 303(d) Impaired Watersheds

Watershed	Beneficial Use Impairment
Santa Ynez River	Nutrients, salinity/TDS/chlorides, sedimentation/siltation
San Antonio Creek	Sedimentation/siltation
Goleta Slough	Metals, pathogens, priority organics, sedimentation/siltation
Arroyo Burro Creek	Pathogens[1]
Mission Creek	Pathogens, unknown toxicity
Carpinteria Marsh	Nutrients, organic enrichment/low dissolved oxygen, priority organics, sedimentation/siltation
Carpinteria Creek	Pathogens
Pacific Ocean at Rincon Point	Pathogens

The TMDL process begins once impaired waterbodies have been established and prioritized. The total amount of pollution that can be discharged to these impaired water bodies (mass load allocation) from all land use categories in the watershed is determined by the agencies that have jurisdiction in the watersheds in coordination with the local Regional Water Quality Control Board. From these load allocations, appropriate water quality standards are established for each beneficial use impairment identified in the 303(d) list.

Local entities that have jurisdiction over the impacted watershed must develop a formalized implementation plan to reduce or eliminate the discharge of these pollutants to levels that meet the previously developed water quality standards. Often this means the cooperation of agencies that have overlapping jurisdiction such as in the Rincon Creek area where both Santa Barbara County and Ventura County have jurisdiction over parts of the creek.

Preliminary target dates have been established for the start of the TMDL process for all of the waterbodies prioritized in the Section 303(d) listing. For Santa Barbara County all impaired

[1] See Section 3.4.1 for explanation of relationship between pathogens and indicator bacteria

waterbodies are scheduled to begin development of the appropriate water quality standard(s) for each waterbody by 2006, except for the Santa Ynez River, which is 2003. Full plan development including establishment of the appropriate water quality standards is to be completed within five years of the target start date. In every watershed but the Santa Ynez River, this will occur by the year 2011.

The TMDL process has gained more attention in recent years due to lawsuit judgments that have forced local jurisdictions such as Ventura and Los Angeles to establish TMDLs more rapidly.

TMDLs are often created for individual watersheds with cross-jurisdictional boundaries and which may be outside of the NPDES permit area. As such, they offer a unique challenge and opportunity to cooperatively work with all entities that discharge to the local watersheds. Because TMDLs have not yet been established in Santa Barbara County, it is difficult to estimate actual costs associated with specific projects or system components. Nor is it possible to judge their effect on the scope of Project Clean Water.

2.3 Basin Plan Objectives and State Ocean Water Quality Standards

In addition to NPDES and TMDLs, the Regional Water Quality Control Board sets water quality objectives to provide the highest quality water reasonably possible (RWQCB 1994). These are presented in the Water Quality Control Plan, or Basin Plan. The objectives are implemented and enforced through waste discharge permits or NPDES permits. Table A-4 (in Appendix A) lists those objectives, and Table A-5 shows the applicable designated uses assigned to each watershed. The Basin Plan is also implemented by the Board's support of local programs that help achieve the goals of the Basin Plan. Numeric and narrative objectives are established in the Basin Plan and these objectives are used in this report to compare with the results of the 2000-01 water quality monitoring data.

The Basin Plan establishes freshwater objectives for fecal coliform for inland surface waters. However, the standards require a minimum number of sampling events within a given time period. Due to the limited number of sampling events spread out over a significant period of time (several months) comparison to these standards was not possible. Therefore, another set of standards is used to determine creek water quality.

The State Ocean Water Quality Standards for body contact and recreation have been established as follows:

Total Coliform – 10,000 MPN
Fecal Coliform – 400 MPN
Enterococcus – 104 MPN

where MPN is the most probable number, the statistical concentration of bacteria in 100 ml of water. (The fourth standard that is applied is the ratio of total coliform to fecal coliform levels, which was not calculated or utilized, since comparison to individual indicator bacteria standards sufficed for the purposes of this study.) Exceedance of these standards requires the local Health Officer to post warning signs at the beach area where recreational water contact may occur. This same mandate does not currently apply to freshwater areas such as creeks, streams and/or freshwater lakes.

3.0 METHODS

The major goal of the 2001-02 water quality monitoring program was to evaluate and compare runoff from all of the urbanized watersheds in unincorporated areas of the South Coast and Orcutt. This watershed-based approach focuses on the overall pollutant contributions from the entire watershed as opposed to pollutant contributions from specific sources or defined land uses. A watershed-based approach was selected for this program in order to maximize the area covered, while minimizing the total number of sampling sites. This was necessary due to the relatively large number of watersheds (23 on the South Coast and 2 in the North County) involved and the laboratory costs associated with each sample.

3.1 Sampling Overview

Creek water was sampled primarily during storm flow conditions. Storm flow conditions were sampled throughout the South Coast and at seven locations in the north coast. The large number of individual watersheds makes the South Coast unique, and also difficult to characterize. To minimize laboratory costs, only one station was monitored for the full suite of parameters per watershed. This one station is located at the most downstream point in the watershed above tidal influence. (The cost of laboratory services for analyzing the full suite of constituents in one sample is approximately $1,300.) In order to provide additional detail, bacteria and other selected constituents were collected at other upstream locations.

3.2 Sample Sites

On the South Coast alone, there are over 50 individual watersheds draining to the ocean in Santa Barbara County, about 23 of which drain the urbanized areas from Goleta to Rincon. Sample sites were selected on all major South Coast watersheds within the urbanized portions of the county from Tecolote Canyon Creek in western Goleta to Rincon Creek on the border with Ventura County. Sample sites were also selected for one North County creek (Orcutt Creek) that drains the unincorporated, urbanized areas of Orcutt. See Table A-1 (in Appendix A) for a list of creeks sampled and Figures A-1 and A-2 for maps of the sample locations.

On the South Coast, one site per watershed was sampled as close to the mouth of the creek as possible (while avoiding tidal influence) for a full suite of constituents. As mentioned above, bacteria samples were collected at several upstream reaches .Additionally, longitudinal sampling was performed on San Jose creek (see Section 3.5). In North County, two full suite sites were located in Orcutt creek at the upstream and downstream end of the urbanized area.

In addition to creek sampling, four storm drains were selected for sampling this year. The sites were chosen as potential pilot project sites for treatment control Best Management Practices (BMPs). The data collected will not only help to characterize target pollutants, enabling selection of the proper BMP technology, but the data will also act as baseline conditions to evaluate performance of the BMP after implementation.

The sampling program also included bacteria and other focused sampling sites. These sampling sites reflect smaller areas, or subwatersheds, within each creek's watershed and in some cases reflect certain primary land uses, such as heavy commercial, light industrial, or residential.

A total of 41 sites were sampled countywide, of which 32 sites were sampled for the full suite of constituents. Note that not all sites were sampled during low flow conditions, or for all storm events due to factors such as lack of flow. Table A-1 (in Appendix A) describes the type and amount of sampling which occurred at each site.

3.3 Sample Collection

The South Coast contains a relatively large number of small watersheds, and thus grab samples were determined to be the most cost-effective use of resources for this year's expanded program. The advantage of grab samples is they can be collected over a large area with a minimum of field crew. The disadvantage is that they represent a single snapshot of water quality at one instant during a storm. In contrast, composite samples combine smaller samples throughout the storm into one single, more representative sample. However, composite samples still only provide a snapshot of the tremendous amount of water that passes through a creek during a storm, *and* require additional manpower by repeated sampling of the same site or automatic samplers, both of which were unavailable during the 2001-02 season.

Since the goal of the 2001-02 program was to continue characterizing the types and, in selected watersheds, the extent, of pollutants within the South Coast watersheds, samplers attempted to collect data representing the maximum concentrations or the maximum range of pollutants within the creeks. It was assumed that the most pollutants would be observed in the creeks during the rising limb of the creek hydrograph, i.e., during the period when the water levels in the creek are rising or at their peak. Every effort was made to capture samples during peak runoff in the creek, although many factors affect the timing of peak runoff. Variability due to permeable surfaces (pavement, etc), orographic effects, saturation of soils, and limitations in predicting peak flow and mobilizing personnel over a wide area to collect the samples are some of the factors.

PCW staff made up the core group of samplers with support from additional County employees and volunteers to make up the necessary numbers of samplers. For safety and efficiency reasons, samplers were divided into teams of two. Ideally, a minimum of seven teams (14 samplers) would be sent out into the field. With seven sampling teams, samples could be collected from all locations within 2 to 3 hours. However, 14 samplers were not always available. As a result, a fewer number of teams were sent into the field for some of the sampling events. In some storm events, this increased the overall sampling time to a maximum of 4 hours per team. However, this turned out to be acceptable since the timing of rainfall was "spread out" as storms swept across the county.

3.4 Analysis Performed

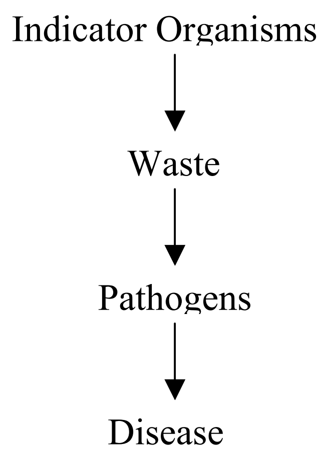
Numerous water quality analytes (128 total) were chosen based upon previous storm water quality assessments in the southern California area (SCWCS 1998, SCCWRP 1996), analytes required to be monitored by Phase 1 communities under their NPDES permit conditions, and pollutants that may be present in the Santa Barbara South Coast area. General categories of constituents include bacteria, pesticides, VOCs, metals, nutrients and other constituents (such as total suspended sediments and oil and grease). The constituents (not including bacteria) are shown in Table A-2 (in Appendix A). Table A-3 shows the EPA method used in processing the constituents, and their associated lab cost.

Each category of analytes is briefly discussed below. See Section 4.2 for a description of the storms that were sampled.

3.4.1 Bacteria

Several watersheds in the county have had TMDLs assigned to them for impairment due to pathogens (see Section 2.2). Pathogens are, by definition, disease-causing organisms. This concern is based upon historic measurements of indicator organisms. Current water quality testing methodology relies on the usage of indicator organisms- total coliform, fecal coliform and enterococcus- as a measure of the potential for human pathogens to be present in the sampled waters. Indicator organisms are more readily detected and quantified than many human pathogens. As shown in Figure 3-1, indicator organisms are used to reveal the presence of waste in a water sample. Waste may be of plant, animal or human origin and may or may not contain human pathogens

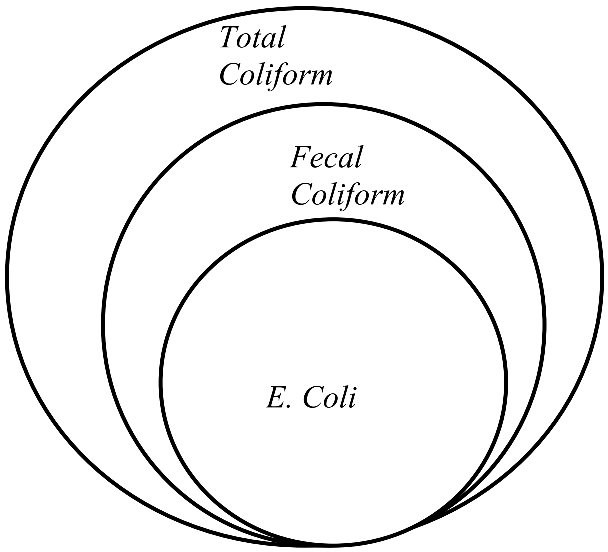
Figure 3-1 Chain of inference for indicator



For fecal coliform and enterococcus species, these organisms exist in the intestines of both human and animal populations. Their presence in the water has a relationship to public health risk (e.g. skin rashes, respiratory infections, gastro-intestinal illness and other diseases).

Water samples were collected and sent to the County Public Health Laboratory for analysis of the concentrations of three indicator organisms: total coliform, enterococcus and *Eschericia* c*oli* (*E. coli*) bacteria. Figure 3-2 below displays the relationship between total coliform, fecal coliform, and *E. coli*. *E. coli* bacteria is the most prevalent form of fecal coliform bacteria. This species normally comprises approximately 85-95% of the fecal coliform that may be present in water sample. Once again, the vast majority of *E. coli* bacteria are not human pathogens and in most cases are beneficial to humans by aiding in digestion of food. One subspecies of *E. coli* (0157:H7) is pathogenic. This pathogenic *E. coli* has been involved in several foodborne illness outbreaks.

Figure 3-2 Schematic Showing Relationship Among Bacteriologic Indicators



3.4.2 Pesticides

Pesticides include all chemicals used to control "pests" of any sort, including herbicides, insecticides, algaecides, fungicides, and rodenticides. These chemicals are used by homeowners and commercial operations to control weeds, ants, termites, undesirable garden organisms, etc.

The presence of these chemicals, particularly chlorinated pesticides, are being monitored because of their toxicity to aquatic life and humans. Several pesticides are described in more detail below.

Chlorpyrifos, an organophosphate pesticide, is sold under several trade names, but the most common is Dursban. Chlorpyrifos made headlines several years ago as the EPA and the manufacturer reached an agreement to cease manufacturer's retail distribution prior to December 2000 and all product sales by December 2001 due to increasing evidence of aquatic toxicity at very low concentrations. Dursban is used for professional as well as non-professional applications, for the control of ants, fleas, and termites.

Diazinon is often used by homeowners to combat ant infestations. Diazinon, another organophosphate pesticide, has been shown to be toxic to aquatic life at very low levels, often below the normal detection limits of testing laboratories. Discussions with pesticide regulators are ongoing regarding the licensing of Diazinon. On December 5, 2000, EPA released its revised risk assessment and announced an agreement with registrants to phase out/eliminate certain uses of Diazinon. It is possible that Diazinon will, like Chlorpyrifos, be removed from the retail shelving in the near future, although we may not see any water quality benefits from these restrictions for years to come.

Glyphosate is a non-selective systemic herbicide that is applied to and absorbed by the leaves of plants. It is available to the general public at most lawn and garden stores under the trade name of Roundup or Rodeo, which is the form used for aquatic applications. The prevalence and frequency of glyphosate in the data suggests its common usage and over-application or inappropriate use.

There are no known aquatic standards for environmental exposure of Glyphosate; only drinking water standards exist. Environmental toxicity tests show a slight to moderate toxicity (LC50) based upon exposures ranging from 3.9 mg/L for fish (carp) to greater than 1,000 mg/L for crayfish (Pesticide Management Education Program).

Endosulfan is a pesticide group that is not available over-the-counter but is permitted for agricultural use.

3.4.3 VOCs

Volatile organic compounds can come from cleaners, solvents, and petroleum products. Although they are short-lived in the surface water environment, they are important because of their toxicity to aquatic life and humans, and the large number of their potential sources. However, VOCs are difficult to measure in storm water runoff because they volatize under the turbulent, high flow conditions in creeks during storms.

3.4.4 Metals

Metals are ubiquitous in the environment. Anthropogenic sources of metals include: brake pads, industrial activities, tire wear (steel belted tires), air deposition, and some types of pesticides (copper algaecides, etc.). Metals can be toxic and bioaccumulate in both solid and dissolved form. Research has shown that aquatic plants and bivalves are particularly vulnerable to exposure. Thus, bivalves tend to suffer from metal accumulation in polluted environments.

3.4.5 Nutrients

Nutrients are vital to the health of an aquatic environment. However, they can be detrimental to aquatic life in high concentrations. Nitrogen and phosphorus tend to be the most commonly problematic nutrients because homeowners and agricultural operations add these nutrients to their lawns and gardens in vast quantities to increase productivity. The presence of nutrients can accelerate growth and the preponderance of water plants such as algae. When water becomes stagnant and temperatures increase, algal growth greatly increases, leading to the formation of large patches of thick green algal mats. These mats are not harmful to humans, but reduce light and oxygen availability in the water and may lead to anaerobic conditions, odors, and severe impacts to other aquatic life.

The nitrogen cycle is normally driven by nitrogen fixing bacteria in the soil. Ammonia, often deposited as animal waste, is oxygenated to nitrites and further to nitrates. In an oxygenated environment, nitrites are short-lived.

3.4.6 Other Constituents

Other constituents sampled for include turbidity, total suspended solids, hardness, specific conductance, oil and grease, and total recoverable petroleum hydrocarbons, among others. While many of these physical parameters are expected to be present and may not be toxic in the aquatic environment, their concentrations may be indicative of other problems, or useful for general characterization of the creek.

Hardness is a measure of the level of dissolved carbonates in the water column. Geological formations in this area (mainly lime and sandstone formations) are easily degraded by water. As a result, most ground and surface water displays fairly high hardness in the range of 300-500 mg/L.

Specific conductance can help to determine the degree of tidal influence at a given sample point, since higher levels of specific conductance indicate higher concentrations of salinity.

The presence of high concentrations of total suspended solids can be attributed to sediment runoff from the development of the watershed or from construction sites, erosion on the banks and creek bed due to increased flow rates.

Total Organic Carbon (TOC) and Biological Oxygen Demand (BOD) are indicators of biological activities within the watersheds. Elevated TOC indicates an abundance of organic (most likely vegetative) materials. Elevated organic materials often lead to an increase of organisms that work to break down these materials (e.g. bacteria, insects, etc.). This degradation activity puts a "demand" on the supply of oxygen in the water. Left unchecked, with an ongoing supply of organic materials, the oxygen supply in the watershed will ultimately drop and the watershed fauna may become impacted due to this reduction.

3.4.7 Benthic Macroinvertebrate Sampling

This year, Project Clean Water conducted a second year of rapid bioassessment monitoring in several local streams using methodology described in the U.S. Environmental Protection Agency's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (1999). The Bioassessment Program involves annual collection of physical and biological data at "study reaches" in several local creeks. Rapid bioassessment surveys include water quality measurement, assessment and measurement of physical habitat parameters (e.g., stream flow, substrate, stream width and depth, etc.), and the collection of benthic macroinvertebrate samples, which are the main focus of the program with respect to biological monitoring.

Our goal is to continue the Bioassessment Program over several years to evaluate the ecological health of and track changes in South Coast streams. Study and comparison of selected creeks will provide a better understanding of their physical and biological conditions, and how they are influenced by various natural and human-induced factors (i.e., agricultural and urban development). Specifically, the Bioassessment Program has been developed to explore the following questions:

1. How is biological community composition in study area streams related to natural variability in physical parameters including water chemistry, water temperature, climate, stream flow, elevation, gradient, stream order, and watershed area?

2. How do physical and biological conditions in local creeks vary through time in response to natural factors?

3. How are biological community composition, water quality, and physical habitat conditions in study area streams related to human land use patterns? Are relationships more apparent when one considers land use patterns at the watershed scale, or at the local scale (i.e., land use at the affected stream reach)? Which land uses, activities, and water pollutants are most harmful to creek ecosystems?

4. How do physical and biological conditions in local creeks change through time in response to human factors, including existing and new development, and efforts restore water quality and natural habitats?

5. Which biological parameters and taxa (i.e., species, genera, families, etc.) are the most reliable indicators of the overall "health" of a given stream reach, and the degree to which it is disturbed by human land uses?

Last year's (2001) Bioassessment Program involved the study of 12 study reaches in Carpinteria (2), Gobernador (1), San Jose (3), Atascadero (2), Arroyo Burro(2), San Onofre (1), and Arroyo Hondo (1) Creeks. In addition, bioassessment data for 10 of the 12 study reaches (all but the two reaches on Atascadero Creek) was collected the previous year (i.e., 2000) by PCW's consultant for the Bioassessment Program, Ecology Consultants, Inc. (Ecology), as part of Jeff Brinkman's graduate studies at UCSB, and was made available to PCW. Recently, Mr. Brinkman, the lead researcher for Ecology, also made available to PCW data he collected in 2000 from 20 other study reaches in local creeks including Refugio, Dos Pueblos, Tecolote, Maria Ygnacio, San Antonio, and Mission Creeks among others. As such, 2000 data is now available for a total of 30 study reaches.

This year (2002), the Bioassessment Program includes 11 of the 12 PCW study reaches from 2001 (one reach on Carpinteria Creek was dry and not surveyed), and a new PCW study reach on El Capitan Creek. The City of Santa Barbara is also participated in the Bioassessment Program this year by funding the study of five new study reaches in Sycamore, Mission, and Arroyo Burro Creeks. In addition, Ecology conducted bioassessment surveys at six additional study reaches this year in Gaviota Creek, Rincon Creek, Matilija Creek (Ventura County), and Sespe Creek (Ventura County), and is providing the data to PCW. In all, 23 study reaches were surveyed this year. Ecology, was hired by PCW as a consultant to help with this year's Bioassessment Program effort.

This year, field surveys were conducted between the dates of March 26 and June 25 to evaluate the physical and biological conditions present at each study reach. Fieldwork conducted at each study reach included the following:

- Measurement of physical habitat parameters including stream flow, stream width and depth, riparian corridor width, and riffle/pool frequency and length.

- Water chemistry measurements including temperature, pH, conductivity, salinity, and dissolved oxygen concentration.

- Collection of three BMI samples from the stream bottom substrate, and field assessment of BMI taxa present.

- Surveys for plant and wildlife species in the creek and adjacent riparian habitat.

- Assessment and scoring of physical habitat conditions using EPA protocols.

In addition to the field survey data, additional physical parameters have been calculated for each study reach by reviewing USGS topographic maps and utilizing GIS software. These include elevation, stream gradient, stream order, watershed area, watershed land use types and percent cover (e.g., % natural open space, % agriculture, and % urban), and relative riparian canopy coverage.

Laboratory sorting and identification of the BMI samples was recently completed by the consultant. Laboratory work involves randomly selecting and identifying 100 BMI specimens from each sample (i.e., 300 specimens per study reach) to the lowest practicable taxonomic level (typically genus) with the aid of standard taxonomic keys. Quality control was implemented to ensure random selection and accurate, consistent identification of BMIs. After preliminary enumeration and identification of the BMI samples was completed by Ecology, another taxonomist was hired to independently enumerate and identify approximately 10 percent of the BMI samples. Ecology and the independent taxonomist met to compare results, and mutually resolved all discrepancies in enumeration and identification. All BMI samples were then re-evaluated for errors based on the results of the quality control.

Currently, the three years of available data (i.e., 2000, 2001, and 2002) are being analyzed using statistical methods [i.e., regression analysis and analysis of variance (ANOVA)] to assess relationships between biological parameters and physical parameters, to compare relatively undisturbed study reaches vs. agricultural and/or urban-impacted study reaches, and to assess year-to-year variability in physical and biological conditions at the study reaches.

In addition to conducting the statistical analysis, Ecology is currently working on the Annual Bioassessment Program Report, which will more fully describe the Program goals, study area, methodology, data gathered during field and laboratory work, results of the statistical analysis, discussion of results, and recommendations for future work. The report is tentatively scheduled for public release in late November or early December.

3.5 Changes to Sampling Program

Several modifications were made to the 2001-02 sampling program based upon discussions with the Technical Advisory Committee and staff evaluation of last year's sampling program.

Four entirely new sites were added at storm drain outfalls selected as pilot project sites for treatment control Best Management Practice[2]. Two sites (Rhoads East and Rhoads West) are located along San Vicente Drive near Walnut Avenue in unincorporated Goleta, one at the end of South Turnpike at Atascadero Creek and one on 6th Street at Carpinteria Creek. The data from these sites reflect urban runoff undiluted by creek flows. Two storm drain outfall sites sampled last year, Robin Hill Road on Carneros Creek and North Kellogg on San Jose Creek, were dropped as potential BMP sites and, therefore, removed from the sampling program.

The San Jose Creek watershed is the subject of a watershed plan currently being developed by the County and other agencies and stakeholders. In order to more accurately characterize the sources of pollutants, staff sampled this watershed at five sites for a full suite of constituents. Furthermore, an intensive bacteria-only sampling was performed on November 29, 2001. Results from this sampling effort are shown in Appendix D.

3.6 Precipitation and Storm Tracking

Based upon local experience, samples were collected following a minimum rainfall of at least 0.25 inches within a period of several hours. Amounts less than this or distributed over a longer duration were not expected to generate sufficient runoff to mobilize pollutants. Also, storm water runoff was not sampled if more than 0.25-inch of rain occurred within the previous three days. Antecedent dry conditions of at least three days prior to storm water monitoring is common practice among the Phase I regulated communities, such as Ventura County (Ventura County 1999). Allowing sufficient antecedent dry conditions is thought to maximize the build-up of pollutants and subsequent flux measured in the runoff.

Each storm is unique in the quantity and intensity of rain, so weather data was closely tracked to determine the best time to initiate sampling. Due to the variation in rainfall within the watersheds sampled, sampling was occasionally initiated at a point when some areas received more than 0.25 inches while other areas did not. Every attempt was made to collect data from a storm that delivered at least 0.25 inch to the entire South Coast and/or north coast area.

Historical average annual rainfall for the South Coast area is approximately 18 inches per year (based on period from September 1 to August 31, and an average of data since 1868). Rainfall varies greatly from year to year, with a standard deviation of 8.17 inches. (SB County Flood Control 1999). During the 2001-02 storm sampling season, only 8.98 inches of rainfall fell in downtown Santa Barbara.

Weather data available on the Internet from various sources including satellite imagery, radar, and modeling was used to forecast storm events. For real-time data, the County maintains a comprehensive flood warning system, the Automated Local Evaluation in Real Time (ALERT) network, that provides rainfall and stream flow gage data. This network is used to determine when,

[2] Under a state grant, the County is installing urban runoff treatment control Best Management Practices to treat stormwater runoff. Four sites were sampled to generate baseline information.

where, and how much rainfall has occurred. Figure B-1 show the location of rainfall and stream gauges throughout the county

Hourly precipitation during the sampled storms is shown in Figures B-2 through B-5. Because of the dearth of rainfall, we were only able to sample three events.

3.7 Sampling QA/QC

Project Clean Water staff developed an extensive quality assurance/quality control plan for field sampling. A sampling protocol document was created (Appendix E) and a preliminary training session was held for the County staff members and volunteers that would be participating in the sampling. The individuals were composed of Project Clean Water staff, Environmental Health Services staff, and volunteers. As mentioned above, for certain sampling events not all of these trained individuals could participate in the sampling events. At no time was a sample team created that did not have at least one trained sampler. Volunteers or less experienced samplers were paired with experienced samplers that performed on-site training during the collection process.

All sample bottles were labeled, handled and transported following the developed protocols. Chain of custody forms identified sample locations, date and time of collection, samplers and time of delivery to testing laboratory and/or transfer to laboratory technicians for transport to testing laboratories. Bacteria analyses were conducted at the Santa Barbara County Public Health Laboratory, while all other analyses were sent to Zymax Envirotechnology laboratory in San Luis Obispo. The Public Health Laboratory is certified by the State of California's Environmental Laboratory Accreditation Program and Zymax is certified by the State of California's Department of Health Services.

Field duplicates were not taken due to the higher lab cost of processing and previously demonstrated reliability of analysis in the South Coast Watershed Characterization Study (1998). Blanks were not included in the shipment of samples to the labs, again due to the high lab cost of processing the constituents. Each laboratory performed QA/QC procedures according to certification criteria.

4.0 RESULTS & DISCUSSION

Table A-4 shows the Practical Quantitation Limit (PQL) and any known standard or objective for each constituent. The PQL is the lowest level that the lab is confident of reporting. Therefore, a null result means that the constituent was not detected or the lab was not confident of the value because it was at or below the PQL.

4.1 Storm Sampling Results

Samples were taken during three storms. South county sites were sampled October 30, 2001, November 24, 2002, and February 17, 2002. North County sites were sampled October 30, 2001, and November 24, 2002. (Since the Public Health Lab is closed on weekends, no bacteria samples were taken for the storm on November 24, 2002.) After each sampling event, the sites were reevaluated to determine whether they were still appropriate in terms of safety, accessibility and tidal influence. No sites were dropped during the 2001-02 season.

The results of the timing of each storm, stream hydrographs, precipitation data, and time of sample collection is shown in Appendix B. Samples were collected during the first few hours of the storm runoff when expected pollutant loads would be at their highest. Sampling during this period is sometimes referred to as the "first flush", a time when pollutants are initially mobilized, especially from impervious areas, and runoff is most concentrated.

As in previous years, very high levels of indicator bacteria were present in most creeks (up to 25 times the State's Ocean Water Advisory level). Metals were also detected in most creeks at levels approaching or, in many cases, exceeding basin plan standards. Nitrogen and phosphorus were found in all creeks with highest levels found in agriculturally dominated watersheds. A limited number of VOCs were detected in some creeks. Pesticide results indicate that glyphosate, malathion, and diazinon were present in a majority of the creeks.

Table C-1 summarizes results from 2001-02, while Table C-2 compares these results to 1999-2000 and 2000-01. Graphs showing data for all storms and constituents that were detected are shown in Appendix C. All graphs are labeled from west to east according to the site numbers listed in Tables A-1a-c and shown in Figures A-2a-c.

4.2 Summary of Findings

Described below are the findings observed from this year's storm water sampling, presented by categories of constituents. For each category of constituent, a table is provided (Tables 4-1 through 4-6) which shows a summary of the results presented in Appendix C.

Although some geographic and temporal trends were observed and some constituents were found in relatively higher concentrations compared to regional and national criteria and objectives, the data discussed below represent only three years of sampling. Therefore, the data may not necessarily be statistically significant or representative. It is not apparent from these results that any watershed stands out dramatically from the rest as having unusually high concentrations of pollutants during a majority of the storms.

4.2.1 Bacteria

Table 4-1. County-wide Bacteria Results Summary

		Minimum	County			Maximum*
			Average	Standard Deviation	# of Samples	
Storm Sample	Total Coliform	3,282	535,596	791,915	41	>2,419,200
	E. coli	10	21,706	43,706	41	241,920
	Enterococcus	20	22,451	33,032	41	120,330

*Maximum detection at 1:1000 dilution (performed for Total coliform and *E. coli*) is 2,419,200 and 241,920 at 1:100 dilution (Enterococcus).

Table 4-2. Area-Wide Bacteria Results Summary

		Goleta			Montecito/Carpinteria			North County		
		Avg.	Standard Deviation	# of Samples	Avg.	Standard Deviation	# of Samples	Avg.	Standard Deviation	# of Samples
Storm Sample	Total Coliform	583,291	795,154	26	419,473	854,082	12	586,727	716,093	3
	E. coli	27,715	51,964	26	12,050	23,810	12	8,249	5,634	3
	Enterococcus	22,299	31,193	26	20,802	37,880	12	30,363	40,705	3

- During the storm on October 30, 2001, total coliform, *E. coli* and enterococcus were above the State Ocean Water Quality Standards at all creeks. During the storm on February 17, 2001, results from 16 tests were below State Ocean Water Quality Standards. The upper site on Gobernador (GO 080+00) and upper San Jose (SJ 166+00) passed with respect to all three criteria for the State Ocean Water Quality Standards during this storm.

- The average and maximum number of total coliform bacteria was greater than that detected during the two previous years. The average and maximum number of *E. coli* bacteria were similar to or less than that detected during the two previous years. Similarly, the average and maximum number of enterococcus bacteria was similar to or less than that detected during the two previous years.

4.2.2 Pesticides

Table 4-3. County-wide Pesticide Results Summary

	Minimum	Average	Maximum	Standard Deviation	# of Detections
Glyphosate	0.011	0.033	0.079	0.018	32
Chlorpyrifos	0.00004	0.00017	0.00120	0.00029	16
Diazinon	0.00004	0.00042	0.00510	0.00086	49
Malathion	0.0001	0.0005	0.0018	0.0005	17

- There were no detections of 2,4-D, 4,4'-DDE, 4,4'-DDT, Endosulfan I, Endosulfan II, and Endosulfan sulfate, which had been detected in previous years.

- The number of detections of glyphosate and organophosphorous pesticides was approximately the same as last year (2000-01) and greater than the previous year (1999-2000).

- Glyphosate and malathion were more frequently detected during the first storm of the season.

- The California Office of Environmental Health Hazard Assessment has developed a Public Health Goal of 1.0 mg/L for glyphosate in drinking water, whereas the federal EPA has published a maximum contaminant level of 0.7 mg/L for glyphosate in drinking water. The Regional Water Quality Control Board has set water quality objectives for glyphosate in drinking water at 0.7 mg/L. Last year, the maximum value observed during the storm events sampled was 0.16 mg/L, which occurred in Carneros creek on October 26, 2000. This year, the maximum value observed was 0.079 mg/L, which occurred in Garrapata creek on October 30, 2001.

4.2.3 VOCs

- Toluene was detected at the Old San Jose site (SJW 006+00) on November 24, 2001 and chloroform was detected at the lower San Jose site (SJ 023+00) on October 30, 2002. As in the previous year's sampling, the number of VOC samples was reduced for reasons discussed in Section 3.4.3.

- Several VOCs that had not been detected in previous wet weather sampling were detected during 2001-02. Trichloroethene and cis-1,2-Dichloroethene were found at the lower San Jose site (SJ 023+00) on February 17, 2002. Tetrachloroethene was found at the Old San Jose site (SJW 006+00) on November 24, 2001.

4.2.4 Dissolved Metals

Table 4-4. County-wide Dissolved Metal Results Summary

	Minimum	Average	Maximum	Standard Deviation	# of Detections
Chromium	0.01	0.02	0.04	0.01	64
Copper	0.01	0.03	0.21	0.03	41
Mercury	0.0002	0.0003	0.0003	0.0001	2
Nickel	0.01	0.02	0.04	0.01	11
Zinc	0.01	0.11	0.41	0.09	85

- There were no detections of arsenic or lead, which had been detected in previous years. The number of detections of chromium increased to levels seen during the 1999-2000 sampling program despite similar PQLs for all three years of sampling. The number of detections of mercury decreased due to higher PQLs

- The number of detections of dissolved metals showed no particular pattern compared to previous years' sampling; some were detected more often, others less often, and some approximately the same number of times. Thus, overall trends for metals were difficult to ascertain other than for the groups of constituents as a whole. Results indicate earlier storms liberated more metals into the creeks than later storms. For example, of the 41 detections of dissolved copper, almost two-thirds of these detections occurred during the first storm of the year. Similarly, 10 of 11 detections of dissolved nickel were found in the first storm of the season.

- Chromium and zinc were detected at least once at every sampling location.

4.2.5 Nutrients

Table 4-5. County-wide Nutrient Results Summary

	Minimum	Average	Maximum	Standard Deviation	# of Detections
Ammonical Nitrogen	0.1	0.4	1.6	0.4	66
Nitrate as Nitrogen (NO_3-N)	0.5	3.9	24.0	4.0	76
Phosphorus as Phosphorus (PO_4-P)	1.1	1.8	2.8	0.7	12
Total Phosphorus	0.03	1.67	18.00	2.81	87
Total Kjeldahl Nitrogen	0.5	2.8	8.9	1.8	85

- The number of detections of nutrients during this year's sampling was generally the same as those from previous years.

- Many nutrients are found in all creeks and at all times of the year.

- Nitrate as nitrogen was found in higher concentrations and/or detected more frequently in creeks influenced by agricultural runoff.

4.2.6 Other Constituents

Table 4-6. County-wide Results Summary for Other Constituents

	Minimum	Average	Maximum	Standard Deviation	# of Detections
Total Recoverable Petroleum Hydrocarbons	1.0	1.4	1.8	0.4	5
Total Organic Carbon	3.8	20.3	78.0	15.8	73
Oil and Grease	1.1	1.8	3.7	0.8	20
Hardness	14	429	2100	384	85
Specific Conductance (umhos/cm)	45	942	6700	999	85
Total Dissolved Solids	18	597	3800	572	85
Total Suspended Solids	5	444	16000	1952	67
Biochemical Oxygen Demand	4	17	50	10	39
Turbidity (NTU)	2.5	701.2	12000.0	1942.0	81

- Total organic carbon, biochemical oxygen demand, and oil and grease were much higher for the first storm of the season than for subsequent storms.

4.2.7 Treatment Control Pilot Projects

For most constituents, levels detected at the Best Management Practice (BMP) sites were approximately the same or worse than at non-Best Management Practice sites. Specific examples are listed below.

- Diazinon was detected in 7 of the 12 samples taken at the BMP sites. The amounts detected were similar to or greater than those detected at non-BMP sites.

- The two Rhoads sites generally had the highest amounts of total coliform, E coli, enterococcus, Diazinon, zinc (the two highest detections of this dissolved metal were at South Turnpike Connector and 6th Street, the other two BMP sites), ammonical nitrogen, and oil and grease. This is especially true of the first storm of the season on October 30, 2001.

4.2.8 San Jose Creek Longitudinal Sampling

- As was shown for a wide range of constituents last year at the Atascadero "loading site," sampling during the rising limb of the creek hydrograph may not provide a full representation of the worst-case scenario. Appendix D shows that the number of *E. coli* bacteria in the "first flush" samples are about 3-13 times less than the maximum *E. coli* bacteria found in later samples. Similarly, "first flush" enterococcus samples underestimate the maximum number of bacteria by approximately 2-10 times.

- No longitudinal pattern is obvious for total coliform or for *E. coli*; in other words, there is no consistent increase or decrease in the number of bacteria found in adjacent sampling locations. However, in many cases, the number of enterococcus bacteria is higher in the upper part of the watersheds, which may indicate that creeks are actually serving to reduce the number of these organisms. Further longitudinal sampling in this watershed during 2002-03 will shed more light on this issue.

- Given the limited number of samples and small concentrations present in the creek, no longitudinal patter emerges for other constituents. As indicated above, we expect 2002-03 sampling to provide more information for these other constituents. Data from both years will be analyzed in concert following the conclusion of the 2002-03 wet weather season.

4.2.9 Benthic Macroinvertebrate Sampling

In all, 42 different study reaches have been surveyed one or more times in 2000, 2001, and 2002. The locations of the study reaches are shown in Figures F-1 to F-4. Preliminary physical and biological data collected in 2002 (23 study reaches) is provided in Table F-1.

As presented in the 2001 Bioassessment Program Report, last year's statistical analysis of data for 10 study reaches in 2000 and 12 study reaches in 2001 indicates that disturbed creek reaches were degraded in terms of biological integrity compared to relatively undisturbed creek reaches. Based on a cursory review, this year's data is expected to yield similar results. A full presentation, statistical analysis, and discussion of the 2000, 2001, and 2002 data will be provided in the 2002 Annual Bioassessment Report, which is tentatively scheduled for public release in December.

5.0 RECOMMENDATIONS

The storm-water quality data obtained in FY 1999-2000, 2000-01 and 2001-02 was developed, in part, to be the basis for both efforts to improve water quality and more limited sampling in subsequent years. Since very little was previously known about the characteristics of the County's urban runoff prior to the first year's sampling effort, results from these first three full seasons of water quality testing have established general characteristics of storm water quality and provided a screening-level evaluation of pollution problems in local creeks. Low-flow and storm sampling of storm drains (Rhoads, 6th Street, South Turnpike, etc.) may establish a "baseline," something that is unattainable by taking grab samples in creeks.

Recommendations developed by staff and by the County's Technical Advisory Committee on Water Quality Sampling for the 2002-03 season are presented below. Staff recommends that the sampling program of 2001-02 be modified to reflect a reduced budget and the desire to sample a couple of watersheds more intensively.

- Study one creek and/or one storm in greater detail. Focus sampling on sub-watersheds, and/or storm drains. Staff has selected San Jose creek to assess relative input of pollutants from various land uses.

- Continue benthic macroinvertebrate sampling.

- Continue sampling on selected individual catchments or storm water outfalls within urban areas before the runoff mixes with creek water, particularly at treatment control pilot project sites.

Below are suggestions that should be considered for future programs, or as suggestions for academic studies.

- Conduct a pilot study to determine a spatial distribution of pollutants as measured across a cross section of flow. (This would help establish the variability of water quality in flowing streams, thus providing a basis of estimating sampling error.)

- Consider adding bioassay tests for toxicity, while keeping all other potentially toxic compounds such as metals and pesticides. (This would help establish the relationship of measured pollutants and environmental effects.)

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