SWRCB- Agreement #00-200-180-01 Final Report of April 30th, 2004

Sources of Selenium, Arsenic and Nutrients in the Newport Bay Watershed

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Executive Summary

There are widespread problems with selenium and arsenic contamination in the western United States. Both of these toxic trace elements are present in the San Diego Creek watershed. Additionally this basin has a known problem with surface water and estuary eutrophication. Given this background this study focused on quantifying the contributions of selenium, arsenic and nitrogen by three as yet unquantified sources of contamination to San Diego Creek and Newport Bay: atmospheric deposition, open space in the watershed and contribution by a large shallow groundwater aquifer in the basin. The first two are a relatively small portion of the study with a bulk of the attention being paid to the groundwater sources of nitrogen, selenium, and arsenic. The study of the groundwater system focused on four questions: Where does the selenium, arsenic, and nitrogen originate from spatially? What processes mobilize these out of the subsurface? Where does the water come from that transports these contaminants? What is the fate of these mobilized contaminants?

Investigations of atmospheric deposition relied on collection of wet and dry deposition in the San Joaquin Reserve at the University of California Irvine. The open space portion of the study relied on samples collected from Tomato Springs, Hicks Canyon and Rattlesnake Canyon as well as sediment samples collected in Round Canyon, Hicks Canyon and an unnamed canyon near the end of Portola and California Highway 241. The study of groundwater influence focused on reconnaissance surveys of springs, weepholes and wells to directly assess the status of groundwater and address the questions we were investigating. To assess the impact of groundwater on surface water quality and potential loss of selenium, arsenic and nitrogen in the surface system of the catchment we also conducted broad surveys of surface water quality particularly focused on assessing water quality at San Diego Creek at Campus Drive.

The atmospheric deposition studies indicate that atmospheric deposition contributes a small but not insignificant amount of nitrogen directly to the surface of Newport Bay, around 3000 pounds of nitrogen per year. Additionally the rates of deposition input varied through the year with the highest rates of input occurring during fall and winter offshore wind events commonly called Santa Ana's.

The open space results indicate that the open space area is not a significant source of dissolved nutrients but that total nutrient concentrations were somewhat higher indicating a significant contribution of nitrogen and phosphorus in the form of sediment attached nutrients. Selenium and arsenic results from the open space indicate that concentrations in Tomato Springs and in Hick's canyon, while not extremely high, were elevated over what would be expected. Additionally the sediments in these areas indicated elevated concentrations of selenium and arsenic were present. Combined these results indicate that the area around Hicks Canyon, Round Canyon and Tomato Springs are the original source region of selenium and arsenic within the San Diego Creek Newport Bay watershed and the selenium and arsenic now observed in the heart of the watershed may have originally come from this area.

The groundwater survey results indicate several major results that are important for future decisions about how to improve the water quality of the watershed. Results indicate an extensive groundwater body within the watershed. As indicated in previous studies by others this groundwater body has elevated concentrations of selenium that

appear to be related to the weathering of pyrite bearing minerals due to the similarly high concentrations of sulfate in the heart of the groundwater body (Hibbs and Lee, 2000). Additionally our results seem to suggest that the majority of the selenium and arsenic that is mobilized into the groundwater of the watershed comes from flushing out of these materials from the vadose zone. This flushing appears to occur most completely on the fringes of the historic swamp in areas currently mapped as members of the Omni soils series. The heart of the swamp (mapped as the Chino soils series) has elevated concentrations of selenium but not as elevated for arsenic. As opposed to the trace elements nitrogen appears to be highest at the lowest elevations in the watershed that also have the longest residence times. This result supports the hypothesis that the nitrogen originated in historical agricultural practices in the watershed and may diminish as the watershed becomes more urbanized and time since citriculture increases.

Not all of the nitrogen and selenium mobilized from the subsurface appears to arrive at the gauging station at Campus Drive and San Diego Creek. In particular ~60% of the nitrogen and ~40% of the selenium appears to disappear before arriving at the gauging station. The loss of nitrogen represents a positive impact of near and in stream processes within the watershed. Additionally a large portion of this nitrogen is likely being lost in the Irvine Ranch Water District's treatment wetlands located adjacent to the Michaelson treatment plant. As for the reduction in dissolved load for selenium, its decrease in the surface streams is less salubrious and indicates a possible accumulation of selenium in the surface streams and wetlands of the watershed.

The results of this study can be used in a number of ways to improve water quality within the watershed. First, areas overlying the Chino and Omni soils series should be developed in a careful manner so as to prevent recharge into the underlying aquifer material as much as possible since the flushing of trace elements by recharge waters seems to be a main mechanism of mobilization of selenium and arsenic. The recommendation to minimize recharge is of a highly local nature (confined to the historic swamp and its fringes). Implementation should take into consideration other possible environmental impacts of minimizing recharge such as increased flood hazard and decreased dry weather stream flow. The possible accumulation of selenium in the surface waters should be studied further and hopefully minimized somehow in the future using some kind of technology to remove selenium from stream water. Several areas of uncertainty remain including how the aquifer might respond to climate variability, urbanization and other factors that might influence aquifer dynamics and groundwater quality. Also the results here indicate the potential for impacts on biota in the watershed may exist. Quantifying these impacts is important and should be pursued by the board as well as the stakeholders within the watershed.

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Chapter 1 Introduction

Concern over selenium and arsenic contamination in the arid western United States led to reconnaissance investigations in the San Diego Creek watershed to detect levels of these toxic trace elements (Naftz, et al. 1993; Presser 1994; Kneebone, et al. 2002; Oremland and Stolz 2003). While much research has examined trace element mobility on a watershed scale (Mok and Wai 1990; Masscheleyn, et al. 1991; Velinsky and Cutter 1991; Dowling, et al. 2002), this project investigates selenium, arsenic and nutrient contamination of the heavily urbanized Newport Bay Watershed. The larger context of the story is that the watershed bears the effects of urbanization on its hydrologic regime and ecosystem dynamics. A century of urbanization in the Newport Bay/San Diego Creek watershed has had dramatic impacts on surface geomorphology (Trimble 1997). Draining of historic wetlands and subsequent channel incision has caused oxidation and mobilization of toxic trace elements accumulated in the former wetlands (Hibbs and Lee 2000). Elevated concentrations of selenium and arsenic enter the watershed's drainage network through a complex chemical mechanism directly influenced by local land use changes and development.

Additionally land use history has created a large pool of inorganic nitrogen that has been slowly leaking out of the groundwater system. The presence of elevated levels of trace elements and of nitrogen has led to surface water eutrophication and potentially negative impacts from trace element accumulation in the food webs within the Newport Bay/San Diego Creek watershed. These possible impacts as well as other events have caused the development of total maximum daily load (TMDL) regulations within the San Diego Creek Newport Bay watershed (Santa Ana Regional Board, 1998; USEPA, 2002). In the development of trace element and nitrogen TMDL's for the San Diego Creek and Newport Bay watershed there were several sources of contamination that had not yet been addressed (T. Reeder, personal communication). This proposal focused on three of these unquantified sources:

A) Atmospheric,
B) Open space, and
C) Groundwater.

Additionally for the groundwater sources the project was driven by the following questions -

1) Where does the selenium, arsenic, and nutrients originate from spatially?
2) What processes mobilize these out of the subsurface?
3) Where does the water come from that transports these contaminants?
4) What is the fate of these mobilized contaminants?

1.1 San Diego Creek / Newport Bay Watershed

The Newport Bay / San Diego Creek watershed is located in central Orange County, California, covering an area of 154 square miles. The heart of the watershed is the low-lying Tustin Plain, which is bordered by Loma Ridge, the Santa Ana Mountains and the San Joaquin Hills. Two principle surface channels, Peter's Canyon Wash and San Diego Creek, and a number of tributaries drain the watershed southwestward toward the

Pacific Ocean (Figure 1.1). The majority of flow enters Upper Newport Bay through San Diego Creek; a smaller portion enters through a smaller channel, Santa Ana Delhi.

The watershed sits at the eastern margin of the Los Angeles physiographic and structural basin formed of fault-blocks and synclines. The local geology consists of a Cretaceous crystalline basement overlain by Tertiary and Quaternary sequences of alluvial, fluvial and marine sediments representing a dynamic depositional history. The

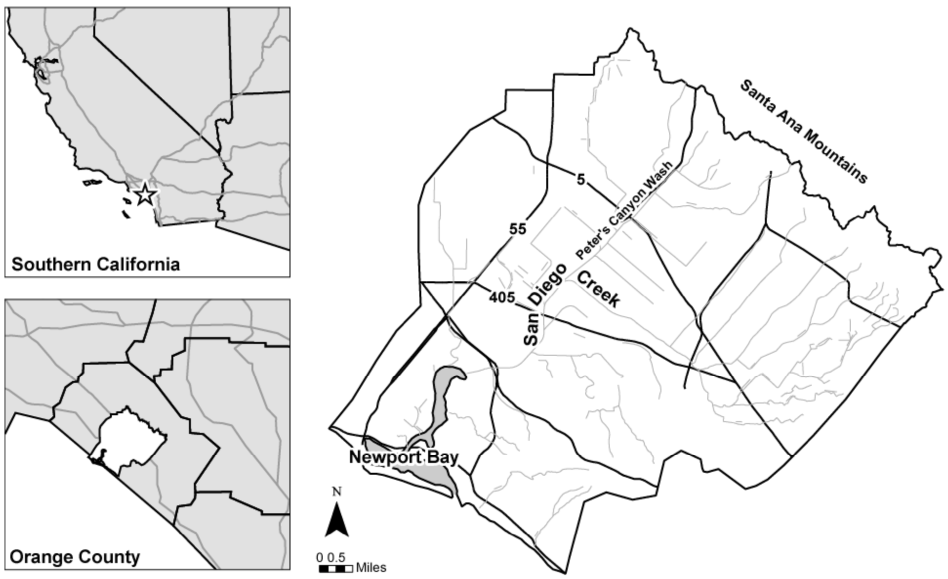


Figure 1.1 Map of San Diego Creek / Newport Bay Watershed.

local depositional sub-basin historically saw a lagoonal environmental similar to modern Upper Newport Bay with episodic floods and droughts, accounting for the interbedding of coarse and fine grained materials. During the Pleistocene, a drop in sea level due to glaciation and tectonic uplift led to a transition from marine-dominated lagoonal to terrestrial-dominated marshland environment. Coarse materials were deposited nearest their mountain source, leaving fine grained silts and clays for deposition in the placid marsh. On the watershed scale, transgressive and regressive events have left complex interfingered stratigraphy representing alluvial to deep marine deposits (McKee 1985; Bechtel 1997).

The subsurface hydrogeology of the watershed consists of two principle aquifers, the shallow aquifer and the regional aquifer. The shallow aquifer exists within the upper 150 feet of strata and was divided into three water-bearing zones during investigations following the base closure of the Tustin Marine Corps Air Station (Tustin-MCAS). This division into three units may or not may extend to the rest of the shallow aquifer system within the basin. The regional aquifer extends from 150 feet below ground surface (bgs) to depths beyond 1500 feet and can be divided into three aquifer systems. The shallow aquifer is of primary interest for studying groundwater-surface water interactions and the transport of contaminants. Unlike the shallow aquifer, the deep, regional aquifer is pumped for agricultural and drinking water purposes. Water levels in the shallow aquifer are much higher than in the regional aquifer, suggesting hydraulic separation between them (Bechtel 1997). The uppermost 30 to 40 feet of sedimentary units are low permeability clays and silts representing historic wetland deposits confining underlying more permeable sands and recent unconsolidated alluvium. These regionally discontinuous units cap the confined and semi-confined shallow water-bearing zones (McKee 1985). The upper 100 feet contain from 60 to 90 percent clay with permeable sand and gravel lenses scattered throughout (Bechtel 1997). Localized perched zones may exist in the upper 5 to 10 feet of the watershed with little to no recharge occurring. Recharge to the shallow aquifer occurs in the forebay area, the region between the Santa Ana Mountains and the Santa Ana Freeway, which is not underlain by confining fine sediments (McKee 1985). Sources of recharge include precipitation infiltration, irrigation return flows and upwelling of deep ground waters (Bechtel 1997). The central part of the basin, the pressure area, represents the low-lying topography in which the marshland existed and contains the confining clays (McKee 1985). The exact locations of the forebay and pressure areas are determined seasonally and depend upon groundwater levels (Bechtel 1997). The clays confining the regional aquifer are estimated to be more laterally extensive and less permeable that those separating the shallow aquifers. This leads to recharge of the deep aquifer occurring closer to the Santa Ana Mountains (McKee 1985). Most of the shallow aquifer flow discharges into the watershed's surface channels (Bechtel 1997). Stream gaging at various points in the watershed indicates gaining conditions and thus supports a significant groundwater contribution to surface discharge (Hibbs and Lee 2000).

1.2 Effects of Development on Watershed Hydrology & Biogeochemistry

The watershed's varied anthropogenically-impacted history has been marked by shifts in land use from grazing to agriculture, followed by modern urban and surburban uses. These changes have directly impacted the hydrology and water quality of the watershed. At the turn of the past century, grazing of sheep and cattle dominated much of the landscape with the central region covered in marshland (McKee 1985). The marshland was essentially a large peat bog (Figure 1.2) known as "La Cienega de las Ranas" or "Swamp of the Frogs" (Liebeck 1990). As ranching gave way to agriculture in the 1930s, the Army Corps of Engineers drained the swamp and deepened the channels of San Diego Creek and Peter's Canyon Wash (McKee 1985).

Recent changes to the hydrology within the watershed represent the classic features of urbanization, including concrete channel linings and other efforts to manage increased flood events. Large amounts of impervious cover and forced channelization of storm flows in an urban watershed result in channel incision (Groffman et al. 2003). This incision has been well documented over the past two decades, contributing two-thirds of the total sediment load to Newport Bay (Trimble 1997). The result of the 1930's deepening of the main channels and more recent efforts to control urban flow has been to reduce groundwater levels to unprecedented lows, forever altering the hydrologic regime of this riparian/wetland area. This "hydrologic drought" is a common effect of urbanization and holds important consequences for groundwater quality. Lowering the groundwater table allows oxygen to enter previously reduced hydric soils, potentially mobilizing redox-sensitive elements. This change is particularly significant for trace elements that may have accumulated over time in a riparian area and are toxic at low concentrations. The historic swamp may also have provided a sink for inorganic nitrogen via biological assimilation and denitrification. Finally, the swamp may have allowed the

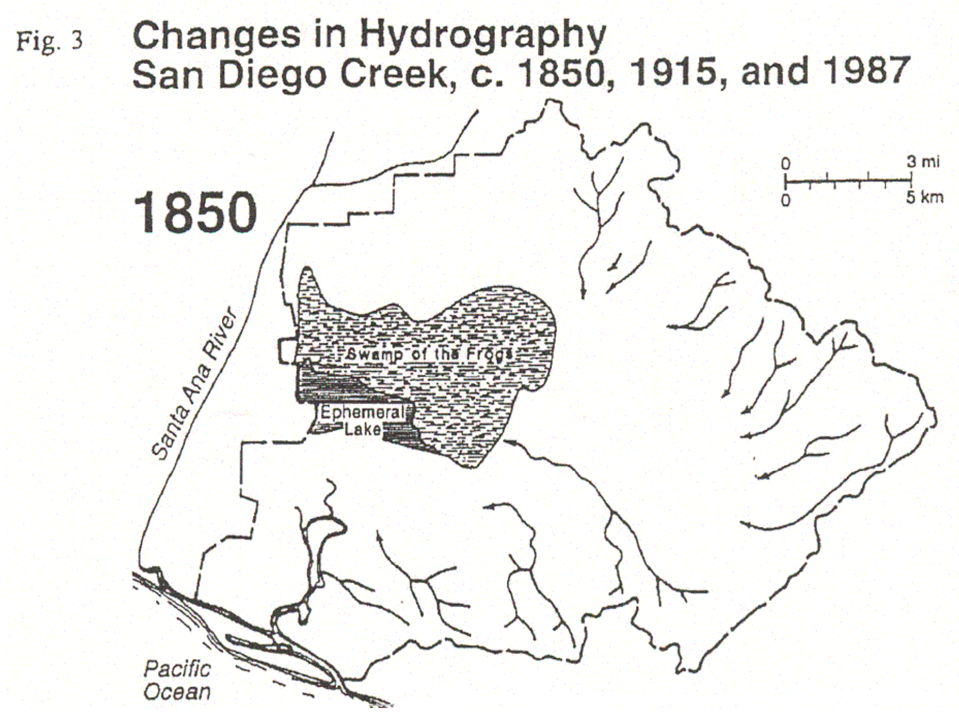


Figure 1.2 Reconstruction of Swamp of the Frogs region, from (Trimble 1998)

accumulation of reduced sulfur that could later be oxidized and release sulfate to the ground and surface waters of the now former swamp.

In fact, the Swamp of the Frogs has been hypothesized to be the key player in producing the elevated concentrations of selenium and arsenic. If the swamp were the main mechanism as the sediments oxidized they would release sulfate, selenium and arsenic into groundwater, while chloride concentrations would change only modestly or not at all. Previous sulfate and chloride data support only limited evaporative concentration of groundwater and indicate an alternative mechanism for selenium and arsenic mobilization. These data show a positive correlation ($r^2 = 0.65$) between sulfate and selenium concentrations, specifically an increase down gradient as water is given more time top interact with the former swamp sediments. Also, chloride concentrations changed very little along the same reach where sulfate and selenium increased. Furthermore, when comparing sulfate and selenium according to the location of the historic marsh, a more notable relationship exists. A stronger correlation coefficient ($r^2 = 0.73$) existed for sample sites within the historic marsh than for those outside of an approximate boundary ($r^2 = 0.56$) (Hibbs and Lee 2000). This evidence leads one to believe that draining the swamp has released selenium, arsenic and sulfate into the groundwater and from there eventually to Newport Bay.

The historic marsh was described as a “giant peat bog” (Liebeck 1990) that created moderately to highly reducing anoxic environments (Drever 1988). Under these conditions selenium would exist as selenide (-II) bound to transition metal solid phases. Similarly, sulfate is reduced to H_2S and HS^- that then form insoluble metal sulfides (Hem 1985). Arsenic has been detected in anoxic environments as toxic arsine gas and as immobile arsenide precipitates, both of the –III oxidation state (Drever 1988; Oremland and Stolz 2003). Selenium and arsenic share many chemical and physical properties with sulfur. Similar ionic radii allow for isomorphic substitution of either into metallic sulfides. Ferroselenite ($FeSe_2$) and arsenopyrite (FeAsS) are the most common associations of selenium and arsenic with the metal sulfide, pyrite. Both can also be found as trace elements in pyrite or as secondary sulfate minerals formed by weathering processes (Presser 1994; Kneebone, O'Day et al. 2002). Because these selenium and arsenic-bearing minerals form under reducing conditions (Drever 1988) co-precipitation in the historic swamp can be inferred as the local source of selenium and arsenic.

As sediment and organic matter accumulated in the marsh, selenium and arsenic did as well (Hibbs and Lee 2000). However, the early 20th century transformation of the watershed by the draining of the marsh altered its redox characteristics. Previous data indicates that the modern groundwaters are oxygen-enriched as well as high in dissolved nitrate (Hibbs and Lee 2000), providing the necessary electron acceptors for oxidation of the reduced selenium and arsenic as recharge waters move through the swamp deposits. This oxidative mechanism is further supported by higher concentrations of selenium occurring within the historic wetland boundary, frequently above 25 μg/L (Hibbs and Lee 2000). The Swamp of the Frogs is thus a case study for a potentially widespread problem of toxic trace element mobilization due to urbanization.

This research will further investigate the Swamp of the Frogs model by assessing the role of pyrite oxidation in selenium and arsenic mobilization. Geochemical analysis of groundwater and soils will be used to determine the nature of this role and to discuss the mechanisms controlling the release of these trace metals. Conclusions from this study will provide specific answers to questions about the impact of urbanization on water quality.

Additionally, past studies have shown significantly elevated levels of nitrate-nitrogen in the groundwater of the San Diego Creek Newport Bay watershed (Hibbs 2000). Given the land use history of the basin with large-scale productive agriculture particularly citrus production prior to urbanization it is reasonable to expect that much of the problem related to nitrate export from the groundwater system is related to citrus heritage pollution. Additionally given the known status of nitrate as a strong oxidant it is important to study nitrate along with arsenic and selenium given the redox sensitive chemistry of selenium and arsenic.

The other two possible sources of nutrients to Newport Bay include direct atmospheric deposition of nitrogen and the impact of atmospheric pollution on wildland biogeochemistry and the possible increase in nutrient export from these wildlands. Southern California has long been known as one of the most polluted air basins in the United States, with this air pollution comes high rates of atmospheric deposition, as high as 40 kg of nitrogen per hectare per year [Meixner and Fenn, 2003; Fenn et al., 2003a; Fenn et al., 2003b]. While the rates of atmospheric deposition are expected to be lower with proximity to the ocean, it would be expected that deposition to bays and estuaries along the coast might not be an insignificant flux. In other estuaries and lakes in the United States atmospheric deposition to the surface of estuaries has been shown to be a significant source of nitrogen to the water bodies in question [Paerl et al., 2003; Whitall et al., 2003; Jassby et al., 1994]. Due to the conditions in southern California and the possible importance of atmospheric deposition we decided to sample for atmospheric deposition in the San Joaquin Reserve of the University of California, Irvine. While not located next to the bay the reserve provided an easy to access location with permanent power to assess the importance of atmospheric deposition to the bay.

The same deposition that reaches the bay may also increase nitrogen export from wildland and other land uses in the basin through a process of fertilization known as nitrogen saturation. In nitrogen saturation a previously nitrogen limited ecosystem begins to have excess nitrogen and exports this to surface waters [Aber et al., 1998; Fenn et al., 1998]. Since urban and agricultural land uses in the watershed were already being studied by others our study focused some effort on capturing how much nitrogen was coming off of wildland land uses in the basin.

Chapter 2 General Field and Laboratory Methods

This chapter describes the methods shared across much of the study in terms of field and laboratory sampling. Methods of data collection, lab analysis or numerical analysis specific to a single portion of this project are described in detail in the chapter covering that individual topic.

2.1 Field Methods

Key locations in the network of surface channels were identified using local maps. Locations of groundwater entering the surface channels were sampled as they were discovered, with sites concentrated in an area bound by the three major regional freeways. These included weepholes, springs, wells and de-watering operations. After several weeks of reconnaissance, sites were sampled every six weeks for the first year of study with quarterly sampling thereafter (Figs 2.1 and 2.2). Surface channel locations of particular significance for their proximity to major confluences or groundwater sources were selected as part of the quarterly monitoring schedule. Storm drains with significant dry weather flow were included in this schedule where reconnaissance data indicated significant release of selenium, arsenic, or nitrogen to the surface channels. Investigations of storm flows, particular channels or specific analytes such as mercury were completed in addition to the routine sampling events.

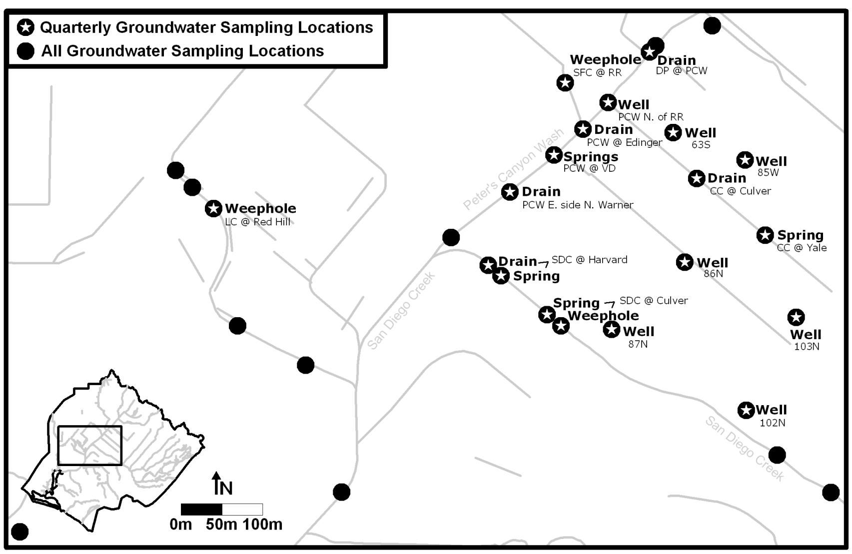


Figure 2.1 Groundwater sampling locations. Please see Appendix A for a list of sample site abbreviations commonly used in this document.

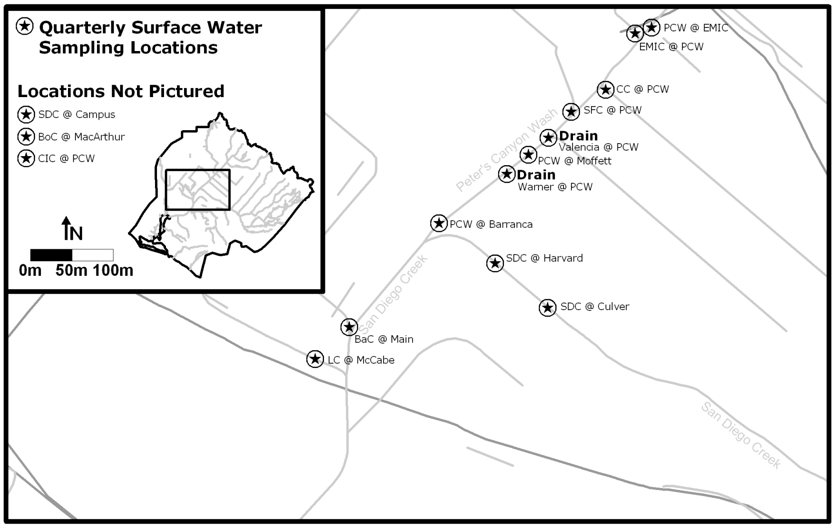


Figure 2.2 Surface Water sampling locations. Please see Appendix A for a list of sample site abbreviations commonly used in this document.

2.2 Surface Water & Groundwater

Water samples were collected via grab sampling in triple washed LDPE bottles. Samples for dissolved nutrients, anions and metals analysis were filtered in the field using 0.4 micron membrane filters. Additional filtered samples were collected for selenium speciation analysis at a subset of sites. The bottles used for metals analysis were pre-acidified with dilute nitric acid. Unfiltered samples were also collected for total nutrients, alkalinity, isotope analysis and dissolved organic carbon (DOC). The DOC samples were collected in brown glass bottles and filtered in the lab with 0.7 micron TCLP glass filters. Bottles for non-acidified filtered and unfiltered samples were pre-contaminated three times using approximately 10 mL of appropriate sample.

In-stream samples were collected primarily by wading to midstream in a riffle area and facing upstream. In some cases, particularly during a storm event, it was necessary to collect a surface water sample from the bank or a bridge. Index parameters were measured in the field using pre-calibrated portable meters. Temperature and temperature-compensated conductivity were measured using an Orion model 130A meter. Dissolved oxygen was determined with a YSI 55 meter, while pH was read with a double junction waterproof pHTestr 3. Discharge measurements in surface channels were made using a Marsh-McBirney Flowmate portable flow meter with a bottom-set wading rod. Velocity and depth were recorded at approximately 10 intervals across the width of a channel. Standard USGS protocol for calculation of total discharge using a flow meter was used, with cross-sections assumed to be rectangular. In the case of a weir confined or very narrow channel or drain, 5 readings were taken at the midpoint and averaged, with cross-sections assumed to be triangular. At all sites, the flow meter head was placed at approximately 40 percent of the stream's total depth. In locations where the channel conditions were unfavorable to flow meter measurements, the discharge was measured by a timed float of a light object for a pre-determined distance.

Groundwater samples were collected primarily by a triple rinsed syringe, except at a small number of locations where grab sampling was possible. Index parameters were taken directly in the groundwater source where possible, else they were inserted into a triple rinsed plastic container containing fresh sample collected by syringe. Discharge measurements were often impossible for groundwater locations, as many springs and weepholes did not have sufficient flow. For strong-flowing weepholes, flow was measured by a timed collection of water in a calibrated bucket. Shallow groundwater wells were sampled quarterly using a DC well purging and sampling pump, with at least three well casings purged before sampling. Pumped water was placed into a triple rinsed plastic container where index parameters were measured and samples collected by syringe. To determine groundwater elevations and aquifer response to precipitation and irrigation, water level elevations were monitored twice monthly with an electric line. Water level data were used to prepare time series hydrographs.

2.3 Interstitial Water

Peepers were used to determine regions of groundwater upwelling. This equipment uses membrane dialysis to retrieve a sediment pore water sample over a timed interval. Plastic vials are fitted with 0.4 micron membrane filters and placed in the peeper housing. Three to five vials are placed on each side of the peeper, which is then installed beneath the sediment-water interface. Several peepers are placed at each site to determine spatial variability. Sites were chosen for having fine textured sediment with quicksand properties, which is often indicative of high groundwater conditions. Peeper samples were then returned to the lab intact in their vials and samples were separated out for analysis.

2.4 Sediments & Soils

A small number of sediment samples were collected for selenium speciation using a box corer or hand auger. These were immediately sealed in plastic and preserved on ice for the return to the lab. They were kept chilled and then air-dried prior to analysis.

Four samples of vadose zone soils were retrieved for assessment of physical and chemical properties relating to their ability to contribute selenium and/or arsenic to the groundwater system. The soils were collected in the exposed vadose zone material near the following surface channel features: Denitrification Plant, Warner Drain, Barranca Channel @ Barranca and Barranca Channel @ Alton. These samples were collected by hand auger approximately 10 feet horizontally into the channel wall. Two kilograms of soil at each location were sealed in plastic bags and kept chilled until returning to the lab.

2.5 Laboratory Methods and Sample Storage

2.5.1 Sediments & Soils

The collected vadose zone soils were frozen and subsequently air-dried for one month. A small sample of each soil was ground to pass a 0.1 mm sieve and underwent microwave digestion using aquaregia for total chemical content. The resulting solution was analyzed for dissolved ammonium, phosphate, selenium, arsenic, major cations and anions. The bulk of the soil collected was then ground to pass a 2 mm sieve; however, samples from two locations, Barranca Channel at Barranca and Denitrification Plant, were ground further to pass a 0.1 mm sieve. All but one of the samples (Barranca Channel at Alton), were incubated for three weeks in a 40 g/L suspension of air-dried sample and ultrapure water. A controlled volume of laboratory quality air was bubbled into triplicate flasks containing the soil sample through fish tank bubblers. Samples of the suspension were removed at pre-determined intervals throughout the three-week period and filtered through a 0.4-micron membrane filter. The filtered solution was then frozen until all samples could be prepared and analyzed for dissolved nutrients, selenium, arsenic, major cations and anions. Following the incubation period, the sample was air dried and ground to pass a 2 mm sieve. The post-incubation soil then underwent total digestion to balance the mass of dissolved constituents lost to the incubation solution. The resulting solution received the same chemical analysis treatment as the initial total digestion.

Sequential extraction procedures selective for selenium and arsenic were employed to distinguish the various forms of the redox-sensitive trace metals in the soil samples. These were carried out using the same size fractions of each soil that went through the incubation process. The sample from the non-incubation location was ground to pass a 2 mm sieve. For selenium, a five step extraction procedure developed by Wright (2002) was utilized, while the arsenic-selective extraction procedure followed Herreweghe’s (2003) revision of Manful (1992). For both procedures, the residual fraction of soil underwent microwave digestion to close the mass balance. Dissolved selenium and arsenic were determined via hydride generation atomic absorption spectrophotometry, the same method employed for all of our selenium and arsenic analysis.

2.5.2 General Sample Methods and Storage

The methods used and details of sample storage for the project are listed in Tables 2.1 and 2.2. The analyses routinely performed on water samples are specified by sample type in table 2.3. Conductivity, pH, temperature and dissolved oxygen were performed in the field. Meters were checked before use and calibrated if necessary and checked after use. Conductivity and temperature were measured with an Orion model 130A portable conductivity meter. pH was measured with an Oakton Instruments pHTestr3 double junction probe. Dissolved oxygen was measured with a YSI Inc. model 55-12 meter by the membrane electrode method. Other analyses were performed in the lab.

Selenium and arsenic in water and sediment were measured using a Varian model SpectrAA-10 atomic absorption spectrophotometer with a VGA-76 Vapor Generation Accessory by the hydride generation method. Calcium, magnesium, sodium, potassium, strontium and silica were measured with a Perkin-Elmer model Optima 3000DV inductively-coupled plasma spectrometer with an AS91 autosampler. Samples were field-filtered into a 30 mL HDPE sample bottle containing 0.5 mL 1+9 trace metal grade nitric acid. This amount was determined to be sufficient to reduce the pH to less than 2. Chloride and sulfate were measured by ion chromatography using a Dionex ion chromatograph with an ED40 electrochemical detector. Ammonia, nitrate, phosphate, total nitrogen and total phosphorus were measured using a Technicon AutoAnalyzer continuous flow analyzer. Total nitrogen was measured by digesting unfiltered samples by the persulfate method then analyzing the digest for nitrate. Total phosphorus was measured by digesting unfiltered samples by the persulfate method then analyzing for phosphate. Alkalinity was measured on unfiltered samples using a Mettler Toledo model DL53 titrator.

Dissolved organic carbon (DOC) was measured by the high temperature combustion method using a Shimadzu model TOC-V_{CSH} with an ASI-V autosampler. Samples were lab filtered using binder-free 0.7u glass fiber Whatman GF/F filters and preserved with hydrochloric acid. Standard Methods, however, defines DOC (in 5310A2) as the fraction that passes through a 0.45um-pore-daim filter. ^{18}O and deuterium were measured by the Department of Geosciences Laboratory of Isotope Geochemistry at the University of Arizona in Tucson. Mercury samples were collected by the EPA method 1669, "Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels". Mercury was measured by Columbia Analytical Services, Kelso, Washington, by the EPA method 1631E, "Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry".

Table 2.1 Method, container, preservative and holding time for various analytes in water samples

Measurement	Method	Container	Preservative	Holding Time
O-18	See ref.	P	None	Stable
Deuterium	See ref.	P	None	Stable
pH[1]	SM4500-H^+ B	N/A	N/A	N/A
Conductivity[2]	E120.1 / SM2510B	P	Cool	28 d
Arsenic	SM3114C	P(A)	Field filter 0.45u, cool	6 mo
Selenium – Total	SM3500-Se B2 & B5 SM3114C	P(A)	Field filter 0.45u, cool	6 mo
Selenium – speciation	See ref.	P	Field filter 0.45u, cool	28 d
Calcium	SM3120B	P(A)	HNO_3 pH < 2	6 mo
Magnesium	SM3120B	P(A)	HNO_3 pH < 2	6 mo
Potassium	SM3120B	P(A)	HNO_3 pH < 2	6 mo
Silica	SM3120B	P(A)	HNO_3 pH < 2	6 mo
Sodium	SM3120B	P(A)	HNO_3 pH < 2	6 mo
Strontium	SM3120B	P(A)	HNO_3 pH < 2	6 mo
Chloride	SM4110B	P	Field filter 0.45u, cool	28 d
Sulfate	SM4110B	P	Field filter 0.45u, cool	28 d
Phosphorus	SM4500-P B5, SM4500-P F	P	Cool	28 d
Phosphate	SM4500-P F	P	Field filter 0.45u, cool	48 h
Total Nitrogen	SM4500-N C, SM4500-NO_3^- F	P	Cool	28 d
Ammonia-N	SM4500-NH_3 G	P	Field filter 0.45u, cool	28 d
Nitrate-N	SM4500-NO_3^- F	P	Field filter 0.45u, cool	48 h
Mercury	EPA1669/1631E	Teflon (A)	HNO_3 pH < 2, cool	28 d
Temperature[1]	SM2550B	N/A	N/A	N/A
Alkalinity	SM2320B	P	Cool	14 d
Oxygen, dissolved[1]	SM4500-O G	N/A	N/A	N/A
Dissolved Organic Carbon	SM5310 B	G	Lab filter, HCl pH < 2, cool	28 d

Table 2.2 Method, container, preservative and holding time for various analytes in sediment samples

Measurement	Method	Container	Preservative	Holding Time
Selenium Speciation	See ref.	P	Cool	28 d
Total Selenium	SM3114C	P	none	6 mo
Total Arsenic	SM3114C	P	none	6 mo

Measurement: [1]field test, [2]lab or field test
Container: P = plastic, A = acid rinsed container, G = glass
Preservative: Cool means stored at 4 +/- 2^{o}C
Method:
SM = (Standard Methods 1999)
O-18 = (Epstein et al. 1953, Friedman et al. 1977, Hoefs1987)
Deuterium= (Kelly et al. 2001)
Selenium speciation= (Zhang et al. 1999a, Zhang et al. 1999b)

Table 2.3 Analyses routinely performed on water samples by sample type.

Sample Type	Temperature	pH	Conductivity	Dissolved Oxygen	Alkalinity	Metals by ICP	Selenium	Arsenic	Chloride	Sulfate	Ammonia	Nitrate	Phosphate	Nitrogen, total	Phosphorus, total	Dissolved Organic Carbon	O-18, Deuterium
Dry Collector		X	X			X	X	X	X	X	X	X	X	X	X		
Wet Collector		X	X			X	X	X	X	X	X	X	X	X	X		X
Grab Water	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Autosampler						X	X	X	X	X	X	X	X	X	X		
Equipment Blank					X	X	X	X	X	X	X	X	X	X	X		

Metals, selenium, arsenic, chloride and sulfate were not performed on wet and dry collector samples after 1-20-04. Conductivity and pH were performed on wet and dry collector samples collected after 1-20-04. The wet collector often had insufficient volume to perform all the requested analyses. Dissolved Organic Carbon was performed on groundwater samples only.

2.5.3 Dilutions

The sample was not diluted for the field tests pH, conductivity, temperature and dissolved oxygen. The sample also was not diluted for alkalinity. Samples analyzed for selenium were given an initial dilution based on historical data from the site. If no data were available then a 1X dilution was used initially. Arsenic, ammonia and phosphate were analyzed at 1X initially. Samples were screened by the "Ultraviolet Spectrophotometric Screening Method" (SM4500-NO_3^- B) for nitrate to determine the dilution except in cases where past data indicated that no dilution would likely be needed. Samples analyzed for total phosphorus received an initial dilution based on phosphate data. Samples analyzed for total nitrogen received an initial dilution based on the sum of nitrate-N and ammonia-N data.

Any sample with an instrument response greater than the highest standard received an additional dilution based on the analyst's judgment. Any sample with an instrument response lower than the lowest standard was re-analyzed at a lesser dilution. Ultimately, to be accepted, the data were within the quantitation range when a dilution was used.

2.6 Quality Control Quality Assurance Reporting

Table 2.4 Precision, Recovery and Detection Limits

	Duplicate RPD median	Duplicate RPD mean	Spike RPD median	Spike RPD mean	Spike % Recovery median	Spike % Recovery mean	MDL
Nitrate (mg/L as N)	2.64	4.84	1.35	2.17	99.13	100.32	0.09
Ammonia (mg/L as N)	NA	NA	1.87	2.00	94.95	96.17	0.04
Phosphate (mg/L as P)	3.14	7.43	2.49	3.52	96.85	97.21	0.03
Total Nitrogen (mg/L)	2.39	9.66	2.41	3.54	99.65	102.71	0.16
Total Phosphorus (mg/L)	2.86	4.68	1.91	2.75	102.07	103.37	0.04
Selenium (ug/L)	1.85	5.88	1.47	1.93	100.43	99.44	0.4
Arsenic (ug/L)	NA	NA	1.76	2.25	95.49	94.93	3.4
Chloride (mg/L)	1.26	2.26	2.67	2.50	114.05	114.67	-----
Sulfate (mg/L)	2.15	15.55	2.42	2.68	102.43	101.87	-----

Relative percent difference (RPD) is the absolute difference between two samples divided by the mean of the analyses for two duplicate samples. RPD is a measure of imprecision, which is, random error in our analyses. All analyses meet acceptable levels and indicate that our analytical methods are relatively precise (Table 2.4 and 2.5). Duplicates are samples collected at the same time and location. In cases where most duplicate data were less than the quantitation limit duplicate RPD was not reported. In those cases imprecision may be estimated from spike duplicates. Values less than the quantitation limit were not included in calculating RPD. A spike is a sample to which a known amount of the analyte has been added. Spike recovery is a measure of accuracy. Spiked samples are used to determine the effect of the matrix on a method's recovery efficiency. The Method Detection Limit (MDL) is defined as the minimum concentration that can be measured and reported with 99% confidence that the concentration is greater than zero. The MDL is only reported for chemical species where our measurements were close to the instrument detection limit for the analytes in Table 2.5 this was not the case.

Table 2.5 Precision of Additional Analytes

	Duplicate RPD median	Duplicate RPD mean
Sodium (mg/L)	0.59	1.86
Potassium (mg/L)	4.21	4.48
Calcium (mg/L)	1.15	5.72
Magnesium (mg/L)	0.93	2.07
Silicon (mg/L)	1.08	2.30
Strontium (mg/L)	2.01	2.45
Alkalinity (mg/L as $CaCO_3$)	4.21	4.21

Chapter 3 Atmospheric Deposition

Atmospheric deposition directly to the bay's surface may be an important flux of nitrogen or other chemical constituents directly to the surface of Newport Bay. To assess the flux of nitrogen in wet and dry deposition we collected rain water and water exposed to the atmosphere for two weeks at a time from a collection site inside the Newport Bay watershed.

3.1 Sampling Approach and Analysis

Atmospheric deposition samples were collected using an Aerochem 301 wet and dry bucket collector located on a raft at the San Joaquin Research Reserve on the University of California, Irvine campus near the intersection of Campus Drive and Jamboree Boulevard. The wet and dry bucket collector has a sensor which when it becomes wet moves a cover from the top of the wet bucket to the top of the dry bucket. In this way the wet bucket is only exposed to the atmosphere during wet weather and the dry bucket is exposed at all other times. The dry bucket was filled with four liters of water every other week. The water in the bucket serves as a surrogate surface for the surface of the bay. Both the wet and dry buckets were retrieved from the collector every other week. Except when it rained in which case the buckets were collected within the week. Samples were then returned to the lab where the volume of water in the collectors was recorded and the samples were analyzed like any other water sample.

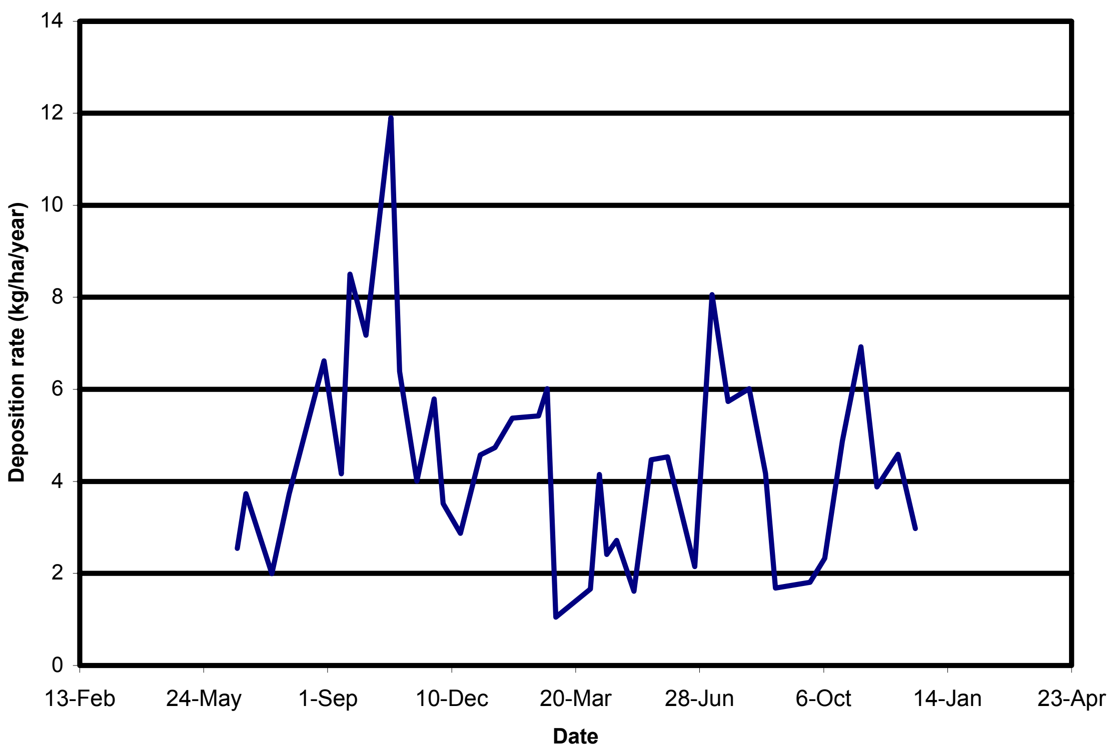


Figure 3.1 Annualized dry deposition rate from dry bucket collections near Upper Newport Bay at University of California Irvine San Joaquin Reserve. Notice higher deposition rates in fall and during Santa Ana wind events in winter and fall.

Calculations of deposition from the lab analyses used concentrations measured in the collectors multiplied by the volume of water to achieve a mass. This mass was then divided by the area of the bucket at the rim (0.065 m^2) to arrive at a mass flux per unit area. This flux was then divided by the number of days between the current and the previous collection to calculate a daily flux that could then be used to estimate an annual flux. Final annual fluxes were calculated based on summing up the calculated results for all of the samples collected.

3.2 Results

Dry deposition varied from a low rate of 1.6 kg-N ha^{-1} $year^{-1}$ up to a high rate of 12 kg-N ha^{-1} $year^{-1}$ (inorganic nitrogen) (Figure 3.1). The dry deposition rate was variable on a seasonal time scale with the highest rates of deposition during fall and winter off shore wind events commonly called Santa Ana winds. It is likely that these offshore wind events caused deposition to increase by keeping photochemical smog local to the Irvine area instead of the normal sea breezes cleaning out the air mass over the reserve and Newport Bay. The mean rate of dry deposition for the sampling period was 4.4 kg-N ha^{-1} $year^{-1}$. At this mean rate loading to the surface of Newport Bay would be approximately 3000 pounds per year. Using the highest rate observed the rate would be about 8000 pounds per year and the low rate of dry deposition results in a rate of 1000 pounds per year. These calculations are based on an open surface water area of the bay of 752 acres. The 14 wet deposition collections to date indicate that very small loadings of N to the bay directly from rain. Total deposition for these rain events samples is about 0.75 kg ha^{-1} over a period of 18 months. No significant levels of phosphorus, arsenic or selenium was detected in either wet or dry deposition collections at the reserve.

3.3 Relative Importance and Impact of Atmospheric Deposition

In light of the 2007 TMDL for total nitrogen for the bay of 154,000 pounds per summer season and around 300,000 pounds per year when winter TMDL's are instated in 2012, the atmospheric dry deposition of approximately 4000 pounds per year are small but significant contributors of loading to the bay. However wet deposition is of little concern since the low rate of deposition in rainfall is far below any uncertainty level there may be for loading of nitrogen to the bay.

Chapter 4 Open Space

Several open space locations were sampled to investigate the open space locations being a possible source of selenium, arsenic, nitrogen or phosphorus to the surface and groundwaters in the basin. Sediment from several detention basins was sampled in May of 2003. Analyses for Se and As (Table 4.1) indicate that the detention basins are not dramatically elevated with respect to Se. The Round Canyon samples have higher Se particularly the sample collected from a saturated area in Round Canyon that receives water from Tomato Springs. Both the Hicks Canyon and Round Canyon sample sites have higher concentrations of As compared to the sites sampled from near the end of Portola Boulevard.

Table 4.1 Sediment Selenium and Arsenic Concentrations for Detention Basins at Foot of Loma Ridge

Site Description	Total Se (mg/kg)	Total As (mg/kg)
Round Canyon 1	0.623	2.594
Round Canyon 2	0.303	1.919
Round Canyon Saturated	2.011	2.45
Portola 1	0.144	1.096
Portola 2	0.116	0.83
Hicks 1	0.218	2.468
Hicks 2	0.329	1.64

A rainstorm generated enough flow to sample for water quality at Hicks Canyon on one occasion where we were able to capture the flow. Flow was never observed in the 2003 winter at the Rattlesnake Canyon site. Concentrations of nutrients were fairly low for the open space sites in the dissolved form. However total nitrogen and total phosphorus had concentrations that are high as compared to the perrenial channel flows of the heart of the watershed that we will discuss later in this report. Selenium and arsenic data indicates elevated concentrations of both species in storm flow in Hicks Canyon. Additional data at Tomato Springs is also interesting in light of this storm event data (Tables 4.2 and 4.3). Tomato Springs is a natural occurring spring at the southeast edge of the Newport Bay watershed. This data shows that the spring has elevated concentrations of Se, As and NO_3^-. This storm data along with the data at Tomato Spring indicate that this region of Loma Ridge is the original source region of Se and As within the San Diego Creek/Newport Bay watershed. Currently the non-storm flows from this region likely recharge the deeper aquifers of the basin and not the shallow of concern elsewhere in this document. Historically it is possible that storm flows from this area recharged the aquifer feeding the "Swamp of the Frogs" or delivered sediment to the swamp that provides the fine grained material making up the aquifer of concern today. The areas also appears to have somewhat elevated nutrient concentrations in total and dissolved form compared to what might be expected for a wildland system in native vegetation [*Meixner and Fenn*, 2003; *Riggan et al.*, 1993; *Riggan et al.*, 1985].

Table 4.2 Storm Flow Water Quality Hicks Canyon

Date	Time	Se (ug/L)	As (ug/L)	NO3-N (mg/L)	NH4-N (mg/L)	PO4-P (mg/L)	TN (mg/L)	TP (mg/L)
3/15/03	0:00	4	4	0.37	0.08	0.18	3.58	7.50
3/15/03	15:00	1	4	0.30	0.09	0.11	1.84	3.60
3/15/03	15:15	6	13	0.58	0.05	0.15	2.65	7.20
3/15/03	21:00	3	4	0.29	0.09	0.09	2.09	4.90
3/16/03	5:00	11	5	0.93	0.06	0.35	4.09	6.20

Table 4.3 Tomato Springs Data

Date	Se (ug/L)	As (ug/L)	NO3-N (mg/L)	NH4-N (mg/L)	PO4-P (mg/L)	TN (mg/L)	TP (mg/L)
2/4/03	77.7	4.54	5.34	0.12	0.04	5.86	0.04
8/7/03	77.4	4.28	4.42	0.05	0.02	4.64	0.00
11/5/03	177.15	3.89	4.89	0.04	0.03	5.23	0.02

4.1 Impact and Importance of Open Space Within the Watershed

The results for open space loading for nutrients indicate that dissolved inorganic nutrient concentrations are low whereas total nutrient concentrations are relatively high. The total nutrient levels are still not high enough to be of a level of concern to the bay. Similarly while selenium and arsenic concentrations are not large in storm runoff or in the constant flows from Tomato Spring they are above geochemical background and are thus indicative of the fact that the original source region for selenium and arsenic in the basin is in the foothill region of Loma Ridge.

Chapter 5 Mercury Reconnaissance

Due to the presence of the historic Red Hill mercury mine within the watershed (personal communication T. Reeder) it was thought that a broad survey of surface and groundwaters within the watershed should be made. The results indicate that there is little cause for concern as the levels of mercury in the surface waters and groundwaters are in the low part per trillion range and are below most commonly issued levels of concern for mercury in surface waters (Table 5.1). Additionally our sampling was conducted in both fall and spring after a rainy wet season that significantly changed groundwater dynamics. Despite this significant change in groundwater dynamics and the evident changes we saw in groundwater export and surface water dynamics (chapters 7 and 12) there is no noticeable change in mercury concentrations in either surface water or groundwater samples. Combined these results indicate that there is no evidence that there should be a concern about mercury contamination from a diffuse watershed source in the Newport Bay/San Diego Creek watershed.

Table 5.1 Hg Concentrations in San Diego Creek Watershed

Date collected	Location	Hg, total (ng/L)
11/12/02	San Diego Creek @ Campus	5.0
11/12/02	Peter's Canyon Wash @ Barranca	2.7
11/12/02	Peter's Canyon Wash @ Barranca Dup.	3.6
11/12/02	San Diego Creek @ Harvard	3.3
11/15/02	Weephole 10N – Santa Fe Channel @ Railroad	1.8
11/19/02	El Modena-Irvine Channel @ Peter's Canyon Wash	2.9
11/19/02	Peter's Canyon Wash @ El Modena Irvine Channel	6.8
11/19/02	Como Channel @ Peter's Canyon Wash	5.1
11/19/02	Drain – Peter's Canyon Wash E. side North of Warner	2.0
01/02/03	Central Irvine Channel @ Northwood Plaza on Trabuco	3.1
01/02/03	Barranca Channel @ Alton	4.4
01/02/03	El Modena-Irvine Channel @ 17th	1.6
04/07/03	San Diego Creek @ Campus	3.4
04/07/03	Barranca Channel @ Alton	2.8
04/07/03	Peter's Canyon Wash @ Barranca	3.4
04/07/03	San Diego Creek @ Harvard	2.2
04/07/03	Drain Peter's Canyon Wash E. Side N or Warner	2.3
04/07/03	Weephole 10N Santa Fe Channel @ Railroad	2.0
04/07/03	El Modena-Irvine Channel @ 17th	1.7
04/07/03	Como Channel @ Peter's Canyon Wash	1.5
04/07/03	Peter's Canyon Wash @ Central Irvine Channel	3.2
04/07/03	Central Irvine Channel @ Peter's Canyon Wash	4.5

Chapter 6 Spatial Geochemical and Hydrologic Properties of Groundwater

The groundwater portion of this study can be broken down into several definable problems. The first problem we decided to approach in explaining the complex hydrologic and biogeochemical processes controlling groundwater and surface water loading of selenium, arsenic and nitrogen in the watershed is related to the spatial makeup of the groundwater body and the spatial structure of nutrient and trace element chemistry.

6.1 Location of Groundwater in the Basin

The region of origin of groundwater in the San Diego creek watershed can roughly be defined by the areas where we have been able to locate sites to sample shallow groundwater in the basin (Figure 6.1). While this boundary is by no means an exhaustive survey and the area of shallow groundwater in the basin may be somewhat larger than this, given the persistence of some in this research team in finding additional groundwater inputs to surface waters we have sincere doubts that there is much shallow groundwater outside of this region within the watershed. The one caveat to this statement

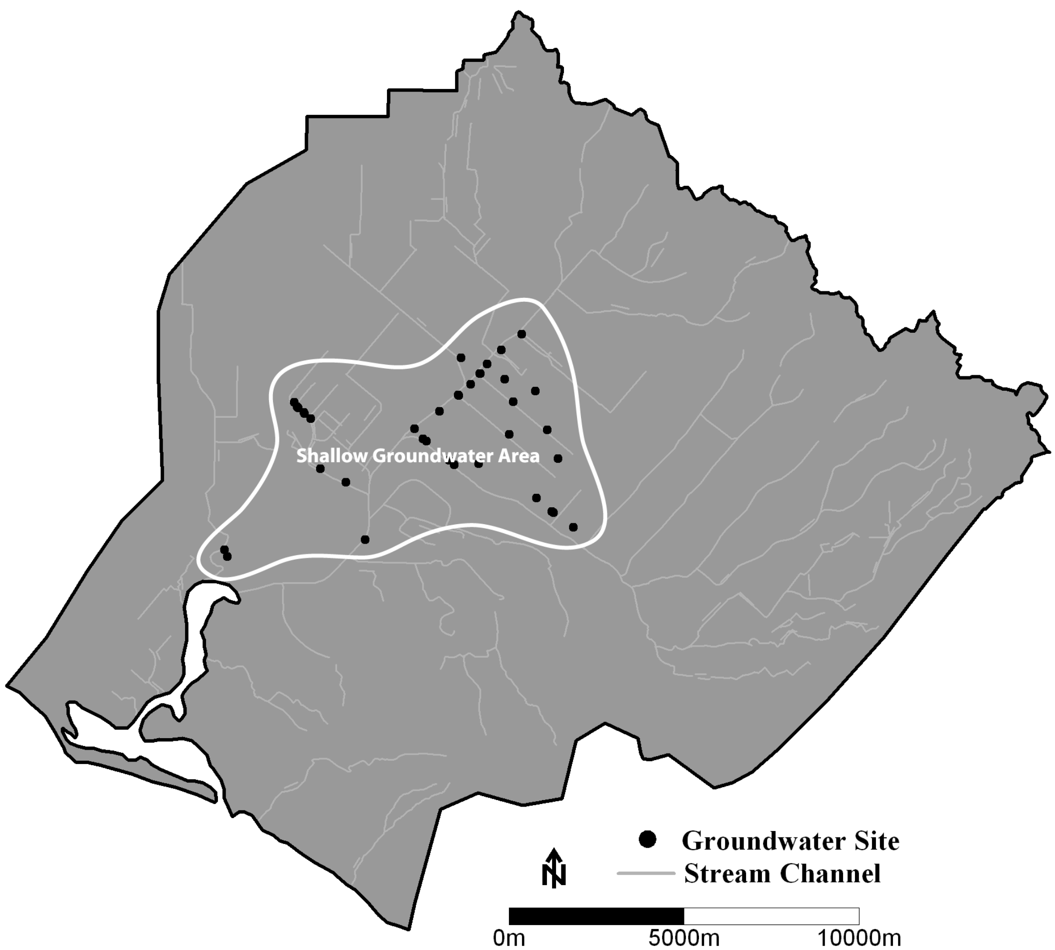


Figure 6.1 Map of the estimated region of shallow groundwater in the Newport Bay San Diego Creek watershed.

is with regards to the Tustin Marine Corps Air Station (Tustin-MCAS) where due to access reasons we were unable to sample. There is more extensive data available on the base indicating that the region of the base we identify as having shallow groundwater is within the boundary we define but we have not been able to independently verify this data.

6.2 Spatial Distribution of Selenium, Arsenic and Nitrate

Quarterly monitoring of springs, weepholes, wells and select surface channel sites was conducted and has given us the ability to investigate the spatial structure and pattern of the geochemical composition of groundwater within the San Diego Creek watershed. The data set for this monitoring program is extensive, allowing for confident data analysis and mapping (Figures 6.2, 6.3, 6.4) of groundwater concentrations of the constituents in question.

Additionally histogram based or correlation plot based analysis of the data provide information about the relationship among the three contaminants of interest, arsenic, selenium and nitrogen that is not contained in the spatial picture of the data. Histograms indicate selenium data is highly skewed toward concentrations less than 40 μg/L (Figure 6.5), indicating widespread distribution of the selenium source. Though less abundant, a select group of samples continue to show concentrations greater than 70 μg/L and are the focus of attention. The arsenic data is similarly skewed (less than 6 μg/L), though histograms (Figure 6.5) indicate more distinct populations for arsenic than selenium with a clear separation in the range of 12-20 ug/L. Significant efforts to investigate the spatial and temporal relationships between the high populations of selenium and arsenic have been made and will be discussed later.

Contour maps of selenium, arsenic and nitrate were generated using a kriging algorithm. The bounds of the map are determined by the three most outlying sampling locations. The maps indicate areas of potential concern for environmental managers and help delineate regions for further study of mobilization mechanisms. For selenium and arsenic (Figures 6.2 and 6.3), the highest concentrations occur south of the confluence of Como Channel and Peter's Canyon Wash, particularly in the Valencia drain area. In particular, the spring adjacent to Valencia Drain currently has concentrations of selenium over 200 μg/L. Levels of this nature have not previously been seen in the 18 months of this study. Some of the highest concentrations of arsenic also occur at Valencia drain, but Edinger Circular drain sees the peak arsenic values. Long term averages of selenium and arsenic at locations in the "hot spot" region support a hypothesis that the highest values are not perfectly co-located (Table 6.1). Furthermore, the extent of high arsenic in the groundwater system appears to be much narrower than selenium, though their individual "hot spots" do overlap.

In contrast to selenium and arsenic, the highest nitrate concentrations are located father downstream, near the confluence of San Diego Creek and Peter's Canyon Wash (Figure 6.4). Elevated nitrate exists in the western-most region of Lane Channel as well but it is lower along the main channel and particularly in the selenium and arsenic hotspot. In fact, correlation plots support this generalization (Figure 6.6). Negative correlations (R=0.67, 0.54) exist between nitrate versus selenium and arsenic where the data is limited to arsenic values greater than 12 μg/L so that the analysis can focus on the areas where both arsenic and selenium are at their highest values.

Table 6.1 Selenium and arsenic data near the hotspot

Location	Se (µg/L)	As (µg/L)
Spring - PCW @ VD	169.73	22.98
ECD @ PCW	127.05	27.93
Drain - PCW E. side N. Warner	97.73	5.77
Weepholes - PCW @ CC	81.08	19.05
Sump - CC @ Culver	20.87	23.24

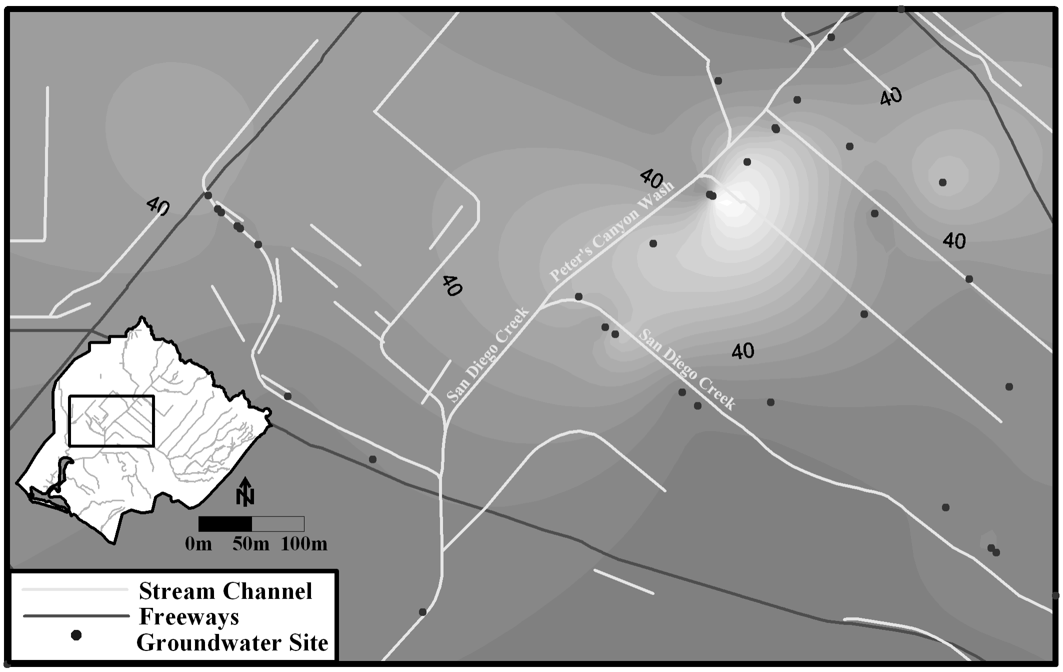


Figure 6.2 Concentration of Selenium in Groundwater, 10 µg/L contour interval. The highest concentrations of Se are located just south of the confluence of Peter's Canyon Wash and Como Channel.

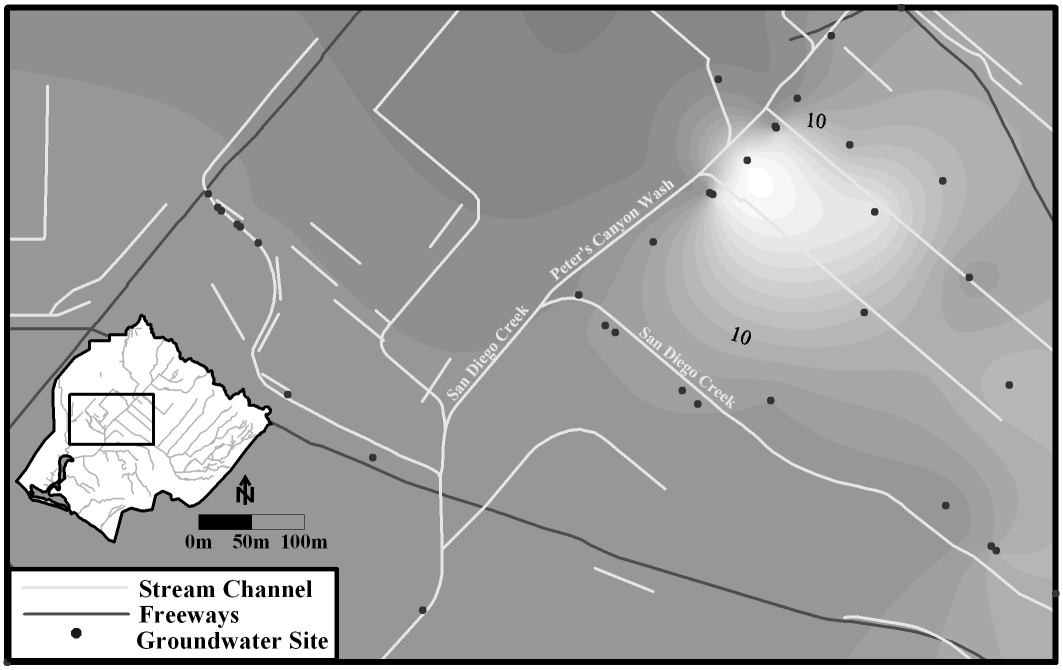


Figure 6.3 Concentration of Arsenic in Groundwater, 2 ug/L contour interval. The Arsenic hotspot appears to be less diffuse that the selenium hotspot, though the highest concentrations occur in a similar region.

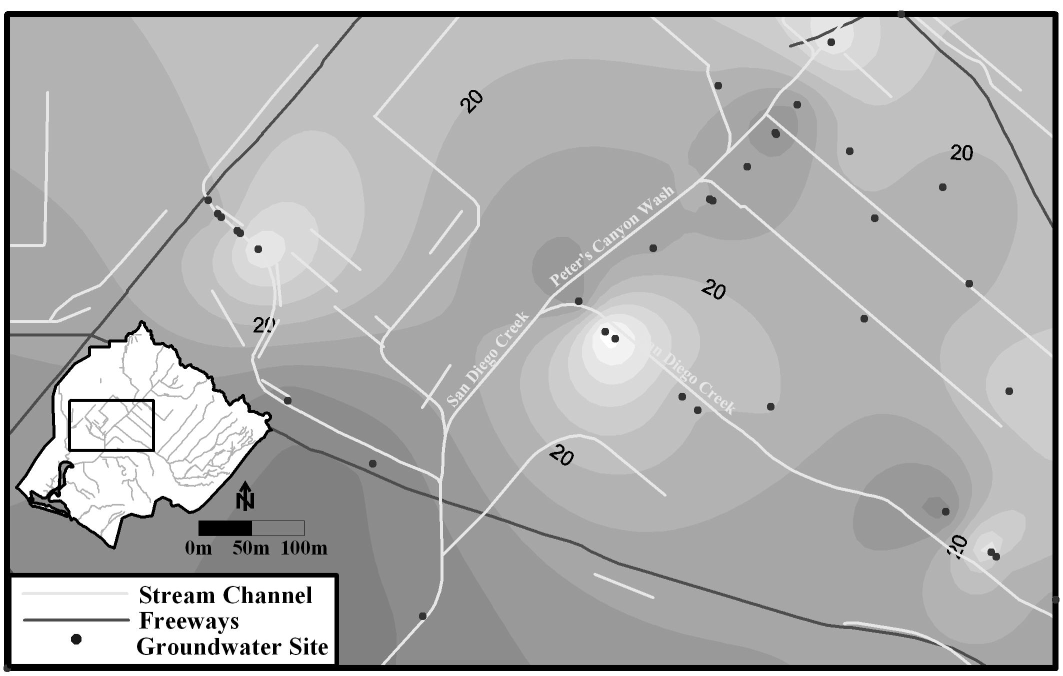


Figure 6.4 Nitrate Concentration in Groundwater, 5 mg/L contour interval. Nitrate concentrations are highest near the confluence of San Diego Creek and Peter's Canyon Wash.

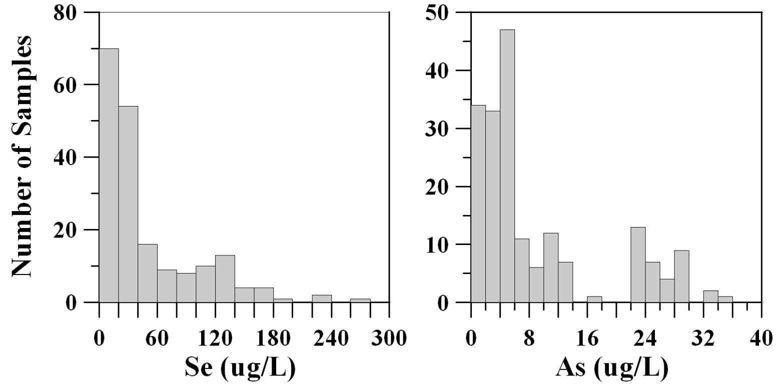


Figure 6.5 Selenium, arsenic histograms. These include all groundwater samples and do not reflect site averages.

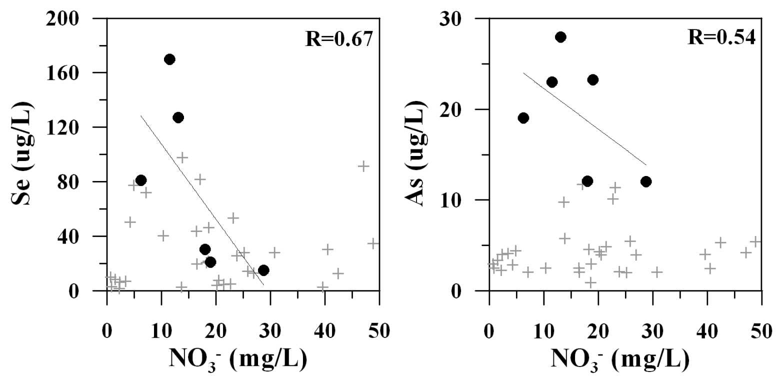


Figure 6.6 The contour maps for these three elements overlap to show highpoints for selenium and arsenic and a depression for nitrate. These plots show a negative correlation for nitrate with Se and As specifically where As > 12 ug/L. Black circles represent data where As > 12 mg/L while grey crosses indicate data of the lower population.

Chapter 7 Temporal Geochemical and Hydrologic Properties of Groundwater

While the spatial characteristics of groundwater chemistry within the watershed illustrate the general geographic extent and form of the problem with groundwater quality within the watershed temporal characteristics can also be useful in understanding what is going on within the watershed. This temporal data takes two forms. First, temporal data of groundwater hydraulic head can indicate where the water in the aquifer is coming from. Second, time series of groundwater chemistry can illustrate what chemicals are being mobilized within the aquifer as hydraulic head increases and then decreases.

7.1 Time Series Hydrographs

Groundwater elevation was monitored during the course of the investigation through the use of various monitoring wells (Figure 2.1). Seven wells were monitored roughly once every two weeks. The depth to water in the wells was measured using an electric water level meter that provides an audible notice when water is encountered. The distance that was recorded was that from the waters surface to the top of the well casing. Measurements began June 27th, 2002, and have continued up to January 19th of this year. A seasonal pattern is evident in the pattern of change in some of the wells. Figure 7.1 shows the hydrograph for well 103N plotted in conjunction with precipitation rates for the same time frame. During the summer and fall months, the region experiences very low precipitation rates, limiting the available recharge to the shallow aquifer. However, during the winter months, when precipitation rates rise and evapotranspiration rates drop, recharge increases dramatically, and the aquifer responds quickly. Once precipitation rates decrease, the water table quickly drops in elevation, returning to the values encountered in the previous dry season. This pattern is noticeable in all of the wells, however, as the distance of the wells to Peters Canyon Wash decreases, the pattern becomes muted (Figure 7.2). The data indicates that rainfall is the primary source for the shallow aquifer in the region.

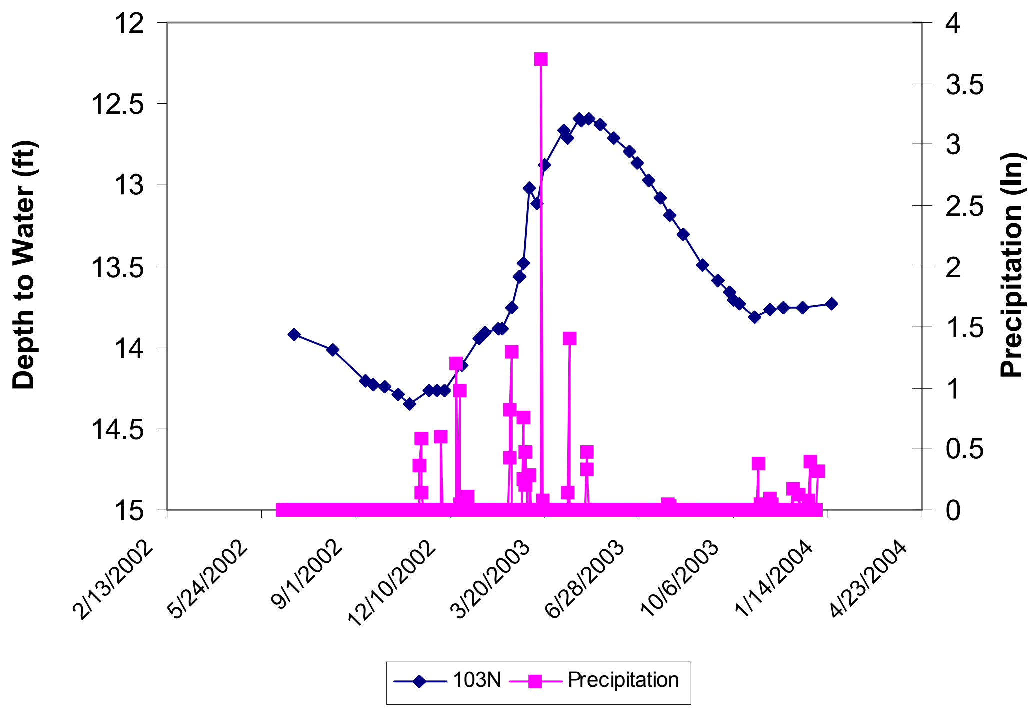


Figure 7.1 Time series hydrograph for well 103N. Graph includes precipitation to show reason for variability in hydraulic head. Well is located over 2 miles form Peter's Canyon Wash.

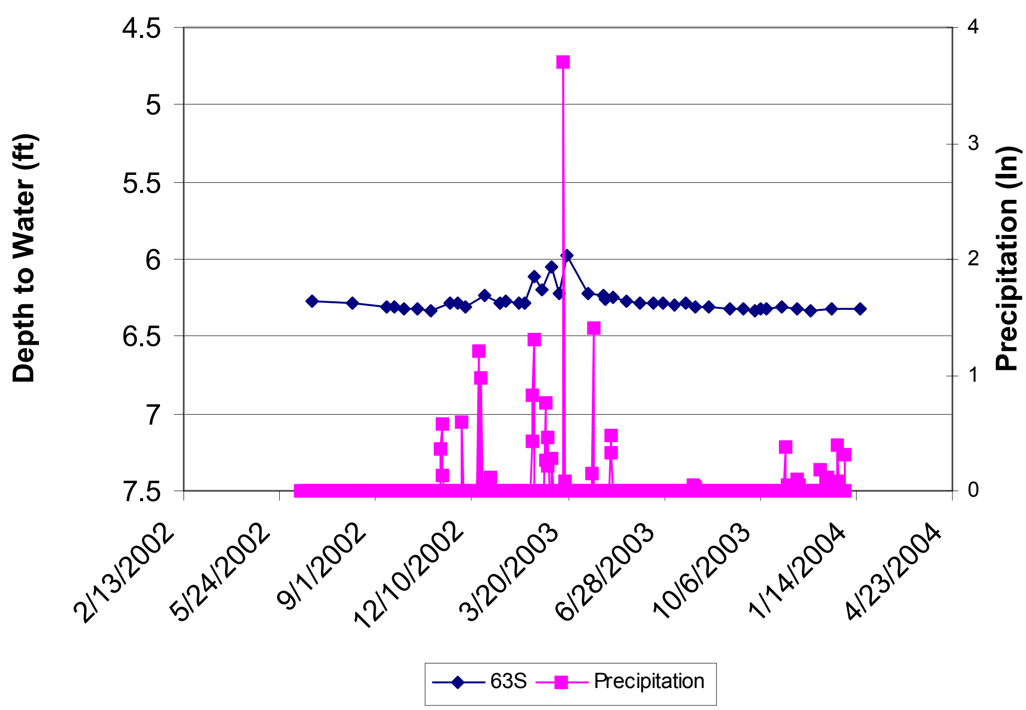


Figure 7.2 Time series hydrograph for well 63S. Graph includes precipitation to show reason for variability in hydraulic head. Well is located close to Peter's canyon wash.

7.2 Temporal Variation in Groundwater Chemistry

Groundwater samples have been collected from various weepholes and springs in the watershed on a regular basis. Data from the groundwater sources can be plotted temporally against groundwater elevation to investigate possible geochemical relations.
Figure 7.3 shows the concentrations of selenium in a spring located in Como Channel at Yale Avenue over time plotted against a chart of groundwater elevation in one of IRWD's monitoring wells. There is a close correlation with a rise in groundwater level and an increase of selenium concentration in the spring. This increase can also be seen in figures 7.4 and 7.5, which plot the concentration of nitrate-nitrogen in the same spring, and the electrical conductivity of that spring over time. Because all three parameters display a reaction at the same time, the cause of that change is probably identical. In this case, all three parameter exhibit an increase in values concurrently with increased groundwater elevation. What appears to be happening is that precipitation recharges the shallow aquifer with oxidized water, raising the water table. This submerges material previously exposed in the vadose zone, oxidizing and dissolving previously immobile forms of selenium and nitrogen.

A spring located within Peters Canyon Wash also exhibits a rise in selenium concentration in conjunction with a rise in groundwater elevation (figure 7.6). However, in this case, electrical conductivity values and nitrate concentrations decrease with increasing groundwater elevation (figures 7.7 and 7.8). Additionally, at a spring located within San Diego Creek, selenium concentrations do not appear to be influenced by groundwater elevation (figure 7.9), while electrical conductivity drops when groundwater elevation rises (figure 7.10). In these cases, there is little material to dissolve and transport during periods of increased groundwater elevation.

It appears that at most locations as recharge elevates the groundwater table it carries with it selenium that may have been mobilized during recharge or during the period prior to recharge when oxygen was available in the vadose zone. This behavior is most prevalent in portions of the study area that lie in or around the boundary of the Swamp of the Frogs. The groundwater sources that do not mimic this behavior, such as the spring in San Diego Creek, lie outside of the boundaries of the swamp of the frogs. Minimal selenium deposition is thought to have occurred outside of the swamp. At these locations there is little additional selenium to dissolve when the water table rises, and concentrations exhibit little change.

A similar trend is likely at work in relation to nitrate concentrations. In the Irvine area, nitrate deposition took place in regions where heavy agriculture was present. When the water table rises in those locations in present day, we see an increase in dissolved nitrogen, much like selenium concentrations within the Swamp of the Frogs. There is currently little knowledge as to where agricultural practices led to a buildup of nitrogen. Agriculture was widespread in the Irvine sub-basin in the past, but records of fertilization practices are not kept. A comparison of nitrate variation in groundwater to historic land usage may reveal more information.

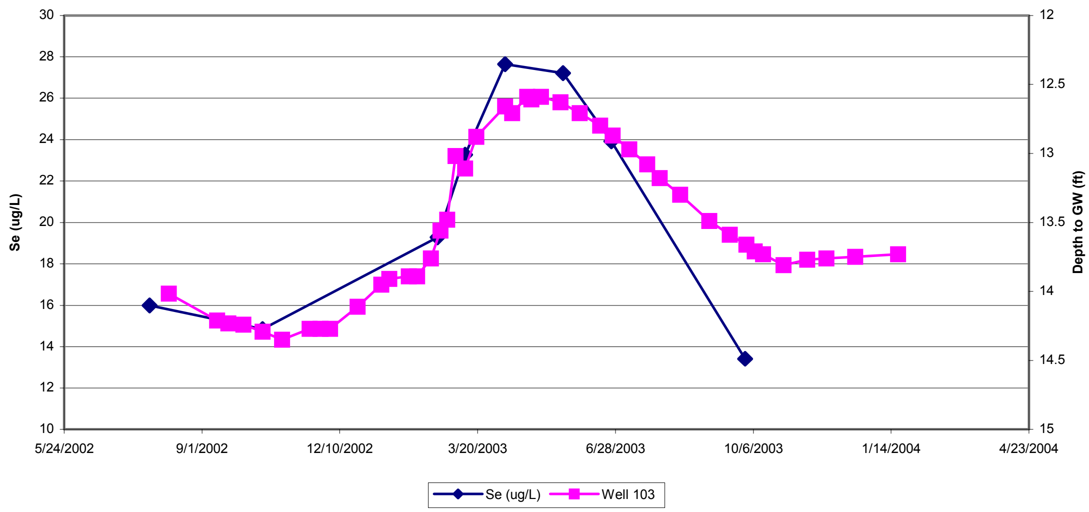


Figure 7.3 Chemical time series for selenium concentration in spring at Como Channel and Yale avenue. Hydrograph for well 103 is shown for comparative purposes.

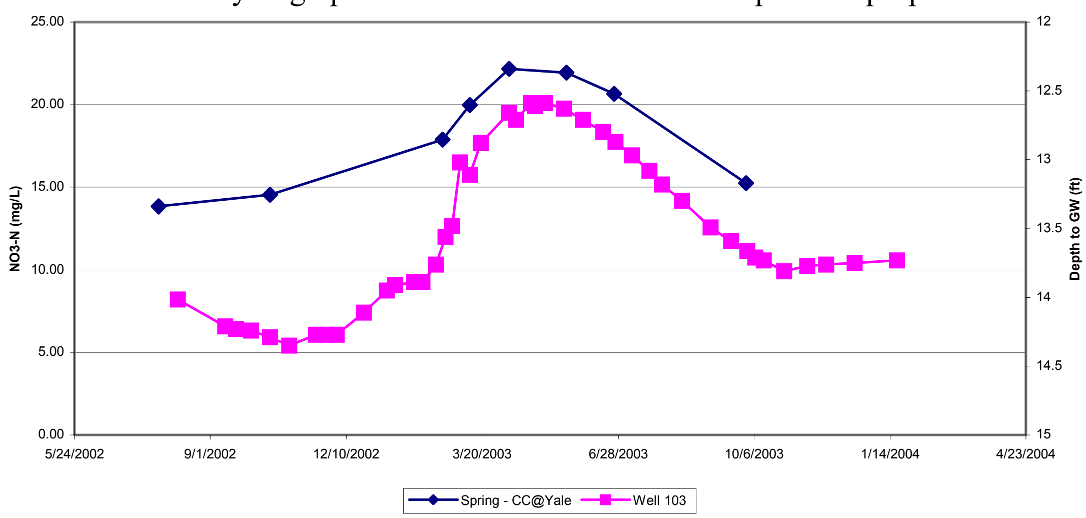


Figure 7.4 Chemical time series for nitrate-nitrogen concentration in spring at Como Channel and Yale avenue. Hydrograph for well 103 is shown for comparative purposes.

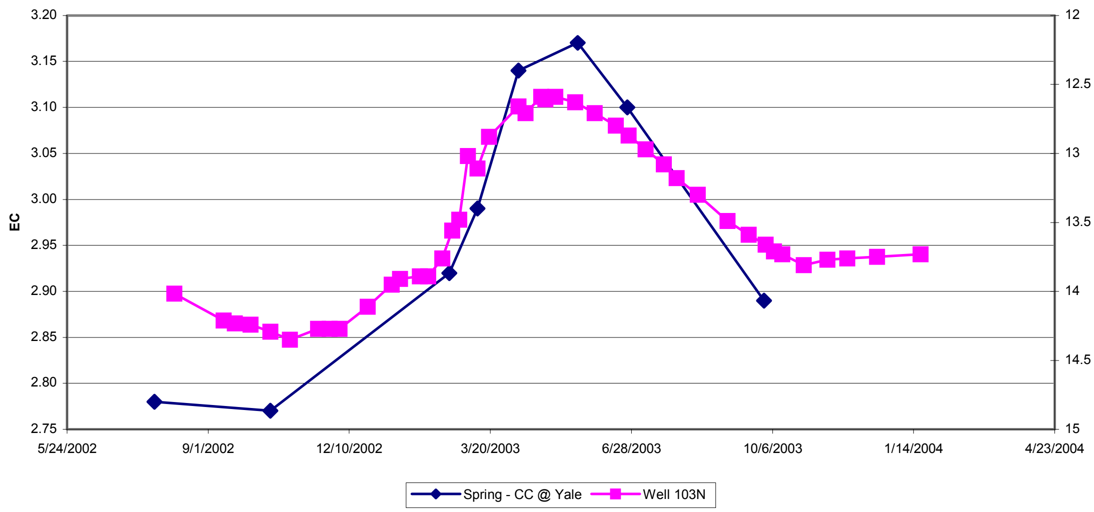


Figure 7.5 Chemical time series for electrical conductivity in spring at Como Channel and Yale avenue. Hydrograph for well 103 is shown for comparative purposes.

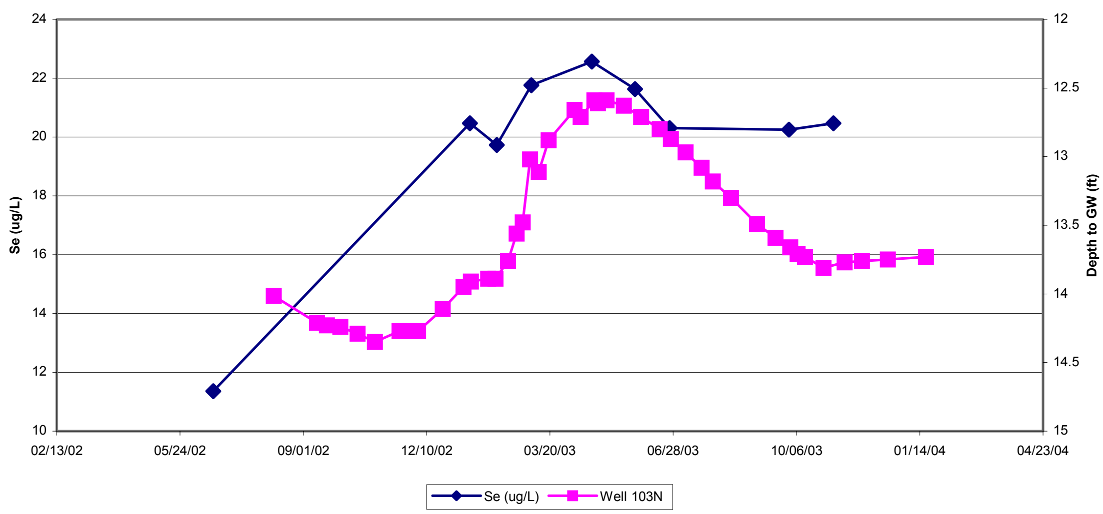


Figure 7.6 Chemical time series for selenium concentration in spring along Peters Canyon wash across from Valencia drain. Hydrograph for well 103 is shown for comparative purposes.

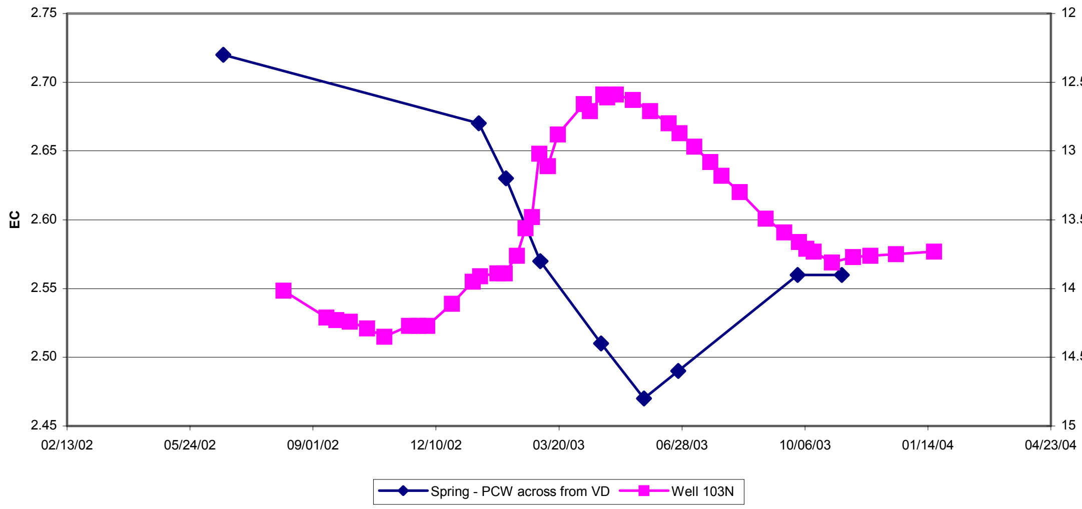


Figure 7.7 Chemical time series for electrical conductivity in spring along Peters Canyon wash across from Valencia drain. Hydrograph for well 103 is shown for comparative purposes.

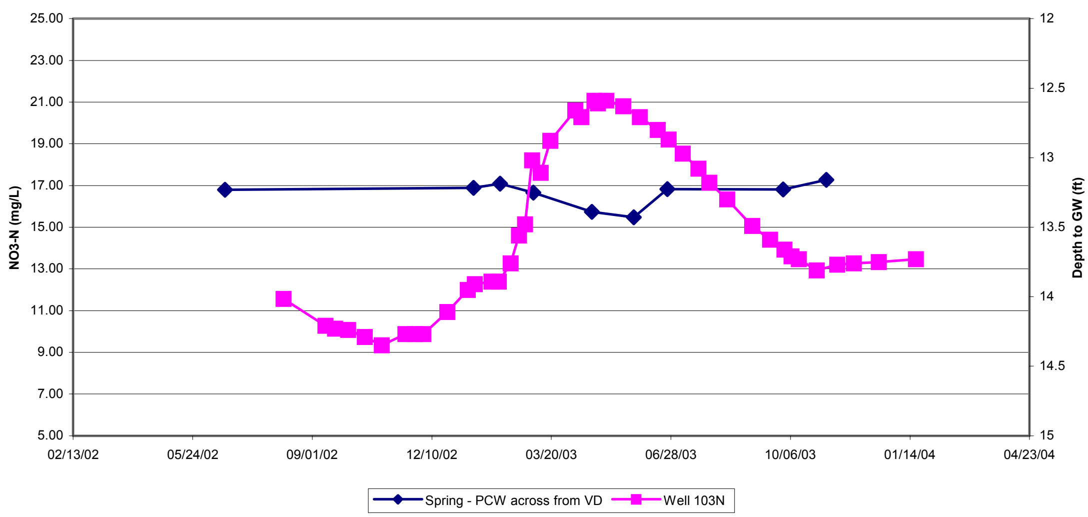


Figure 7.8 Chemical time series for nitrate-nitrogen in spring along Peters Canyon wash across from Valencia drain. Hydrograph for well 103 is shown for comparative purposes.

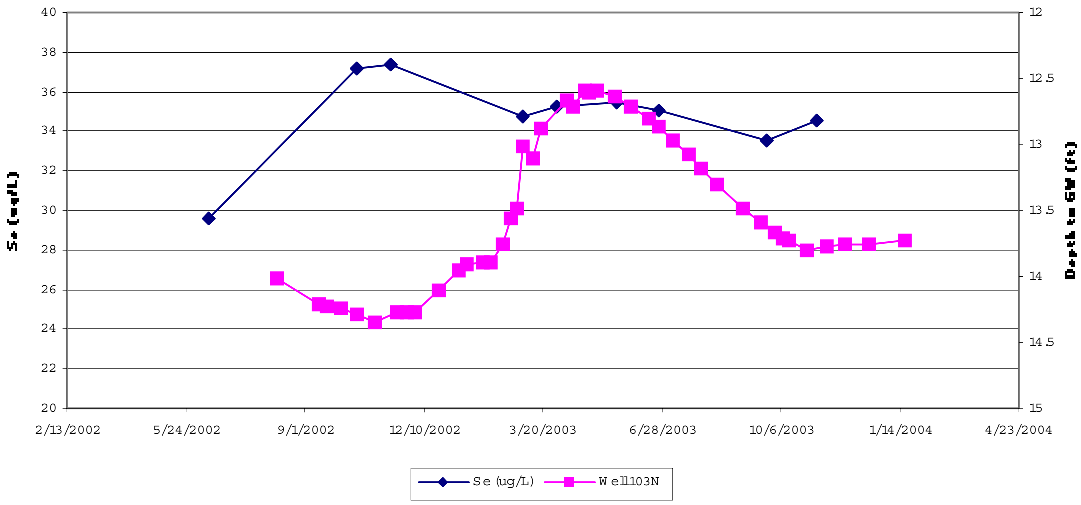


Figure 7.9 Chemical time series for selenium in spring along San Diego Creek at Harvard Avenue. Hydrograph for well 103 is shown for comparative purposes.

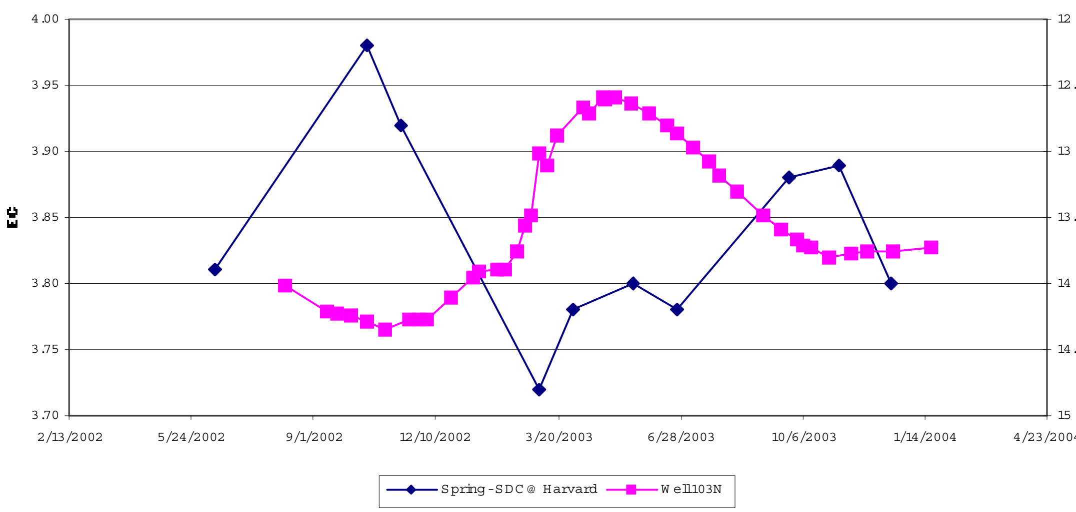


Figure 7.10 Chemical time series for electrical conductivity in spring along San Diego Creek at Harvard Avenue. Hydrograph for well 103 is shown for comparative purposes.

Chapter 8 Focused Study on Baseflow Contributions in the Hotspot

The spatial and temporal properties of groundwater within the San Diego Creek watershed indicate that a significant amount of selenium, arsenic and nitrate is being mobilized out of the subsurface of the and into surface channels. While some groundwater sources to surface are easy to identify in the field (e.g. springs, weepholes, and dewatering operations) other sources of groundwater are more difficult to identify and quantify. One particularly difficult source to identify is how much groundwater is seeping directly out of the stream bank and stream bottom and into the surface channels. We therefore conducted specific field campaigns to quantify this baseflow contribution form seepage in the area of the hotspot of selenium, arsenic and nitrogen contribution that we previously identified to the surface channels (Figure 6.2, 6.3, and 6.4).

On three occasions (November 5, 2002, June 19, 2003 and November 18, 2003) detailed stream gauging and water quality sampling was performed along Peters Canyon Wash in the region where we have found the most elevated selenium and arsenic concetrations. The purpose of the activity was to determine contributions to the channel via groundwater baseflow and pollutant loading along the portions of the channel being monitored. Stations were established along Peters Canyon Wash above the confluence with El Modena Irvine Channel, and below the confluence with Santa Fe Channel. All tributaries that intersected with Peters Canyon Wash between these points were also monitored. These included El Modena Irvine Channel, Como Channel, Santa Fe Channel, and a Circular Drain located at Edinger Drive. Repeated flow measurements were collected at all monitoring points, and multiple water quality samples were collected through the course of each day.

The first detailed monitoring took place on November 5th, 2002. This event differed from the following two events, in that the Denitrification Plant was actively discharging at the time. In order to more accurately measure its influence, the Denitrification Plant was monitored, and a monitoring location of Peters Canyon Wash and Walnut Avenue was used for the most upstream measurements. Figures 8.1, 8.2 and 8.3 detail the locations of the monitoring points for each monitoring event.

In order to calculate pollutant loading to the channel, both pollutant concentrations and stream discharge are necessary. In the case of selenium or nitrate, concentrations are reported in values of micrograms per liter. These values must be converted to pounds per cubic foot. This can then be multiplied by the stream discharge to determine a value of pounds per day of pollutant. The values that we used are averages of the samples that were collected. Because the samples cover only a fraction of the day, the assumption must be made that the average concentrations and the average discharge at each point remains constant over the course of a full 24-hour period.

In the case of the first day of monitoring on November 5th, 2002, selenium loading increased by 0.526 lbs/day, from 0.044 to 0.57 lbs/day from the upstream to the downstream monitoring points of Peters Canyon Wash. Nitrate loading increased from 27.39 to 145.35 lbs/day. Concurrently, total stream discharge increased along the same reach by 2.8 cubic feet per second (cfs), from 0.69 cfs to 3.49 cfs. The greatest contributions to pollutant load were derived from the Denitrification plant and Como Channel, which added 0.21 and 0.10 lbs/day of selenium respectively. Both inflows were also significant contributors of nitrate. However, Como Channel had higher loading rates

(57.56 lbs/day) than did the Denitrification plant (54.50). While higher concentrations of selenium were observed in Edinger Circular Drain (117.28), its extremely low rate of discharge (0.06 cfs) resulted in little overall pollutant loading.

While discharge increased by 2.8 cfs from the upstream to downstream points, the contributions of incoming tributaries to Peters Canyon Wash totaled only 2.5 cfs, indicating a contribution of approximately 0.3 cfs by baseflow (Figure 8.1). Additionally, the contributions of the tributaries does not account for the increased selenium loading. The measured loading from upstream Peters Canyon Wash and the tributaries is 0.43 lbs/day Se, while the loading at the downstream monitoring point is 0.57 lbs per day, leaving 0.14 lbs/day of Se unaccounted for. Much of this can probably be attributed to baseflow contributions. If so, then the concentration of selenium in baseflow is approximately 86.5 mg/L Se. This is a high value, but not impossible, as concentrations of selenium in groundwater are known to reach similar concentrations along this stretch of PCW.

Similar results could be seen when evaluating the loading rates of nitrogen. However, in this case, the total of nitrogen loading from the tributaries entering Peters Canyon Wash exceeds the calculated loading at the downstream location. Total loading above Peters Canyon Wash below Santa Fe Channel, is calculated to be 173.54 lbs/day, while the calculated loading for Peters Canyon Wash below Santa Fe Channel is 145.34. The difference in loading is unknown, but may be due to fluctuations in concentration measured at the various monitoring points. In particular, the concentration of nitrate in the Denitrification Plant varies from 9.08 to 15.56 mg/L nitrate between the two measurements. It is possible that denitrification or other nitrogen removal processes has contributed to the decrease in nitrogen mass downstream. However, it is unlikely that these processes would account for more than a small percentage of the total difference, as the residence time of the water in the measured portion of the stream are not long enough to allow for significant denitrification.

The second monitoring event took place on June 19th, 2003. Calculating selenium loading for this event showed that upstream at Peters Canyon Wash above the confluence with El Modena Irvine Channel, selenium loading was 0.054 lbs/day. Downstream, loading was approximately 0.537 lbs/day, an increase of 0.483 lbs/day. At this time, the tributaries contributed approximately 0.259 lbs/day of selenium, leaving 0.224 lbs/day unaccounted for and probably attributable to baseflow contributions. Discharge along the channel increased from 1.14 cfs to 3.89 cfs, a difference of 2.75 cfs. Tributary flows were measured and calculated to be approximately 1.78 cfs. This result would indicate that baseflow contributions were about 0.97 cfs at the time of monitoring.

At this point in time, the Denitrification plant was not discharging to Peters Canyon Wash, leading to the establishment of Peters Canyon Wash above El Modena Irvine Channel as the upstream monitoring point. Additionally, Edinger Circular Drain had increased its rate of discharge, and had the greatest rate of selenium loading of the incoming tributaries (0.124 lbs/day). Como Channel maintained a high rate of nitrate loading at 57.44 lbs/day, while Santa Fe Channel had the next highest rate of loading at 27.72 lbs/day.

Assuming the measured and calculated values of selenium and discharge to be representative of groundwater, than the concentration of selenium in baseflow would be about 42.9 μg/L. This is a lower value than the previous monitoring event and well within the valid range for selenium concentrations in groundwater. It should be noted that the first monitoring event took place in November, before the rainy season began, which corresponds to a low point for the groundwater table, as can be seen in figure 3.3.35. However, the 2nd monitoring event, took place after the rainy season, while the groundwater table was higher. The additional hydraulic head may explain the greater contribution that baseflow has towards total discharge. The groundwater discharging into the channels, may be diluted due to the recent infiltration, resulting in the lower selenium concentrations that are calculated for baseflow.

Nitrate loading increased from 27.81 lbs/day at the upstream monitoring point to 162 lbs/day at the downstream point. Tributaries contributed approximately 97.08 lbs/day of nitrate. This indicates that baseflow contributed approximately 37.11 lbs/day nitrate. Dividing the pollutant loading by baseflow discharge indicates that the concentration of NO3-N is approximately 7 mg/L in groundwater. This concentration is low for the region, but some loss of nitrogen has been documented for waters seeping through vegetated streambeds into streams. Dissimilatory nitrate reduction occurs as the waters travel through a reducing hyporheic zone in the streambeds and into the channels [Jones and Mulholland, 2000].

The final and most recent monitoring event took place on November 18th, 2003. During this event, three water quality samples were collected for each monitoring point, as opposed to three samples during the previous event, and two samples for the first event. Calculated loading rates for this event showed that upstream, selenium loading was approximately 0.047 lbs/day, while downstream it was 0.402 lbs/day. The selenium loading contributed by tributaries was approximately 0.187 lbs/day. Discharge increased from 0.85 cfs to 2.58 cfs from upstream Peters Canyon Wash to the downstream monitoring point. The calculated input by the tributaries is 1.65 cfs. This suggests that baseflow contributes about 0.08 cfs over the monitored stretch of PCW (Figure 8.3).

Similar to pollutant loading during the previous monitoring event, Como Channel was the source of the most selenium loading (0.092 lbs/day), while Edinger Circular Drain had a similar loading rate of 0.082 lbs/day of selenium. Nitrate loading was also similar to the previous monitoring event. The highest nitrate loading levels originated from Como Channel (71.74 lbs/day) and Sante Fe Channel (20.29 lbs/day).

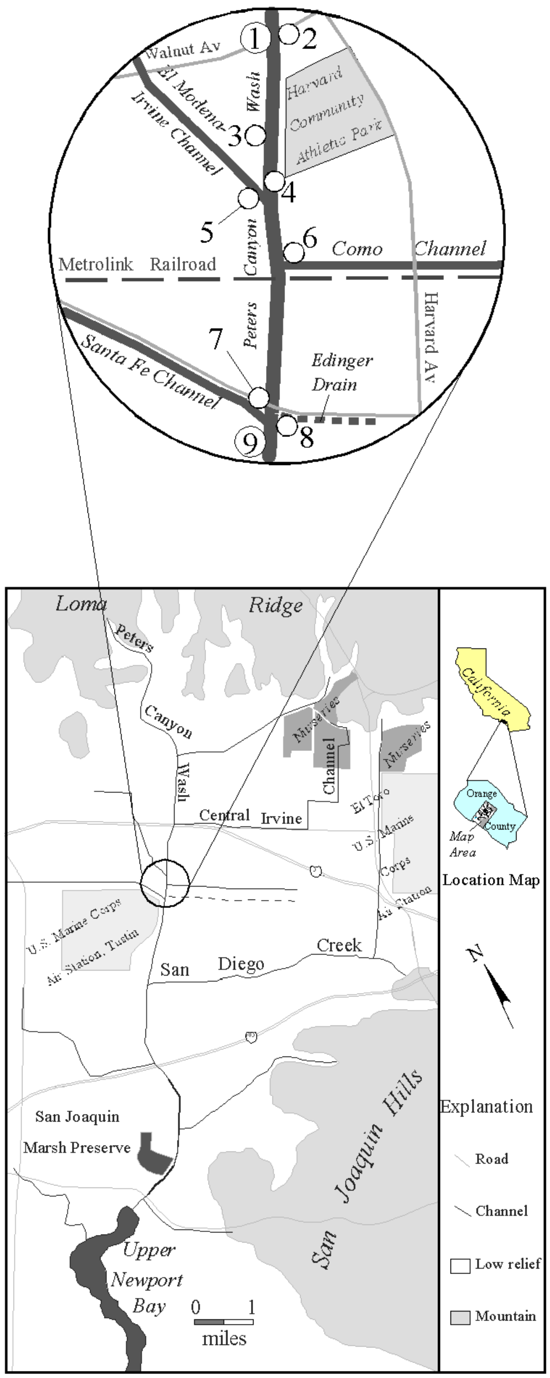
Using the same assumption that was used for the previous monitoring event, the unaccounted pollutant loading and discharge is attributed to baseflow. Under these assumptions, groundwater is loading approximately 0.168 lbs/day of selenium and discharging at 0.08 cfs into Peters Canyon Wash. Under these conditions it can be calculated that groundwater discharging into Peters Canyon Wash as baseflow has a concentration of 390 µg/L of selenium. This concentration is excessive, and may be due to erroneous measurements in discharge rates, downstream.

Nitrate loading increased from 26.52 lbs/day to 146.25 lbs/day nitrate-nitrogen from the upstream monitoring point to the downstream monitoring point. Tributary contributions were calculated at 104.68 lbs/day nitrate-nitrogen. Assuming that baseflow contributes the remaining nitrate, 15.05 lbs/day nitrate-nitrogen originate with baseflow. Dividing the pollutant loading by the baseflow discharge indicates that the concentration of nitrate in baseflow discharge is approximately 34.95 mg/L nitrate-nitrogen. While this value is greater than that calculated for the previous monitoring period, it is within the known concentrations of nitrate in the watershed.

As mentioned previously, the fluctuation in baseflow contributions to the system may be due to changes in groundwater elevation. The calculated baseflow was significantly lower for the first and the third monitoring periods. However, the third event calculated a very low baseflow. As can be seen in Figure 8.4, both of the first and the third sampling dates coincided with a lowered groundwater elevation. The calculated baseflow contribution for the second monitoring period was greater than three times as much as the calculated contribution during the first monitoring period. This monitoring period coincided with a period of high groundwater elevation. For future work, it would be beneficial to conduct another monitoring event at the end of a rainy period.

The very low baseflow amount for the third sampling date indicates some of the caution that should be exercised in interpreting these results. The low baseflow calculated may be a result of the discharge measurement methods used in this baseflow study. We made multiple measurements of streamflow on each of the days studied here using standard USGS flow velocity area measurement techniques. While the multiple measurements should have reduced our uncertainty, the method still relies on how good the locations are where we measure stream flow. The estimations of groundwater base flow contribution hinge most specifically on how good the farthest down stream gauging location (Peters Canyon Wash Below Santa Fe Channel) is since from this number is subtracted the streamflow at the other locations and the baseflow value is determined by difference. If this downstream value is significantly in error the estimate of baseflow will not be accurate. Unfortunately this downstream location is also the most difficult to gauge as the stream is wide and rocky at this location and it is difficult to set up a god cross section. On the other two dates apparently the cross section was fairly god and on this third date it may have been a little more faulty. Still the overall indication from all three dates is that there is a significant contribution of groundwater directly to Peters Canyon wash along this reach and this contribution is larger during wet conditions than it is during dry conditions.

Location And Index Maps



Stream Gaging Stations

1. Peters Canyon Wash (PCW) at Walnut Av
2. Subsurface drain tributary at Walnut Av
3. Denitrification plant outlet at PCW
4. Peters Canyon Wash above confluence with EMIC
5. El Modena Irvine Channel above confluence with PCW
6. Como Channel above confluence with PCW
7. Santa Fe Channel above confluence with PCW
8. Subsurface drain tributary at Edinger
9. Peters Canyon Wash below Santa Fe Channel

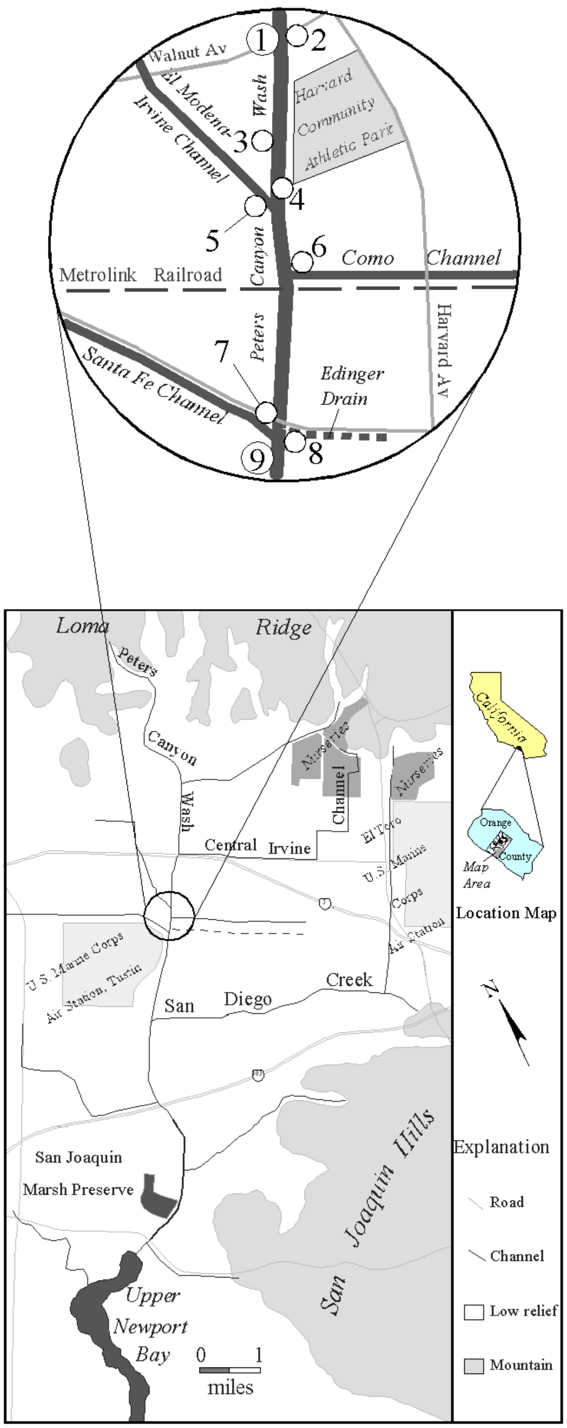
Stream Gaging Data
11/05/02, 10:55 to 16:50

Station #	Measurements (total number)	Average Flow (cubic feet/sec)
1	9	0.69
2	9	0.026
3	2	0.82
5	2	0.47
6	2	0.74
7	5	0.39
8	2	0.055
9	7	3.49

Groundwater baseflow =
station 9 - stations (1+2+3+5+6+7+8) =
0.30 cubic feet per second (cfs)

Figure 8.1 Stations and data for first baseflow study.

Location And Index Maps



Stream Gaging Stations

1. Peters Canyon Wash (PCW) at Walnut Av
2. Subsurface drain tributary at Walnut Av
3. Denitrification plant outlet at PCW
4. Peters Canyon Wash above confluence with EMIC
5. El Modena Irvine Channel above confluence with PCW
6. Como Channel above confluence with PCW
7. Santa Fe Channel above confluence with PCW
8. Subsurface drain tributary at Edinger
9. Peters Canyon Wash below Santa Fe Channel

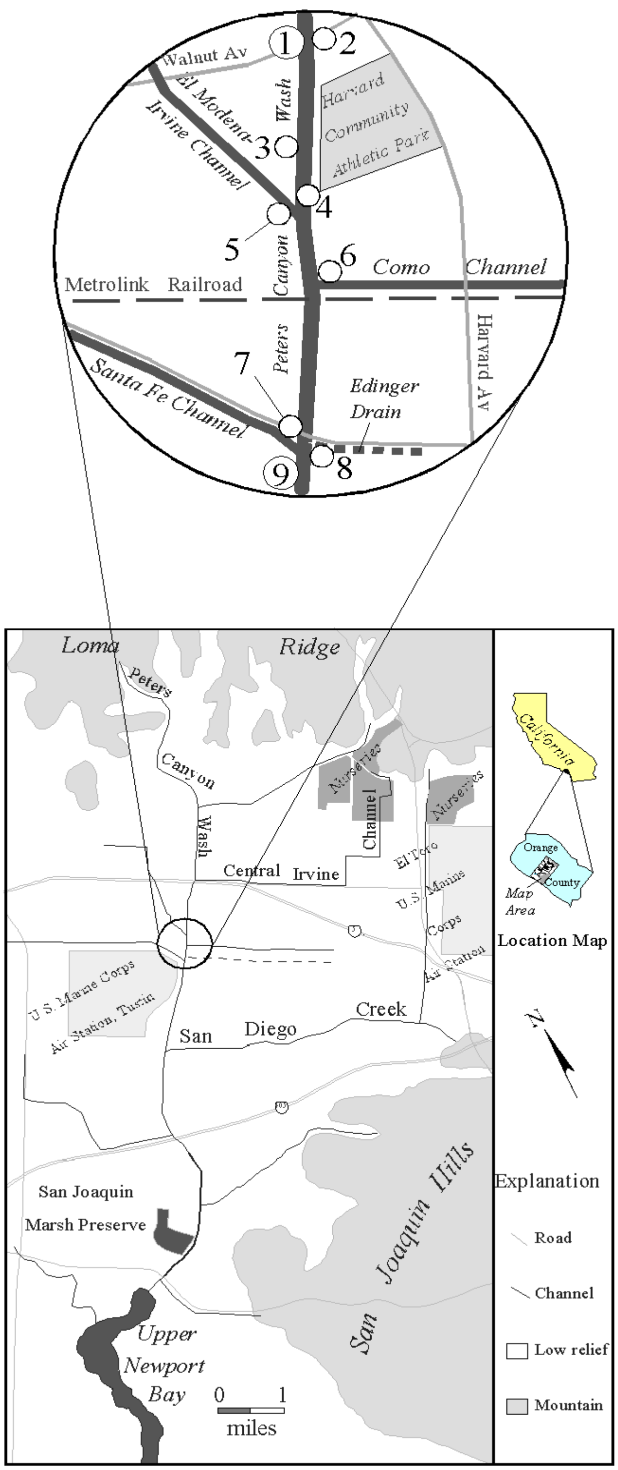
Stream Gaging Data
6/19/03, 9:35 to 15:30

Station #	Measurements (total number)	Average Flow (cubic feet/sec)
4	4	1.14
5	4	0.57
6	4	0.61
7	4	0.43
8	3	0.17
9	4	3.89

Groundwater baseflow =
station 9 - stations (4+5+6+7+8) =
0.96 cubic feet per second (cfs)

Figure 8.2 Locations and data for second baseflow study.

Location And Index Maps



Stream Gaging Stations

1. Peters Canyon Wash (PCW) at Walnut Av
2. Subsurface drain tributary at Walnut Av
3. Denitrification plant outlet at PCW
4. Peters Canyon Wash above confluence with EMIC
5. El Modena Irvine Channel above confluence with PCW
6. Como Channel above confluence with PCW
7. Santa Fe Channel above confluence with PCW
8. Subsurface drain tributary at Edinger
9. Peters Canyon Wash below Santa Fe Channel

Stream Gaging Data
11/18/03, 10:02 to 16:06

Station #	Measurements (total number)	Average Flow (cubic feet/sec)
4	5	0.85
5	5	0.58
6	5	0.63
7	6	0.32
8	6	0.12
9	6	2.58

Groundwater baseflow =
station 9 - stations (4+5+6+7+8) =
0.07 cubic feet per second (cfs)

Figure 8.3 Stations and data for third baseflow study

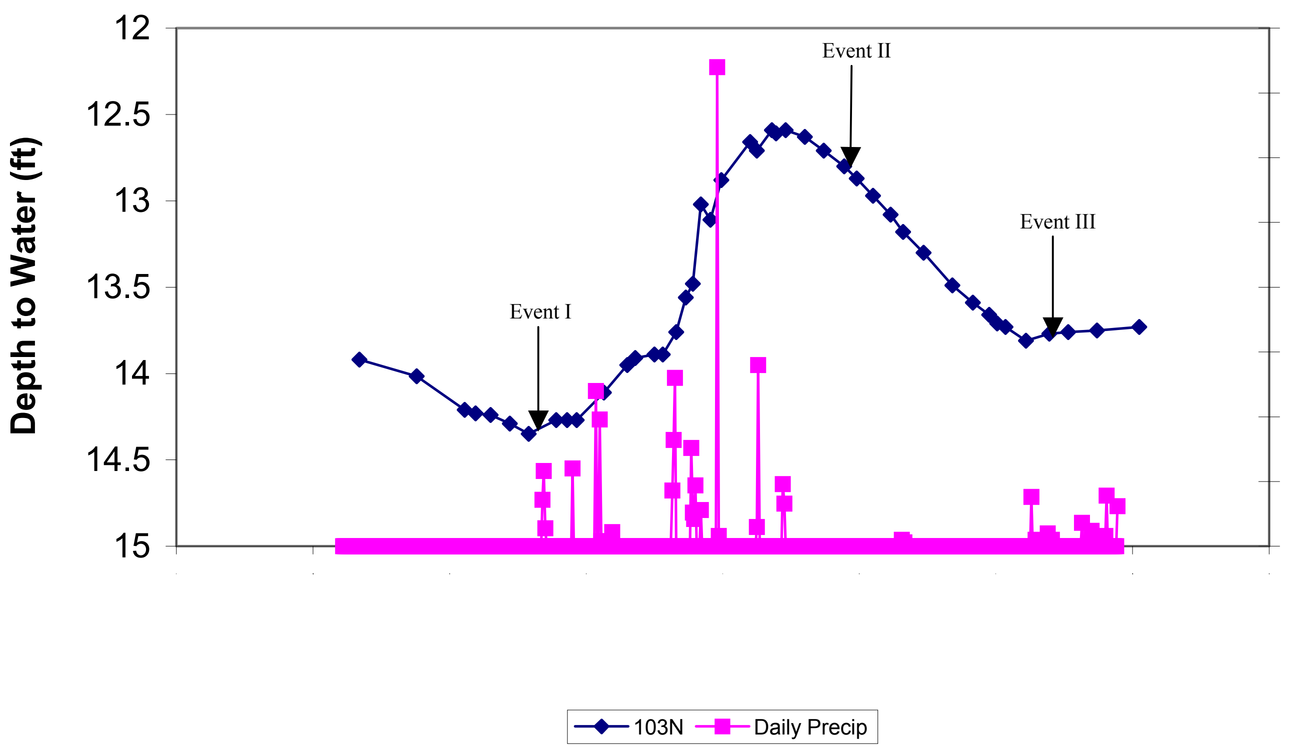


Figure 8.4 Depth to groundwater for IRWD monitoring well 103N and daily precipitation for Irvine, CA. Results show response of groundwater to rainy season.

Table 8.1
Selenium Concentrations and Loads
11/5/2002

Station	Time	Selenium (µg/L)	Selenium (avg) (µg/L)	Discharge (cubic-ft/sec)	Load (lbs-day)
PCW@Walnut	1225	12.26	12.26	0.690	0.046
	1640	11.39			
Subsurface Drain @ Walnut	1230	27.13	28.63	0.026	0.004
	1650	30.12			
DP@PCW	1300	49.84	46.83	0.820	0.207
	1620	43.81			
EMIC@PCW	1330	3.14	3.31	0.470	0.008
	1530	3.48			
CC@PCW	1200	27.8	25.58	0.740	0.102
	1500	23.35			
SFC @ PCW	1055	15.81	15.57	0.390	0.033
	1420	15.32			
ECD @ PCW	1110	116.72	117.28	0.055	0.035
	1445	117.84			
PCW below SFC	1130	29.66	30.14	3.49	0.566
	1430	30.62			

Total mass loading of stations above and including Santa Fe channel = 0.34 lbs/day
Total discharge of stations above and including Santa Fe Channel = 2.66 cfs

Table 8.2
Nitrate Concentrations and Loads
11/5/2002

Station	Time	NO3-N (mg/L)	NO3-N (avg) (mg/L)	Discharge (cubic-ft/sec)	Load (lbs-day)
PCW@Walnut	1225	7.97	7.36	0.690	27.30
	1640	6.74			
Subsurface Drain @ Walnut	1230	10.54	11.64	0.026	1.63
	1650	12.74			
DP@PCW	1300	15.56	12.32	0.820	54.35
	1620	9.08			
EMIC@PCW	1330	1.03	1.93	0.470	4.87
	1530	2.82			
CC@PCW	1200	14.31	14.47	0.740	57.61
	1500	14.63			
SFC @ PCW	1055	11.28	11.45	0.390	24.02
	1420	11.62			
ECD @ PCW	1110	12.43	11.72	0.055	3.47
	1445	11.00			
PCW below SFC	1130	7.25	7.72	3.49	145.05
	1430	8.19			

Total mass loading of stations above and including Santa Fe channel = 128.31 lbs/day
Total discharge of stations above and including Santa Fe Channel = 2.66 cfs

Table 8.3
Selenium Concentrations and Loads
6/19/2003

Station #	Station	Time	Selenium (µg/L)	Selenium (avg) (µg/L)	Discharge (cubic-ft/sec)	Load (lbs-day)
4	PCW@EMIC	1040	8.55	8.78	1.14	0.054
		1140	8.84			
		1410	9.13			
		1510	8.59			
5	EMIC@PCW	1010	2.38	2.61	0.57	0.008
		1130	2.57			
		1350	3.19			
		1445	2.29			
6	CC @ PCW	1115	24.78	25.41	0.61	0.083
		1220	24.42			
		1425	26.05			
		1530	26.37			
7	SFC @ PCW	935	16.87	19.32	0.43	0.044
		1120	26.13			
		1310	17.34			
		1505	16.94			
8	ECD @ PCW	1050	136.65	132.15	0.17	0.124
		1206	129.30			
		1444	130.50			
9	PCW below SFC	955	27.22	25.69	3.89	0.537
		1136	26.29			
		1344	24.14			
		1527	25.11			

Total mass loading of stations above and including Santa Fe channel = 0.313 lbs/day
Total discharge of stations above and including Santa Fe Channel = 2.92 cfs

Table 8.4
Nitrate as Nitrogen Concentrations and Loads
6/19/2003

Station #	Station	Time	NO3-N (mg/L)	NO3-N (avg) (mg/L)	Discharge (cubic-ft/sec)	Load (lbs-day)
4	PCW@EMIC	1040	4.36	4.52	1.14	27.81
		1140	4.66			
		1410	4.51			
		1510	4.55			
5	EMIC@PCW	1010	2.69	1.61	0.57	4.89
		1130	1.98			
		1350	1.13			
		1445	0.63			
6	CC @ PCW	1115	14.65	15.69	0.61	51.44
		1220	15.03			
		1425	15.81			
		1530	17.27			
7	SFC @ PCW	935	11.76	12.04	0.43	27.72
		1120	12.32			
		1310	11.96			
		1505	12.12			
8	ECD @ PCW	1050	13.33	13.89	0.17	13.03
		1206	14.67			
		1444	13.67			
9	PCW below SFC	955	8.20	7.75	3.89	162.00
		1136	7.52			
		1344	6.88			
		1527	8.40			

Total mass loading of stations above and including Santa Fe channel = 124.89 lbs/day
Total discharge of stations above and including Santa Fe Channel = 2.92 cfs

Table 8.5
Selenium Concentrations and Loads
11/18/2003

Station	Time	Selenium (μg/L)	Selenium (avg) (μg/L)	Discharge (cubic-ft/sec)	Load (lbs-day)
PCW@EMIC	1040	9.72	10.29	0.85	0.047
	1230	10.26			
	1445	10.9			
EMIC@PCW	1015	2.27	2.71	0.58	0.008
	1225	2.79			
	1430	3.06			
CC @ PCW	1110	26.35	27.00	0.63	0.092
	1300	27.06			
	1500	27.6			
SFC @ PCW	1005	13.39	13.71	0.32	0.024
	1345	13.43			
	1529	14.32			
ECD @ PCW	1120	122.4	122.40	0.12	0.082
	1433	122.3			
	1606	122.5			
PCW below SFC	1040	28.69	28.99	2.58	0.402
	1412	28.52			
	1545	29.77			

Total mass loading of stations above and including Santa Fe channel = 0.234 lbs/day
Total discharge of stations above and including Santa Fe Channel = 2.50 cfs

Table 8.6
Nitrate Concentrations and Loads
11/18/2003

Station	Time	NO3-N (mg/L)	NO3-N (avg) (mg/L)	Discharge (cubic-ft/sec)	Load (lbs-day)
PCW@EMIC	1040	5.54	5.83	0.85	26.52
	1230	5.69			
	1445	6.27			
EMIC@PCW	1015	1.49	1.04	0.58	3.23
	1225	0.96			
	1430	0.66			
CC @ PCW	1110	20.23	21.09	0.63	71.74
	1300	21.72			
	1500	21.33			
SFC @ PCW	1005	11.93	11.66	0.32	20.29
	1345	11.36			
	1529	11.70			
ECD @ PCW	1120	14.13	14.09	0.12	9.42
	1433	13.74			
	1606	14.41			
PCW below SFC	1040	10.18	10.54	2.58	146.25
	1412	10.56			
	1545	10.87			

Total mass loading of stations above and including Santa Fe channel = 130.55 lbs/day
Total discharge of stations above and including Santa Fe Channel = 2.50 cfs

Chapter 9 Focused Study on Lane Channel

Surface water studies by OCPFRD and Hibbs and Lee (2000) showed that Lane Channel consistently contained moderately high concentrations of nitrogen, selenium, and salinity (>8 mg/L total N; > 14 ug/L Se; and > 5000 uS conductivity). Data collected during this study since 2002 showed the same results, but also indicated that arsenic concentrations are low, and sulfate concentrations are very high in Lane Channel (< 3.0 ug/L As; and > 1500 mg/L SO_4). In other channels, elevated selenium and sulfate concentrations are frequently correlated to high arsenic concentrations; but not in Lane Channel

Nitrate and selenium concentrations in the current and historical data suggest a demonstrable source of groundwater baseflow into Lane Channel. Accordingly, the research team performed extensive field evaluations in the Lane Channel area. The evaluations included gaging streamflows, measuring concentrations of hydrochemical parameters at surface water stations and lateral inflows, mapping and sampling groundwater discharge outlets such as weepholes and springs, and collecting soil samples.

A subset of findings is presented in Figure 9.1. These data indicate that surface flows at upstream stations, midpoint stations, and downstream stations had consistently high concentrations of nitrogen and selenium during field-testing (> 19 ug/L Se; > 9 mg/L total N). Arsenic, on the other hand, was below 4 ug/L at all surface water monitoring stations. Conductivity increased along a downstream trend, from 2260 uS to 5300 uS. These data suggest substantial groundwater input into Lane Channel that contains high conductivity, high selenium, high nitrogen, and low arsenic. This was confirmed by sampling local groundwater. Field studies indicated the existence of several groundwater weepholes and springs at and below the 55 freeway. Groundwater in these springs and weepholes usually exceeded 25 ug/L Se and 15 mg/L total N. Conductivity in groundwater was also very high, and arsenic was less than 4 ug/L (Figure 9.1).

High sulfate and selenium concentrations, and low arsenic concentrations in groundwater near Lane Channel are not consistent with other findings. In many areas, high selenium and sulfur concentrations, from oxidation of metal sulfides that formed in the Swamp of the Frogs marsh, are often correlated to moderate to high arsenic concentrations. Differences in land regions prior to development may provide insights on these important differences.

Lane Channel drains a region historically identified by Trimble (1998) as an ephemeral lake, identified by historical 1901 soil survey maps as containing concentrated alkali salt deposits. While the evaporation of ephemeral floodwaters could create these alkali salt deposits, it is more likely that the evaporitic salt crusts originated from evaporation of shallow groundwater at the southern edge of the Swamp of the Frogs marsh. Such salt crusts are best developed in areas where the water table is within 1 meter of land surface. Areas of evaporitic salt crusts are characterized by poor development of vegetation, which would tend to preclude the existence of sufficient organic matter needed to produce a highly reducing environment.

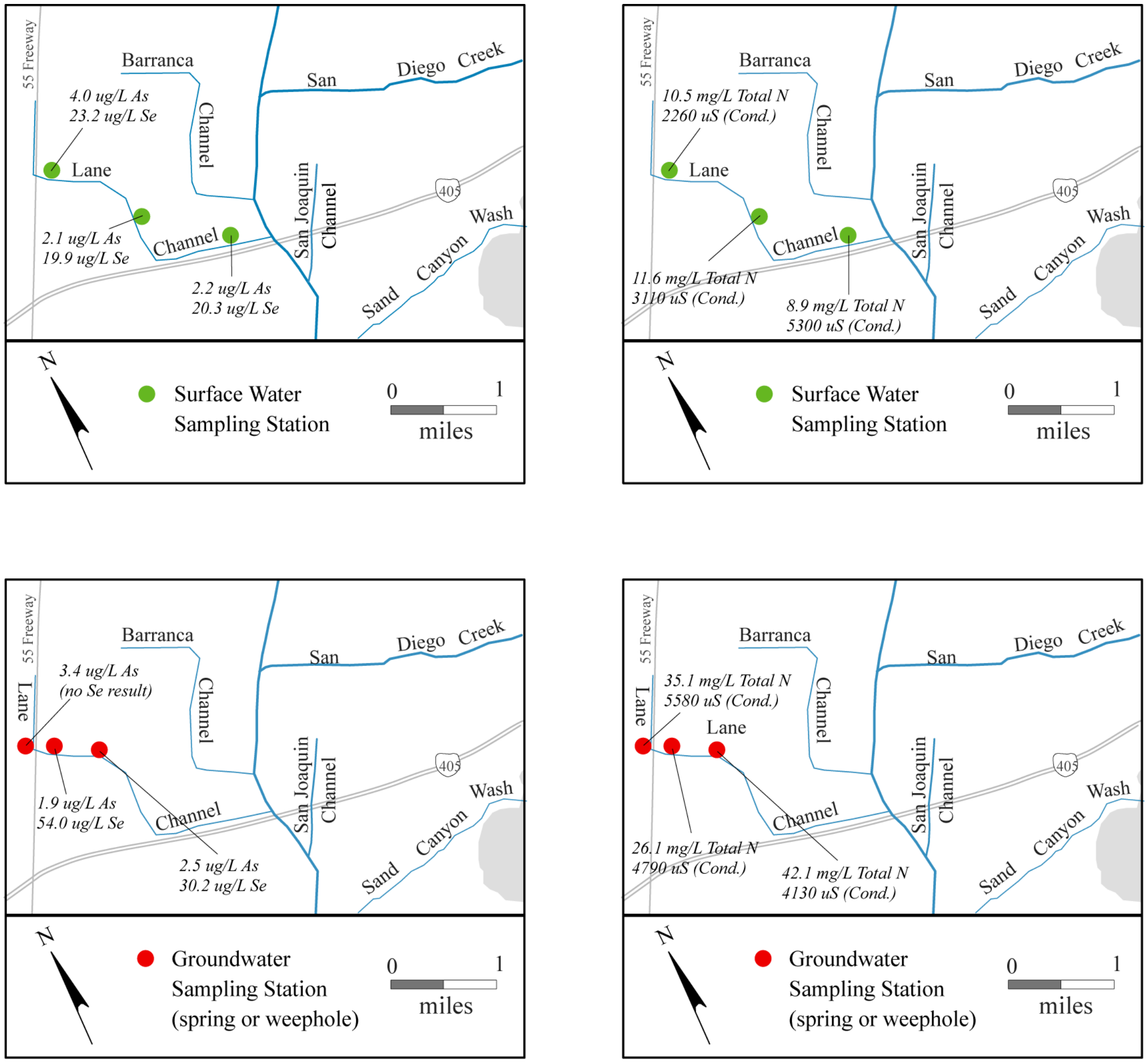


Figure 9.1 Selected results of sampling of Lane Channel and nearby groundwaters for hydrochemical parameters.

Proof of a historical water table very near to land surface in the Lane Channel area is shown by several exposures of phreatic caliche along the walls of Lane Channel. Phreatic caliche forms as horizontal layers and seams of somewhat continuous deposits of calcium carbonate that precipitates when shallow groundwater evaporates by upward flux through overlying soils. As water "wicks" above the water table by capillary action and begins to evaporate, the dissolved solids in the soil solution start to concentrate by evaporation. As a result, dissolved minerals become oversaturated and begin to precipitate.

Just above the water table, calcium carbonate, which is already close to equilibrium saturation in most groundwaters is the first mineral to precipitate, creating layers of phreatic caliche (Figure 9.2). Alkali salts containing calcium, sodium, and sulfate are more soluble and tend to precipitate as surface evaporative residues at land surface, leaving behind evaporitic salt crusts consisting of Mirabilite and Thernardite (Figure 9.2). The process of groundwater evaporation and precipitation probably accounts for the heavy alkali deposits that once existed at land surface before the Lane Channel area was entrenched and drained by channels (USDA, 1901).

Layers of alternating sequences of phreatic caliche are exposed along Lane Channel and are interlayered with thernardite salts that have leached downward through openings and seams in the caliche layers (Figures 9.3 and 9.4). Layers of phreatic caliche vary from as little as 2 cm to 24 cm thick and are exposed near the top of the channel down to the streambed. Beds of silty clay, silt, and sand, some not at all indurated, are interbedded with phreatic caliche layers (Figures 9.3 and 9.4). The horizontal caliche layers indicate relatively long periods of stability of the water table elevation at various depths below ground surface. Stacked layers of phreatic caliche may have formed in the Lane Channel area during fluctuating hydraulic head elevations in predevelopment groundwater discharge areas, such as the meandering Santa Ana River or Upper Newport Bay. In these areas, sea level changes and migrating streams might have influenced groundwater levels in the shallow aquifer.

When water tables rose to their highest point near land surface prior to the historic period of agricultural development, caliche layers at deeper intervals were submerged beneath the water table. The caliche beneath the water table remained relatively stable because groundwater was probably at equilibrium saturation with respect to calcite. Groundwater does not attack and dissolve calcium carbonate at equilibrium saturation.

Around 1900, entrenchment of the historical alkali flats and drainage of the shallow water table resulted in leaching of alkali salts from land surface. This opened the Lane Channel area to vegetative growth and agriculture development. Once the area was vegetated, decaying organic matter from invasive plant species and crops produced acidity (H+). The carbon dioxide produced by decaying organic matter probably reacted with water in the soils to form weak acids such as carbonic and organic acids. Applications of ammonium producing fertilizers (e.g., urea, anhydrous ammonia) may have also acidified soils slightly through a biological reaction by which ammonium is oxidized to nitrate and H+ (see Table 9.1 for nitrate levels in the soils near Lane Channel). These processes probably account for the partial dissolution and mottling of the caliche layers at shallow depths below land surface (Figure 9.3). At greater depths, the caliche layers are intact because they have not been attacked by acids that formed in soils close to land surface. Acids contained in downward percolating wetting fronts are buffered by calcium carbonate deposits, creating neutral pH conditions at depth.

Thernardite salts precipitating along the sides of Lane Channel contain elevated concentrations of selenium, their open lattice structures incorporating the selenate anion in the sulfate space. The continual leaching of these residual alkali salts from the vadose zone near Lane Channel is a probable explanation for high sulfate, high selenium, and low arsenic concentrations in groundwater. The data suggests the existence of an alkali salt region south of the Swamp of the Frogs marsh region that was the evaporative discharge area for waters (surface waters and groundwaters) that moved into and through the historic Swamp of the Frogs marsh region. Evaporation of waters just below the alkali flats probably produced salts containing high sulfate, high selenium, and low arsenic in soil profiles. Arsenic in the vadose zone was probably bound by adsorption or coprecipitation with hydrous iron oxides. After the region was drained, leaching of selenium-bearing, efflorescent sulfate salts through vadose zone profiles could account

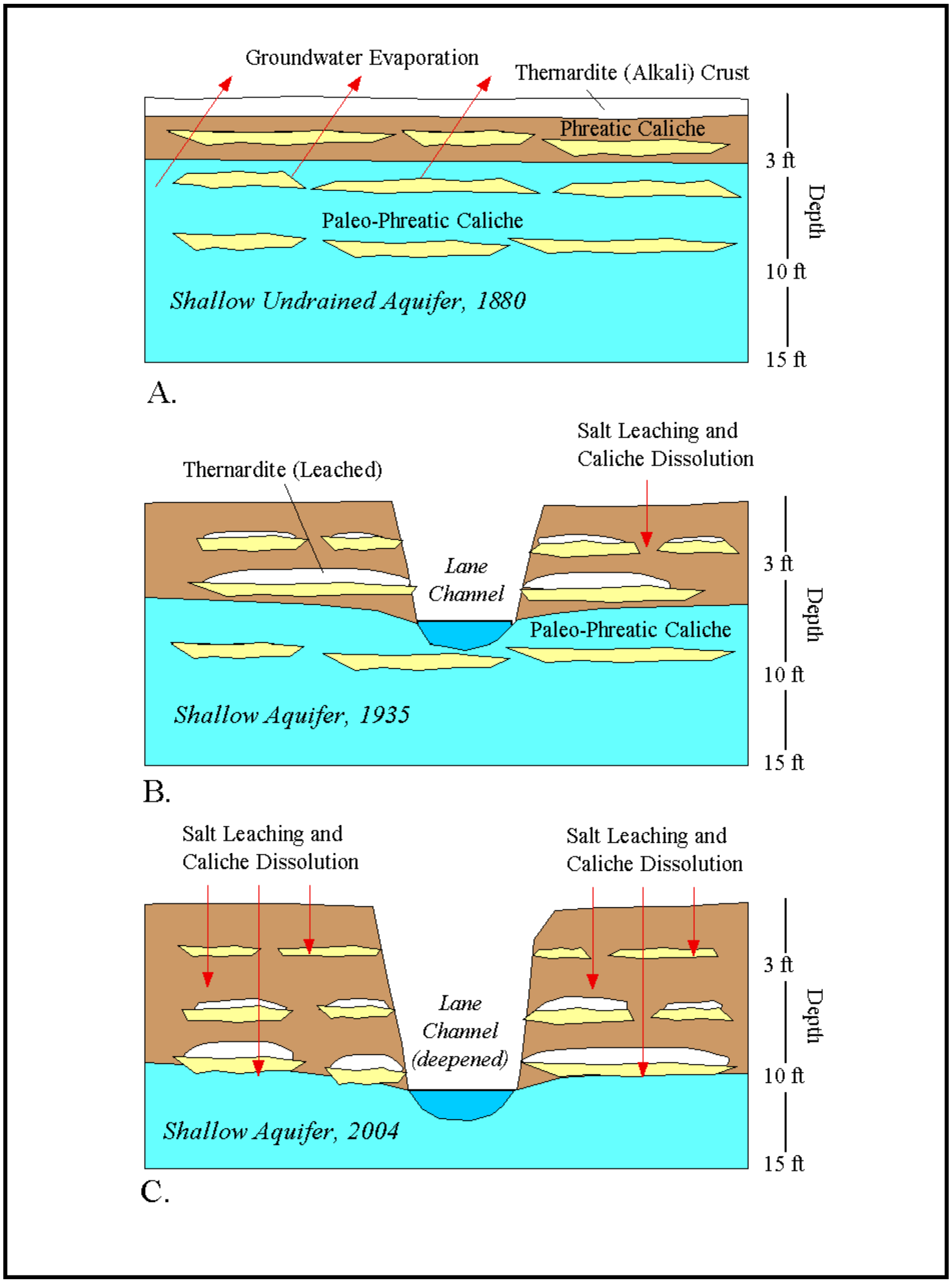


Figure 9.2 Schematic diagram showing how phreatic caliche and alkali (sulfate salts) may have formed in the historical "evaporative lake" area near Lane Channel (A.). When the alkali flat was drained, the salts were leached downward through the vadose zone and into groundwater (B.). Additional deepening of Lane Channel allowed the phreatic caliche at shallow depths to be dissolved partially by weak acids in soil solutions (C.).

Figure 9.3 Photograph showing phreatic caliche layers and sulfate salts (thernardite) along Lane Channel. Each of the benches is an outcrop of phreatic caliche. The white residue is thernadite salt. Notice the thin, partially dissolved caliche layer about 3 feet above the hydrologist's head in the background. This layer is about 3 feet below grade in Lane Channel, representing a stable water table that existed very near to land surface in predevelopment times.

Figure 9.4. Photograph showing phreatic caliche and sulfate salts (thernardite) along Lane Channel.

for the anomalous geochemical signatures in the Lane Channel area. Surface water and groundwater are relatively free of arsenic, but contain high concentrations of sulfate and selenium.

9.1 Soil Sampling and Hypothesis Testing in the Lane Channel Area

To test the hypothesis that leaching of salts from the vadose zone in the "evaporative lake" area may be responsible for the anomalous concentrations of selenium and arsenic, soil coring and extractions were performed in this region. Soil cores were collected along the unlined walls of Lane Channel by using an AMS stainless steel auger (Figure 9.5). Data from two soil cores collected near the 55 Freeway are presented in this discussion. Core 1 was collected 8.5 feet below land surface and 3.2 feet above the Lane Channel stream surface (low flow). Core 2 was collected 3.5 feet below land surface. Cores were pushed into the channel walls to a penetration depth of about 7.5 feet. Extractions of chemical parameters from soil cores included 1:1 distilled/deionized water extractions to determine concentrations of soluble elements, and acid digestion extractions to determine concentrations of total elements. Data are reported as ug/L and mg/L for water extractions, and as mg/kg for acid digestions.

A comparison of 1:1 water-extracted parameters and groundwater parameters near Lane Channel and 55 Freeway shows very similar hydrochemical and trace element compositions (Table 9.1). The similar electrical conductivity (EC) of soil water-extracts and groundwater implies that a direct comparison between soil extracted parameters and groundwater parameters is valid. Of particular significance are the very similar arsenic, selenium, and sulfate concentrations in soil water-extracts and groundwater (Table 9.1). These data provide compelling evidence for leaching of salts through the vadose zone, producing the concentrations of selenium, arsenic, and sulfate measured in groundwater near Lane Channel.

Standard inorganic parameters and 1:1 soil water-extracts also show very similar concentrations, although relative concentrations of calcium are proportionally higher and sodium is lower in the uppermost core (Figure 9.6, Table 9.1). This is possibly because calcium carbonate in the shallow core contributes calcium to the water extract, whereas sodium-sulfate salts have already been partially leached at the depth of the shallow core (3.5 feet below land surface, Figure 9.2). Sodium and sulfate concentrations are also lower in the uppermost core, supporting the Thernardite "leach" model described above (Figure 9.2). Ion exchange processes may also be partly responsible for the cation trends shown in the Piper diagram (Figure 9.6).

Direct comparisons between total elements in acid digestions with soluble elements from 1:1 water soil-extracts is not strictly valid because the former is reported in mg/kg and the latter is reported in mg/L (Table 9.2). A rough comparison can be made by multiplying the acid-digestion values in mg/kg by an assumed soil bulk density factor of 1.9. This comparison implies that almost all chemical parameters tested by both extraction methods (arsenic, selenium, calcium, sodium, magnesium, iron, manganese) are in bound or precipitated forms. Soluble sodium is the single exception (compare "tot" and "sol" sodium in Table 9.2). Arsenic is also present in higher total concentrations than selenium (Table 9.2). However, the soil extraction data indicate that selenium is much more mobile than arsenic in the 1:1 soil water-extracts. This data fits the hypothesis of selenium associations with soluble Thernardite, along with arsenic that is bound with relatively insoluble iron oxides. Sulfate and selenium are leached into groundwater as thernardite dissolves in the vadose zone, and arsenic is not leached because it remains in bound forms (Figure 9.6).

Table 9.1 1:1 Soil Water-Extracts and Groundwater Samples Collected Near Lane Channel*

Sample ID	**EC** (mS/cm)	**As** (sol) (ug/L)	**Se** (sol) (ug/L)	**Na** (sol) (mg/L)	**Ca** (sol) (mg/L)	**Mg** (sol) (mg/L)	**Cl** (sol) (mg/L)	**SO4** (sol) (mg/L)	**NO3-N** (sol) (mg/L)
Soil core 1 (deep)	4540	2.0	31.8	578	526	253	397	2774	0.3
Soil core 2 (shallow)	3450	1.7	45.5	201	748	91	179	1549	166.2
	EC (mS/cm)	**As** (ug/L)	**Se** (ug/L)	**Na** (mg/L)	**Ca** (mg/L)	**Mg** (mg/L)	**Cl** (mg/L)	**SO4** (mg/L)	**NO3-N** (mg/L)
Groundwater 1	4291	2.0	43.5	396	452	200	205.	2165	36.4
Groundwater 2	5830	2.0	33.0	658	620	272	517	3073	32.2
Groundwater 3	3478	2.5	43.5	316	476	128	280	1752	13.9
Groundwater 4	4127	3.5	73.5	354	492	160	287	2076	15.3
Groundwater 5	4624	3.0	35.0	402	630	185	365	1940	32.6

*sol refers to 1:1 extracts with distilled-deionized water (soluble extracts)

Figure 9.5 Collection of Soil core 2 from Lane Channel. Soil Core 1 is located directly beneath Soil Core 2.

Table 9.2 1:1 Soil Water-Extracts and Acid Digestion Soil Extracts Collected Near Lane Channel*

Sample ID	**As** (sol) (mg/L)	**Se** (sol) (mg/L)	**Na** (sol) (mg/L)	**Ca** (sol) (mg/L)	**Mg** (sol) (mg/L)	**Fe** (sol) (mg/L)	**Mn** (sol) (mg/L)	**Sand** %	**Silt** %	**Clay** %
Soil core 1 (deep)	0.0020	0.032	578	526	253	<1.0	3.50	35.9	36.6	27.5
Soil core 2	0.0017	0.046	201	748	91	5.6	5.97	48.2	48.7	3.1
	As (tot) (mg/kg)	**Se** (tot) (mg/kg)	**Na** (tot) (mg/kg)	**Ca** (tot) (mg/kg)	**Mg** (tot) (mg/kg)	**Fe** (tot) (mg/kg)	**Mn** (tot) (mg/kg)	**Sand** %	**Silt** %	**Clay** %
Soil core 1 (deep)	5.97	0.41	1639	87774	14469	36550	1248	35.9	36.6	27.5
Soil core 2	6.97	0.50	948	45301	8294	41607	585	48.2	48.7	3.1

*sol refers to 1:1 extracts with distilled-deionized water (soluble) and "tot" refers to total elements in acid digestions

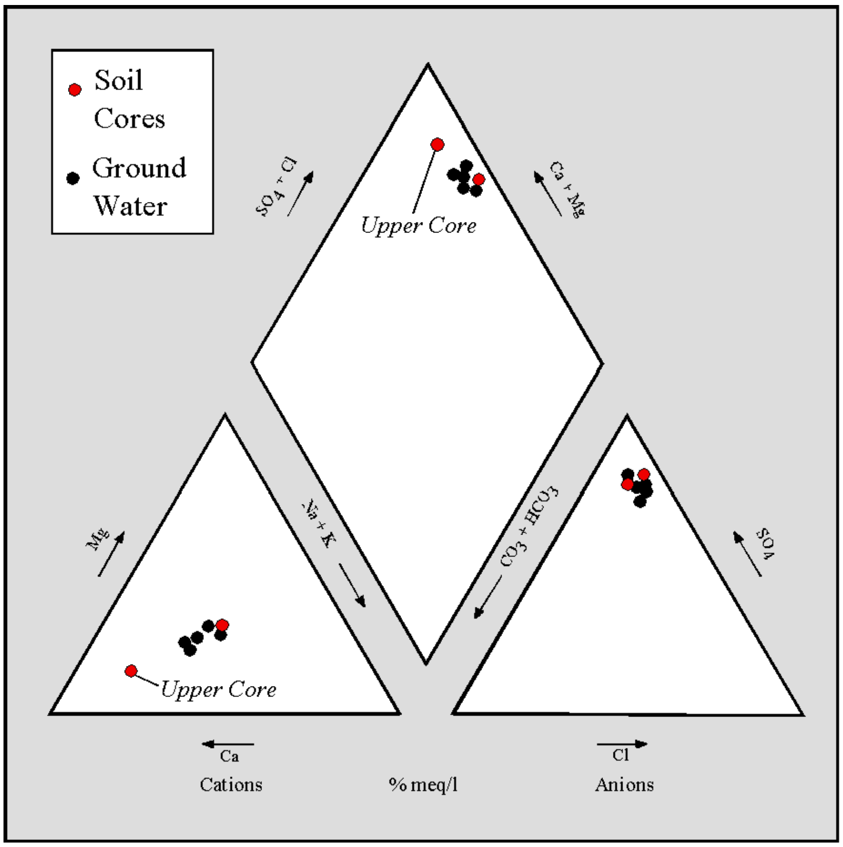


Figure 9.6 Piper diagram presenting soil and groundwater data from Table 1. Data indicate that the lower soil core water-extract (Soil Core 1) is almost identical to the chemical composition of groundwater collected near Lane Channel. The upper soil core (Soil Core 2) has a greater percentage of calcium and a lower percentage of sodium than local groundwater. This is possibly due to caliche dissolution at shallow depths, and lesser abundance of residual Thernardite that has already been leached to greater depths (closer to Soil Core 1)..

9.2 Sulfur Isotopes and Lane Channel Groundwater

Several groundwater samples were collected during the study for sulfur isotope analysis. Analysis of sulfur isotopes was performed in the Isotope Geochemistry Laboratory in the Department of Geological Sciences, University of Arizona. Samples were collected from springs and weepholes at several locations within and outside of the region formerly occupied by the historic Swamp of the Frogs marsh (Figure 9.7).

East of Peters Canyon Wash, measured $\delta^{34}S[SO_4^{2-}]$ were slightly positive in all but one sample. West of Peters Canyon Wash, groundwater isotope values were negative in all samples (Figure 9.7). Positive sulfur isotope values varied only slightly, from 1.4 to 2.5 per mil $\delta^{34}S[SO_4^{2-}]$. Negative values varied more widely, from –1.9 to –13.5 per mil $\delta^{34}S[SO_4^{2-}]$. Positive $\delta^{34}S[SO_4^{2-})$ values may indicate multiple sulfate sources and mixtures, including fertilizers, organic matter, marine salts, and atmospheric deposition (Krouse and Grinenko, 1991). Negative sulfur isotope values are consistent with oxidation of Fe-sulfides and dissolution of second-cycle terrestrial evaporitic salts that may have been derived originally from oxidation of metal sulfides (e.g., Thernardite or Mirabolite salts).

Negative values of $\delta^{34}S[SO_4^{2-})$ coincide with the Swamp of the Frogs marsh region and with the region identified by Trimble (1998) as an "ephemeral lake" that created alkali salt deposits. As already discussed, we believe this area was a groundwater discharge area for groundwaters that flowed out of the Swamp of the Frogs region. The negative values of $\delta^{34}S[SO_4^{2-})$ in the Swamp of the Frogs marsh area and Lane Channel area implies a genetic link between the origins of sulfate in these two regions. A link is not shown between positive of $\delta^{34}S[SO_4^{2-})$ in groundwater around San Diego Creek and negative values of $\delta^{34}S[SO_4^{2-})$ in groundwater near Lane Channel. Because the ephemeral lake is assumed to have formed due to overflows of San Diego Creek during times of flood (Trimble, 1998), we would expect to see positive sulfur isotope signatures in the Lane Channel area if the sulfate that eventually precipitated in the alkali flats area was from evaporation of San Diego Creek overflows (Figure 9.8). Instead, the sulfur isotope data show a probable link between negative values of $\delta\,^{34}S[SO_4^{2-})$ in the Swamp of the Frogs area, and negative values of $\delta\,^{34}S[SO_4^{2-})$ in the Lane Channel area. This implies groundwater flow and discharge between Swamp of the Frogs marsh and the alkali flat region that once existed near Lane Channel, as shown by other lines of evidence.

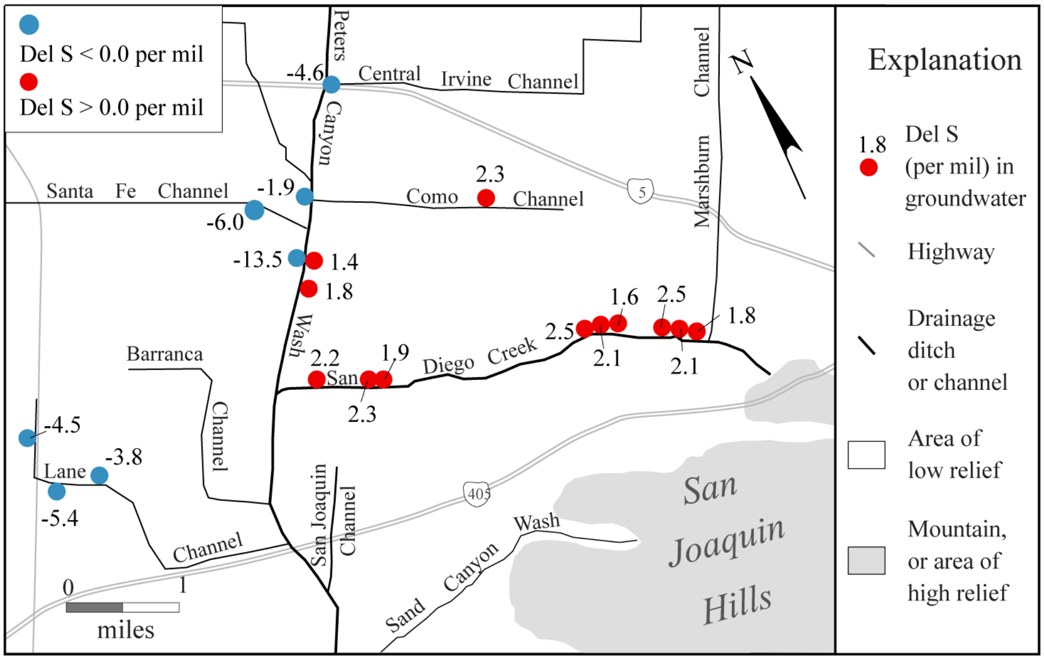


Figure 9.7 Per mil values of sulfur isotopes in groundwaters collected from springs and weepholes in the study area, including the Lane Channel area.

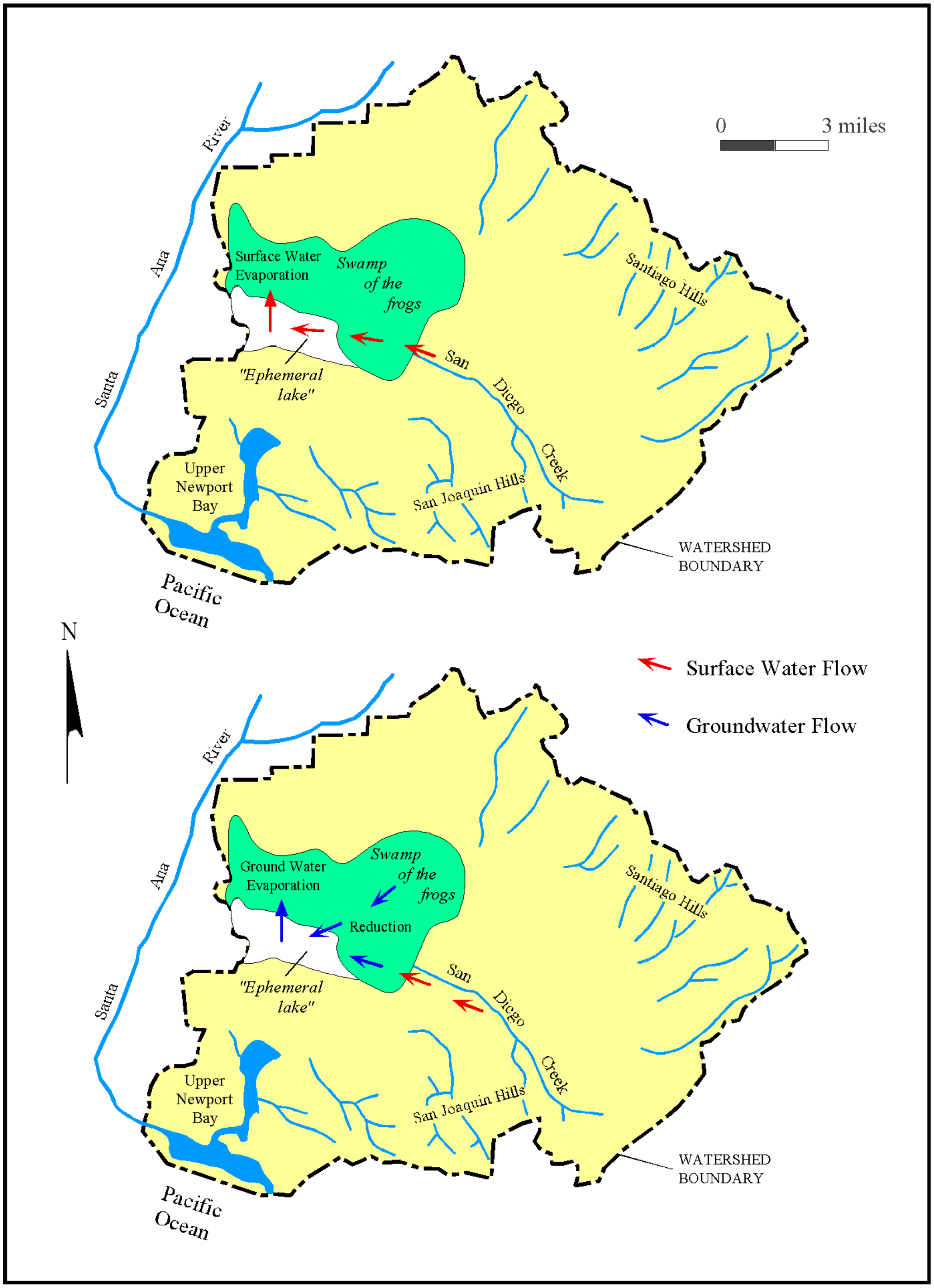


Figure 9.8 Upper diagram, initial conceptual model for formation of "ephemeral lake" deposits in the alkali flats. Lower diagram, conceptual model developed in this study that is consistent with development of negative sulfur isotope signatures in both the Swamp of the Frogs area and "ephemeral lake" area (modified from Trimble, 1998).

Chapter 10 Geochemistry of Groundwater System

The individual studies outlined above provide separate and distinct windows on the spatial and temporal characteristics of the groundwater hydrology and chemistry of the San Diego Creek watershed. Utilizing the limited sampling network that was described in chapter 2 this chapter seeks to integrate the various geochemical data on the groundwater system to provide a complete picture of what the geochemical controls on selenium, arsenic and nitrate mobility are.

Selection of groundwater sampling locations was limited by temporal hydrology as well as the man-made constructs of the watershed. In a highly urban watershed such as the study area, traditional widespread well sampling is impossible. Thus, the groundwater system was characterized primarily through monitoring of groundwater where it interfaces with the surface water system. In addition to springs, weepholes and dewatering operations, a set of tributary drains were characterized as part of the groundwater study set. Index parameters and chemical data assisted with denotation of drains as groundwater dominated or surface water dominated. Except in the case of storm event flows, groundwater dominated drains are treated as any other groundwater source. This involves an assumption of no direct surface water contamination, but possible and predictable changes in index parameters such as dissolved oxygen.

With persistent routine monitoring of groundwater in the past 18 months, the geochemistry of the system has been well defined. Future sampling for other projects will add further supportive data for geochemical characteristics and aid in identifying hydrologic responses to winter recharge events. However, it is unlikely that the typical characteristics of the groundwater system will change. Major and trace ions help to identify past and present processes occurring within the groundwater and at the groundwater-aquifer interface.

10.1 Chemical Data – Major Ions

Field index parameters are used to help define a water sample's origin. The local groundwaters are characterized by near neutral pH, electrical conductivity (EC) greater than 2.5 mS with a long-term average of 3.8 and low, but oxic levels of dissolved oxygen. When comparing these typical values (Table 10.1) to those for surface water, the ability to discern origin becomes clear. The pH of surface water is more than one pH unit higher and the average electrical conductivity is more than one mS lower. The most significant difference is in quantity of dissolved oxygen in the groundwater. While it is abundant in terms of providing oxidizing conditions, it is several-fold less than found in surface water. This result is not at all surprising, thus low dissolved oxygen is a very helpful indicator of undisturbed groundwater.

Table 10.1 Comparison of groundwater index parameters to those values in surface water.

Source	pH	EC (mS)	DO (mg/L)	Temp (°C)
Groundwater	7.23	3.77	2.64	22.03
Surface Water	8.31	2.47	10.83	22.00

Several oxidized ions in aqueous solution are known to compete with arsenic for adsorption location in soils. Among the possible candidate ions only silicon ions appear to have compete with arsenic for adsorption sites in the soils and aquifer materials of the watershed. The competition may be one factor leading to the elevated arsenic concentrations in portions of the basin. Silicon is a significant nonionic dissolved constituent of this groundwater system and is most likely in the form of the uncharged species $H_4SiO_4^0$ (Deutsch 1997). There are two populations of silicon concentrations within the groundwater samples (Figure 10.1). The boundary of 23 mg/L will be used to divide sampling locations into populations for analysis. In fact, a plot (Figure 10.2) of silicon against selenium and arsenic displays a positive correlation within the high population of silicon (R = 0.62, 0.59). Though including all values of silicon in these correlations produces positive relationships (R=0.44, 0.64), selecting only the higher population of silicon best accounts for the highest values of selenium and arsenic.

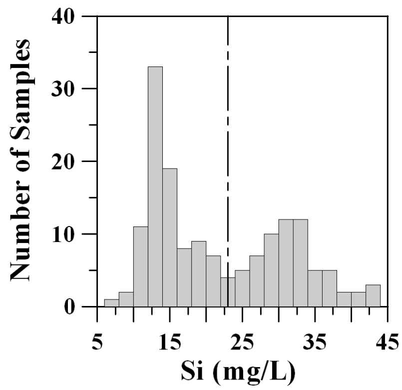


Figure 10.1 Histogram for silicon. Two populations are separated by a dotted line.

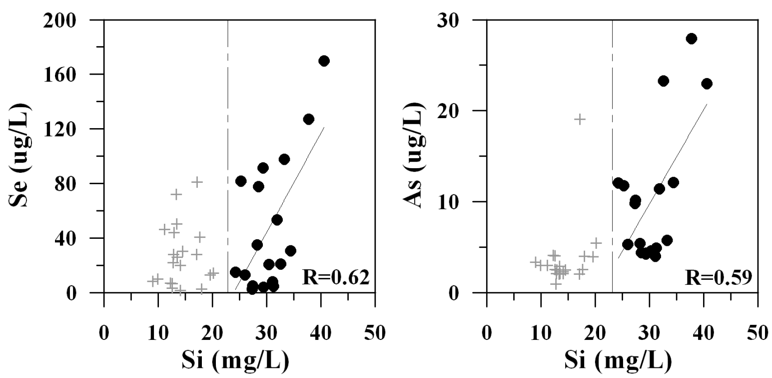


Figure 10.2 Correlations between silicon and selenium, silicon and arsenic. The dotted line separates the two populations of silicon at 23 mg/L. The R values are for correlations of the high population with each metal. Black circles represent data where Si > 23 mg/L while grey crosses indicate data of the lower population.

A contour map of silicon (Figure 10.3) spatially defines geochemical controls on the solubility of the constituents of interest – selenium and arsenic. We see the highest concentrations of silicon in the same region as the most elevated selenium and arsenic – the hotspot. The spatial distribution of silicon however is more like that of arsenic than selenium. It is more contained and does not extend towards the Lane Channel region, though the higher population of silicon has a larger number of data points. When comparing the histograms for arsenic (Figure 6.5) and silicon (Figure 10.1), it becomes evident that the two silicon populations are nearly normal while the high population of arsenic is quite discrete.

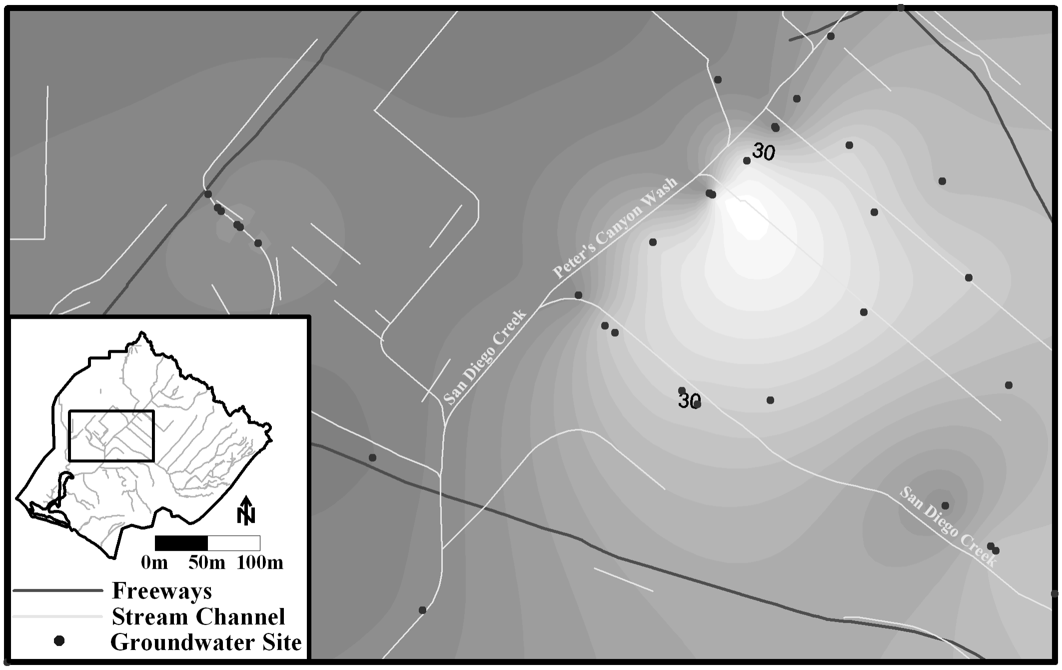


Figure 10.3 Silicon Concentration in Groundwater, 2 mg/L contour interval. The silicon hotspot appears to correlation well with the Se & As hotspot, as the highest concentrations are found southeast of Peter's Canyon Wash.

Chloride is conservative in groundwater because its reaction with the solid phase is very limited. Thus, only evaporation controls its concentration. This nature of chloride allows it to be compared with other groundwater constituents to determine the presence or lack of influence of evaporation on the concentration of the constituent in question (Drever 1988). A ratio of chloride to sulfate in equivalents per liter would thus indicate the presence or absence of sulfate enrichment beyond that of concentration due to evaporation.

A chloride to sulfate equivalence ratio of the local groundwater data shows two populations of data with a 0.8 boundary value (Figure 10.4). Values less than 0.8 indicate sulfate enrichment that is not explained by evaporation. This set of values is the larger of the two populations, indicating that many of the groundwater samples have this sulfate enrichment as observed initially by Hibbs and Lee (2000). In fact, a large part of the groundwater system has concentrations of sulfate above 1000 mg/L including the areas of highest selenium and arsenic (Figure 10.5). Most noticeable though is an area of extremely high sulfate along Lane Channel. This area of high sulfate coincides with an area denoted by Trimble (1998) as being an ephemeral lake. Investigations into the source of these localized concentrations and whether they can be attributed to an ephemeral lake will be discussed later on.

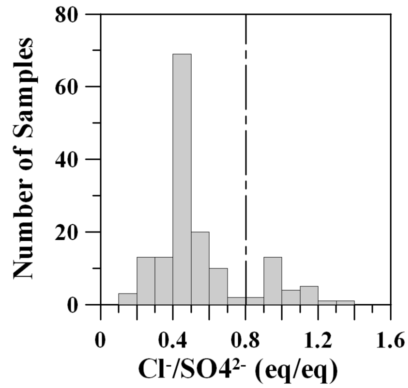


Figure 10.4 Histogram for chloride-sulfate equivalence ratio. Two populations are separated by a dotted line.

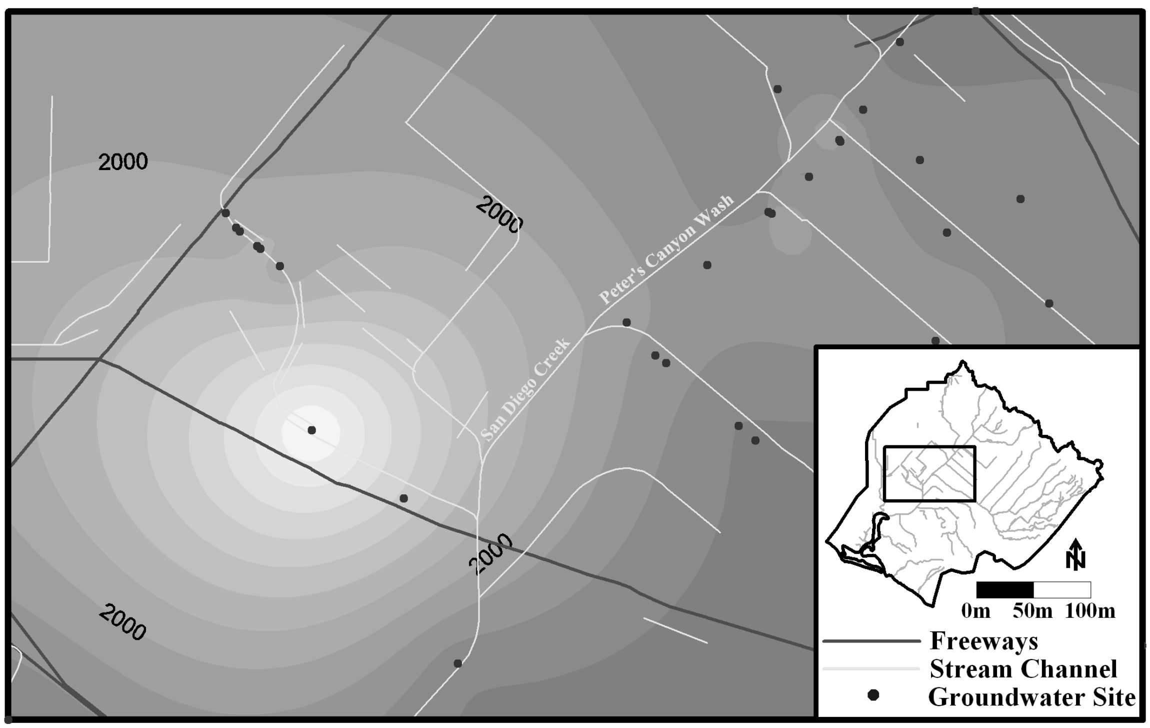


Figure 10.5 Sulfate Concentration in Groundwater, 500 mg/L contour interval. A hotspot for sulfate exists in the area of Lane Channel where Trimble proposed an ephemeral lake was to have existed.

The presence of sulfate enrichment in the area of elevated selenium and arsenic begs correlation relationships to be examined, particularly in terms of the higher population of silicon identified above. There is a positive correlation (R=0.76) between sulfate and selenium where silicon is high (Figure 10.6), but this relationship does not hold between sulfate and arsenic. The relationship between sulfate and arsenic is only slight (R=0.28) where silicon is greater than 23 mg/L, indicating that sulfate enrichment and arsenic mobility may not be related in this watershed.

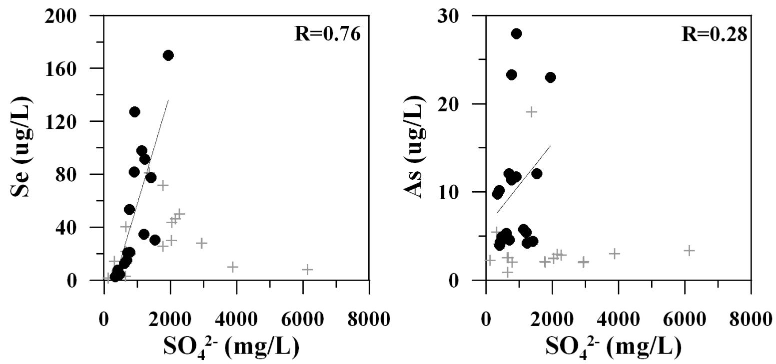


Figure 10.6 Correlations between sulfate and selenium, sulfate and arsenic. Black circles represent data where Si > 23 mg/L while grey crosses indicate data of the lower population.

The groundwater system is not only enriched in sulfate, but also contains elevated sodium and other cations. The reason for this is that the negative charges of anions such as sulfate and nitrate must be balanced by positive ions such as calcium and sodium. This statement is supported by a positive correlation (R=0.86) between the two. However the small number of points on the high end obscures the real relationship. The correlation is not as strong when data from Lane Channel, the region of extremely high sulfate, is removed (Figure 10.7). Additionally, major ion data shows a negative correlation between calcium and alkalinity (Figure 10.8, R=0.62), a relationship that is often indicative of aquifer weathering processes (Drever 1988).

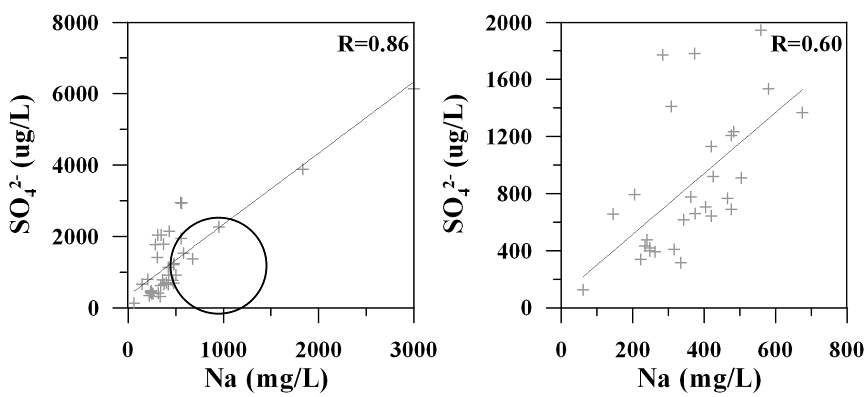


Figure 10.7 Groundwater data shows a strong positive correlation between sodium and sulfate. The figure on the right shows the relationship for all values where sulfate is less than 2000 mg/L.

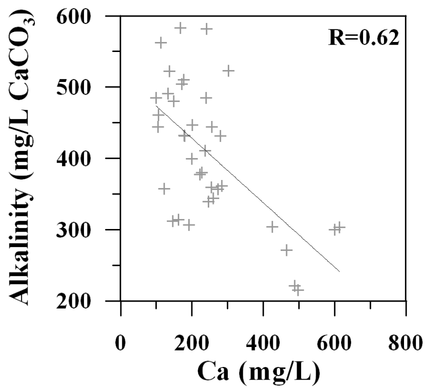


Figure 10.8 Groundwater data shows a negative correlation between calcium and alkalinity.

10.2 Chemical Data – Redox Sensitive

The highest concentrations of selenium and arsenic are found in a particular area that has been referred to as the hotspot. However, as described previously and in Figure 10.9, this relationship is not perfect. Correlation between selenium and arsenic is positive, but the variation is evident (Figure 10.9). The redox-sensitive nature of these constituents makes this "groundwater contamination" problem more complicated than a simple pollution plume. Since their mobility is directly controlled by redox status, determination of this status and its affects on other redox-sensitive elements was investigated.

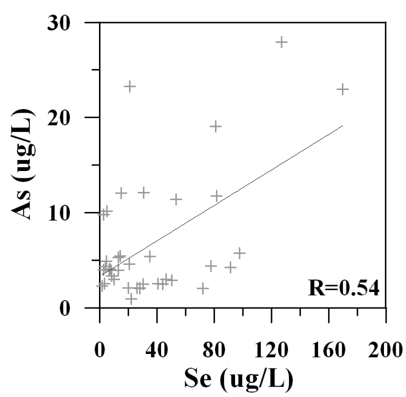


Figure 10.9 Relationship between selenium and arsenic. A positive correlation exists within groundwater sampling locations.

10.3 Other Redox-Sensitive Trace Elements

Low level concentrations of the redox-sensitive trace metals vanadium and molybdenum were obtained through graphite furnace atomic absorption spectrophotometry. Concentrations of these types of elements can indicate redox and adsorption/desorption processes in a groundwater system. A very strong correlation exists between vanadium and the constituents in question – selenium and arsenic (R=0.71, 0.87) (Figure 10.10). A significant positive correlation also exists between molybdenum and selenium (R=0.83) (Figure 10.11) as well as molybdenum and arsenic (R=0.73) within the higher silicon population (Si > 23 mg/L). This correlation does not hold for the lower silicon population.

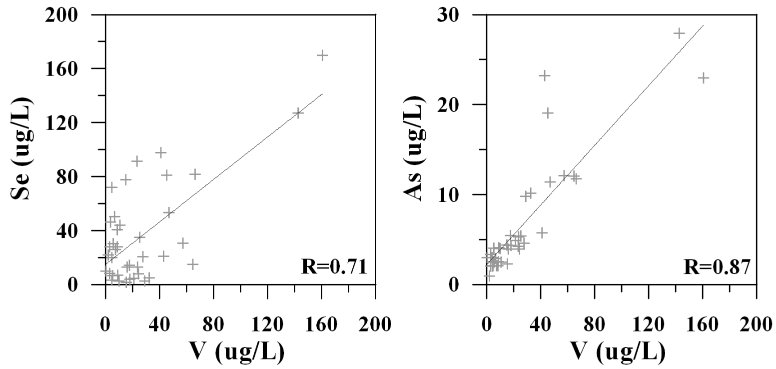


Figure 10.10 Correlations between vanadium and selenium, vanadium and arsenic.

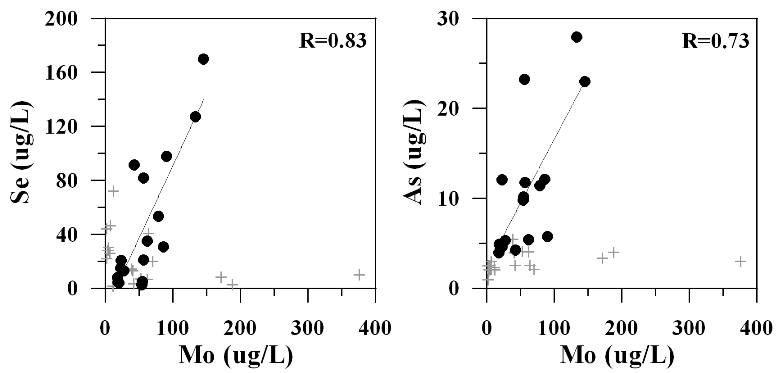


Figure 10.11 Correlations between molybdenum and selenium, molybdenum and arsenic.

The relationship between phosphate and arsenic has been widely studied as they are adsorption competitors (Dowling 2002). The data for this groundwater system shows that no relationship exists between phosphate and arsenic, regardless of silicon concentration (Figure 10.12).

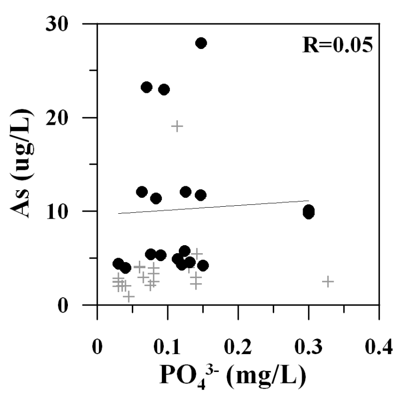


Figure 10.12 No correlation exists between phosphate and arsenic concentrations in groundwater.

10.4 Sequential Extraction of Soils

A sequential extraction procedure selective for selenium was used to determine selenium and arsenic fractions in four soil samples (Wright 2002). The extractant solutions were analyzed for both selenium and arsenic, though the selectivity of the procedure for arsenic is questionable. Thus, the initial results (Tables 3.3.6 and 3.3.7) are highly preliminary. The same procedure will be repeated to verify the selenium fractionation results. In addition, a new method will be employed for sequential extraction of arsenic. For all four soils, the results indicate selenium is concentrated in the reduced forms – the organic, elemental and residual fractions. However, the soils at Warner Drain and Denitrification Plant have a greater amount of well-oxidized soluble selenium than do those sites on Barranca Channel. The percentage of arsenic in the soluble fraction was similar to selenium such that the sites along Peter's Canyon Wash (Warner Drain and Denitrification Plant) had more well-oxidized arsenic than those along Barranca Channel. However, the most significant differences between pools of selenium and arsenic occur within the adsorbed fraction. While very little selenium is found in this fraction, 22 to 35% of arsenic is adsorbed to soil surfaces in this exchangeable fraction. While the results indicate the organic and residual fractions of arsenic are also substantial, this may be an artifact of the selenium-specialized method.

Table 10.2 Selenium Sequential Extraction Results

Sequential Extraction Results (Se %) - Wright, 2003 Method SEPOH					
Location	**Soluble**	**Adsorbed**	**Organic**	**Elemental**	**Residual**
Warner Drain	6.56	1.81	36.80	14.85	36.67
Denitrification Plant	31.00	3.76	16.91	18.00	30.34
Barranca @ Barranca	2.32	4.15	18.42	24.92	48.01
Barranca @ Alton	1.98	3.49	15.67	15.63	63.50

Table 10.3 Arsenic Sequential extraction results

Sequential Extraction Results (As %) - Wright, 2003 Method SEPOH				
Location	**Soluble**	**Adsorbed**	**Organic**	**Residual**
Warner Drain	2.48	34.46	30.25	32.08
Denitrification Plant	6.16	31.65	23.87	38.32
Barranca @ Alton	0.00	22.30	25.36	49.87
Barranca @ Barranca	0.07	26.49	43.72	28.13

10.5 *Geochemical Controls on Selenium and Arsenic Mobilization*

The histograms, contour maps and correlation plots helped to identify significant relationships that are crucial to understanding why selenium and arsenic have entered the groundwater system. However, the key to the puzzle involves redox geochemistry not of solution, but of the soil. Two soil series, Omni and Chino, are prominent in the study region. The Chino series is a moderately alkaline, calcareous gray silty clay loam while the Omni series is also moderately alkaline and calcareous, but is a gray clay. While they share some similarity, there is one notable difference. The Omni series contains prominent olive brown mottles while the Chino only has very few light brown mottles (OC Soil Survey 1978). The importance of the mottles is that they would only develop under conditions of variable oxidation-reduction status. Oxidation-reduction status would be variable in the natural environment under conditions of variable saturation. In other words the Omni soils were historically, during the pre-drained period, saturated for part of the year and dry for part of the year while the Chino soils were saturated the entire year and thus have no mottles.

A visual comparison (Figure 10.13) of the locations of these soil series with the geochemical predictors outlined above provides an interesting story. The area where the chloride-sulfate ratio is less than 0.8, where sulfate is enriched, overlaps with negative sulfate isotope data. Much of the Chino series falls within this overlap. In addition, the area where the chloride-sulfate ratio is less than 0.8 also overlaps with the high population of silicon, where silicon is greater than 23 mg/L. Most of the Omni series falls within this boundary. These three parameters overlap in a small region that falls precisely on the boundary between the Omni and Chino series.

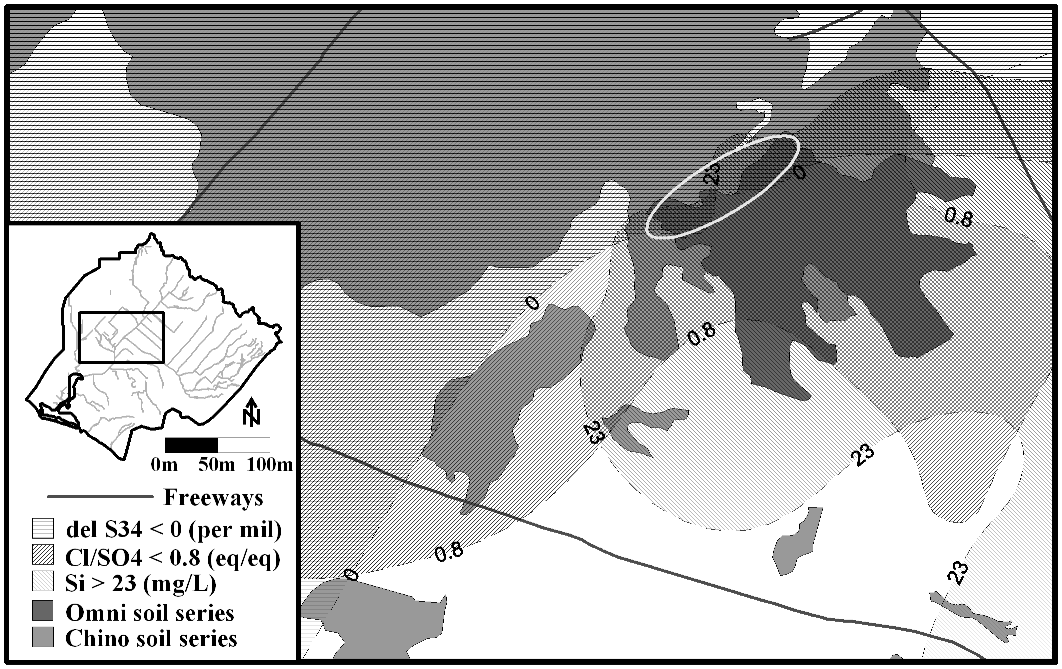


Figure 10.13 Overlay of significant geochemical boundaries related to selenium and arsenic concentrations with Omni and Chino soil series. The white circle identifies the region where high silica, low Cl/SO4 ratios, negative del S34 values and the soil series Omni and Chino intersect. This region also overlaps with the present day hot spot where both selenium and arsenic concentrations are elevated.

To examine the significance of these associations, attention must return to the groundwater concentrations of selenium and arsenic. Histograms of site-averaged data show two populations of these constituents with boundaries at 70 µg/L and 16 µg/L, respectively (Figure 10.14). An overlay of regions where the groundwater is equal to or higher than these values is plotted on Figure 10.15. The overlap of the individual selenium and arsenic "hot spots" falls within the three parameter overlap and the boundary between the two soil series. This result indicates that the boundary between these two soils series, which likely represented the edge of the historically saturated marsh, is the area with the highest selenium and arsenic concentrations. The reason for the elevated selenium and arsenic concentrations being highest in this area is that at the boundary of the Chino series soils is where oxidized groundwaters in the Omni series would first meet significantly reducing conditions. Where the conditions are first reducing is likely where the most selenium and arsenic would be reduced into an immobile form and these trace elements would thus have accumulated at this boundary during the historic period prior to drainage of the marsh.

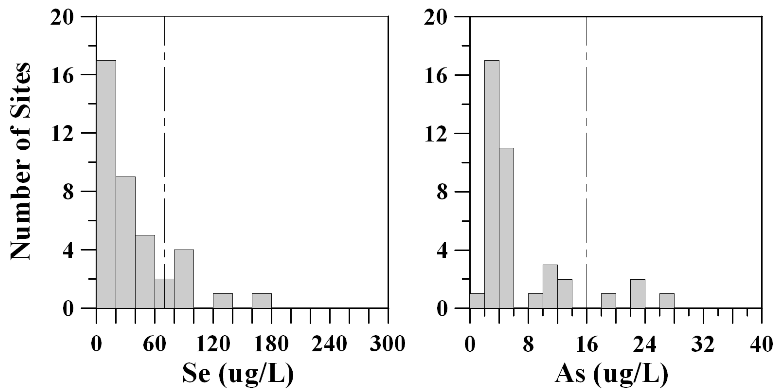


Figure 10.14 Two populations of sampling sites exist for both Se and As. The "high" populations can be stated as Se > 70 µg/L and As > 16 µg/L.

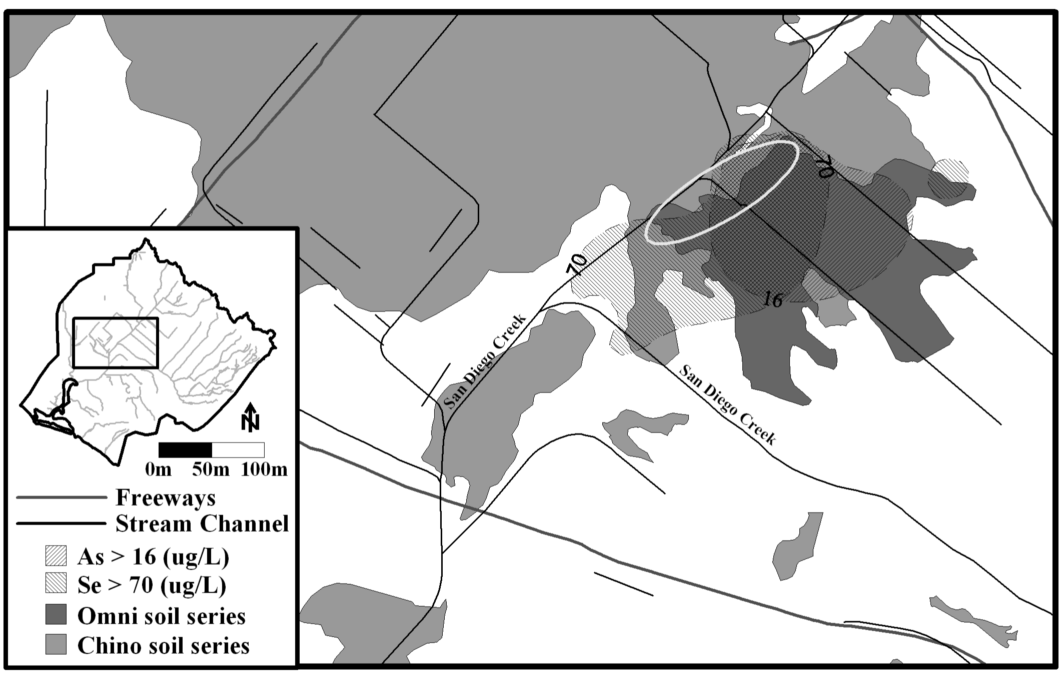


Figure 10.15 Overlay of selenium, arsenic hot spots with Omni and Chino soil series. The white circle bounds the same area as in Figure 3.3.18 where the two soil series meet, Si > 23 mg/L, Cl/SO4 < 0.8 and δS^{34} is negative. Conclusion to be drawn from this figure and from Figure 3.3.18 is that the edge of the permanently saturated historic swamp was the location of intense immobilization of selenium and arsenic.

Chapter 11 Groundwater Age Dating and Source of Groundwater

While the discussion so far has focused on the geochemistry and hydrology of the groundwater system two important properties of the groundwater system have not yet been discussed. First, how long has the groundwater we are observing been resident in the subsurface of the watershed? Second, what is the ultimate source of the water recharging the shallow groundwater system?

11.1 Groundwater Age Calculations by Darcy's Law

Groundwater dating is used to estimate the residence times of groundwater. Residence time is defined as the period of time a parcel of groundwater resides in an aquifer, from the inception of recharge to the time of outflow at a discharge point, such as at a spring, stream, lake, bay, or pumping well. It is important to estimate groundwater residence times because it can be used to help determine the number of aquifer pore volumes that will leach soluble pollutants, such as nitrate and selenium, out of an aquifer.

A time-honored method of estimating residence time is to calculate the average linear velocity of groundwater, based on Darcy's law:

$$V_i = K * i * 1/n_e$$

where: V_i = average linear velocity of groundwater (ft/day)
K = hydraulic conductivity of the aquifer material (ft/day)
i = hydraulic gradient (ft/ft, or dimensionless)
n_e = effective porosity (dimensionless)

In this expression, hydraulic conductivity is basically the permeability of the aquifer, usually determined by aquifer pump tests. Hydraulic gradient is the slope of the water table, and effective porosity is the drainage porosity, which excludes the water contained in retention capacity (i.e., dead end pores and water clinging by surface tension to solid particles).

Estimates of average linear velocity of shallow groundwater have already been calculated for the Tustin Air Station, based on aquifer pump tests, accurately constructed water table maps, and Darcy's Law. The estimated horizontal flow rates are on the "order of 50 to 120 ft/yr within the silty sand and gravel units, and are likely to be much lower in the intervening silt layers" (Draft Final Remedial Investigation Report for Operable Units 1 and 2, 1997). Thus, by Darcy's Law, the time for groundwater to travel the distance between the upgradient part of the base near Red Hill Ave to discharge points at Peters Canyon Wash (~8,000 ft) is 160 years and 67 years, for velocities of 50 ft/yr and 120 ft/yr respectively.

Estimates can also be developed from raw data and maps prepared by Silverado Constructors (1997). For a line of section oriented from Bryan Avenue to Como Channel, roughly sub parallel to Peters Canyon Wash, the hydraulic gradient is about 0.0055. A conceptual and numerical groundwater flow model described by Silverado Constructors (1997) includes an upper silt and clay aquifer layer that is 15 feet thick. Based on aquifer tests and grain size analyses, this upper aquifer zone has a horizontal hydraulic conductivity of 0.028 ft/day. Combining the computed hydraulic gradient, hydraulic conductivity values, and an estimated effective porosity of 25%, the horizontal groundwater velocity in the upper layer computed by Darcy's law is 0.23 ft/yr. Below the upper aquifer zone is a silty-sand and gravel rich layer that is 55 ft thick, with measured hydraulic conductivities of 15 ft/day. The horizontal groundwater velocity of the lower layer is 120 ft/yr. Accordingly, for a travel distance of 1 mile, the residence time in the upper layer is 22,956 years and the residence time in the lower layer is 44 years.

Hibbs and Lee (2000) developed a potentiometric surface map for the shallow aquifer beneath San Diego Creek Watershed (reproduced in Figure 11.1). Two lines of section are shown on this water table map (A-A' and B-B'). Using the hydraulic gradient measured along section A-A' (0.0061), along with an assumed hydraulic conductivity of 15 ft/day and an estimated effective porosity of 25%, the average linear velocity of groundwater is 133 ft/year. The total estimated residence time for groundwater to travel the distance along line of section from A to A' (13,000 ft) is 98 years. The potentiometric surface is steeper along line of section B-B' (0.0092). Using the same hydraulic conductivity value (15 ft/day) and effective porosity value (25%), the travel time along section B-B' is 201 ft/year. The estimated residence time for groundwater to travel the 6500 ft distance between B and B' is 32.5 years.

It must be kept in mind that precipitation recharge is added continuously on top of the water table along the flowpaths cited above, at least where impervious cover is not present. Recharge that occurs very close to the discharge areas has a much shorter residence time, but a similar velocity of groundwater flow. However, in all analysis residence times estimated by Darcy's law imply that only a few aquifer volumes have cycled in and out of the aquifer, from recharge to discharge areas, since the historic period of drainage of the Swamp of the Frogs marsh. In the next section, radioisotopes are used to test calculations made with Darcy's law.

11.2 Tritium Age Dating of Groundwater

Tritium (^3H), a naturally occurring radioisotope of hydrogen, is commonly used to identify parcels of modern groundwater recharge. An isotope of hydrogen with a half life of 12.4 years, tritium is directly incorporated into the water molecule and flows into aquifers during recharge events.

Natural tritium is formed in the upper atmosphere from the bombardment of nitrogen by cosmic ray neutrons. Free tritium then combines with atmospheric oxygen to form water in the atmosphere. Air moisture has a short residence time and is removed from the atmosphere by precipitation fallout over watersheds and aquifers. Downward moving wetting fronts carry "tritiated waters" into aquifers, where tritium decays to produce helium-3. This decay process and the short half life of tritium allow ^3H to be used as a short range indicator of modern groundwater recharge.

Tritium concentrations are given in tritium units (TU) where 1 TU = 1 ^3H atom per 10^{18} hydrogen atoms. Natural tritium concentrations in precipitation are very low, with greater production rates at high latitudes (e.g., 15 TU) and smaller natural production rates in lower latitudes, such as Southern California (e.g., 3 to 6 TU). Atmospheric testing of nuclear weapons from 1952 to 1962 released an exceptionally large amount of tritium into the atmosphere ("bomb tritium"). Bomb tritium became incorporated in the recharge to groundwater, producing concentrations of several hundred

TU in aquifers. In the three decades since the last major above ground weapons testing, bomb tritium has decayed and has been attenuated by oceans. Levels of tritium in the atmosphere now approach natural atmospheric production.

Bomb tritium signals still are present in aquifers, which can be used to date, at least semi-quantitatively, groundwaters that were recharged during the era of

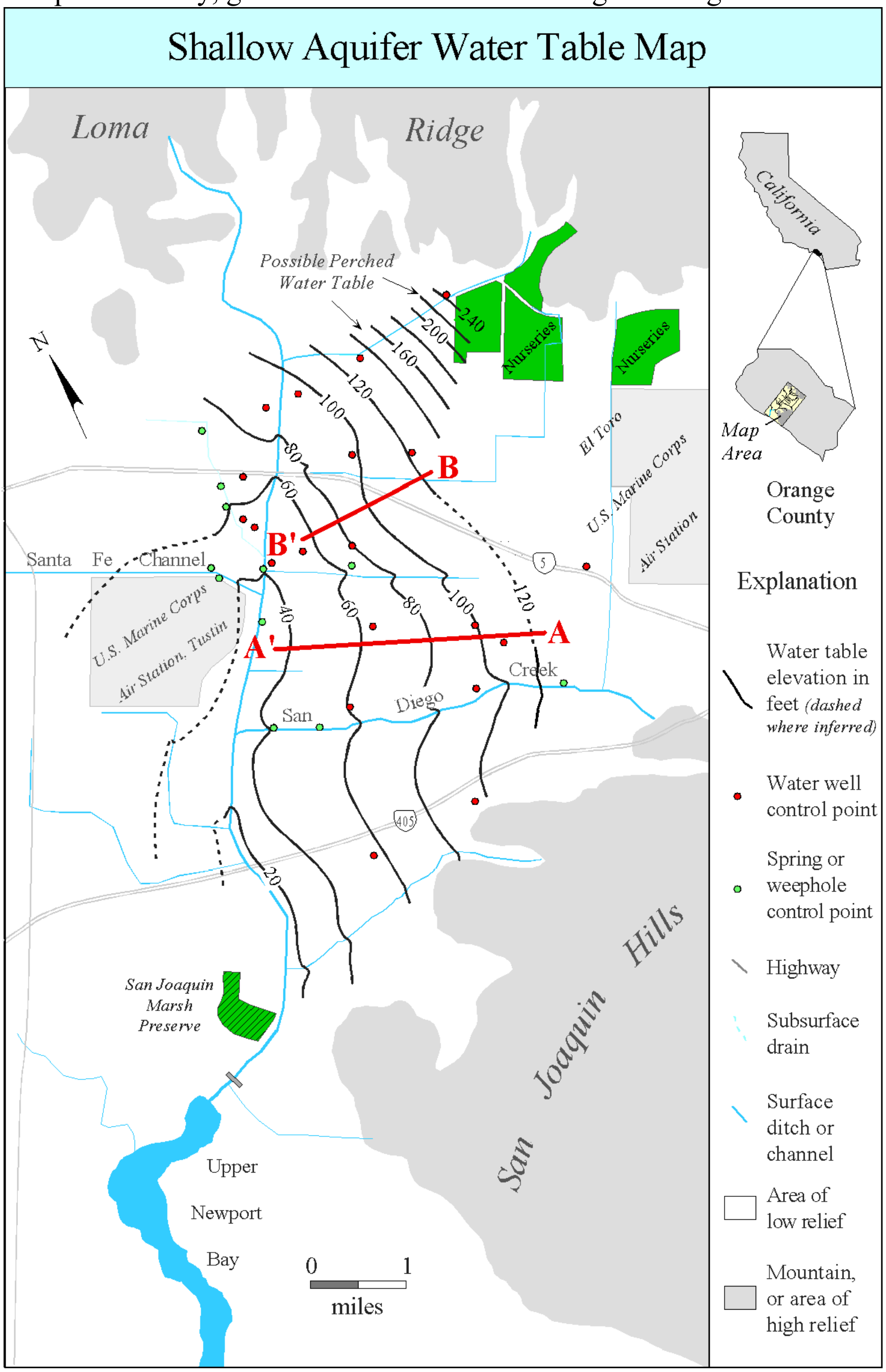


Figure 11.1 Potentiometric surface map and lines of section used to estimate groundwater residence times with Darcy's Law (modified from Hibbs and Lee, 2000).

thermonuclear detonations in the atmosphere. Groundwater dating conventions for coastal and low latitude regions have been adopted by Clark and Fritz (1997):

<0.8 TU	Submodern, recharged prior to 1952
0.8 to 2 ~TU	Mixture between submodern and recent recharge
2 to 8 TU	Modern (<5 to 10 yr)
10 to 20 TU	Residual bomb tritium present
>20 TU	Considerable component of recharge from 1960s or 1970s

These conventions are generally supported by the U.S. Geological Survey based on recent tritium sampling in the Los Angeles Basin (Reichard and others, 2003). In their work, the USGS interpreted tritium in the aquifers of the LA Basin with no measurable tritium to have been recharged prior to 1952; water with greater than 1.0 TU to have been recharged after 1952; water with greater than 8.0 TU to include a significant portion of bomb tritium; and water with 1.0 to 8 TU to include recent water not attributable to any specific period after 1952 (Reichard and others, 2003).

Using these numbers as a guide, some general interpretations can be made from limited tritium sampling that was done during this study (Table 11.1). Namely, that two of the three wells have greater than 10.0 TU and contain bomb tritium. This means that at least a major component of these two groundwater samples dates to a recharge period between 1960 and 1985. The well sample with 2.1 TU (Table 11.1) includes some modern water (post-1952). However, the sample is not necessarily post 1994, as suggested by the rules of thumb of Fritz and Clark (1994). This sample could include a mixture of water at least hundreds of years old combined with younger water. Interpreting tritium analysis is complicated by the potential mixing of older and younger water. Rules of thumb by Fritz and Clark (1994) apply primarily to unmixed waters.

Table 11.1 Tritium Values in Shallow Water Wells in San Diego Creek Watershed

Location	Depth of Well (ft)	Depth to Water (ft)	Tritium Concentration (ft)
Sand Canyon @ I5	92	76	10.0
McGaw St @ Pullman	33	11	2.1
McGaw St @ Pullman	23	10	11.8

Despite the problems and uncertainties with tritium analysis, two of three tritium values in Table 11.1 are demonstrably of the bomb tritium variety. This dates these two waters (or at least a major component of mixed groundwater) to at least 20 years old, but not older than 45 years. These results are consistent with residence times estimated by Darcy's law, based on measured hydraulic head gradients and hydraulic conductivity estimates. Travel time estimates imply that only a few aquifer volumes have cycled in and out of the aquifer, from recharge to discharge areas, since the historic period of drainage of the Swamp of the Frogs marsh and other marshes in the study area. Such estimates will be combined with other tritium and age dating analysis in the future to develop calculations of leaching of selenium from soils in the study region.

11.3 Source Water Analysis with Oxygen and Deuterium Isotopes

Several groundwater samples for stable isotope analysis were collected during the study. Samples were collected from springs, weepholes, and water wells located near perennial channels. A few samples were also collected from outflows from Hines Nursery and El Modena Nursery. Samples were analyzed for oxygen and hydrogen isotopes. Stable isotopes of oxygen and hydrogen were then plotted as δ^{18}O‰ vs δD‰ scatter plots (Figure 11.2).

The isotopic composition of the water is expressed in comparison to the isotopic composition of ocean water, using the internationally agreed upon standard, called Standard Mean Ocean Water (SMOW) (Craig, 1961). The isotopic composition of the water, in turn, is expressed in per mil (‰) deviations from the SMOW standard. Water with less D (^{2}H) and ^{18}O than SMOW has a negative δD and δ^{18}O signature whereas water with more D and ^{18}O than SMOW has a positive δD and δ^{18}O signature.

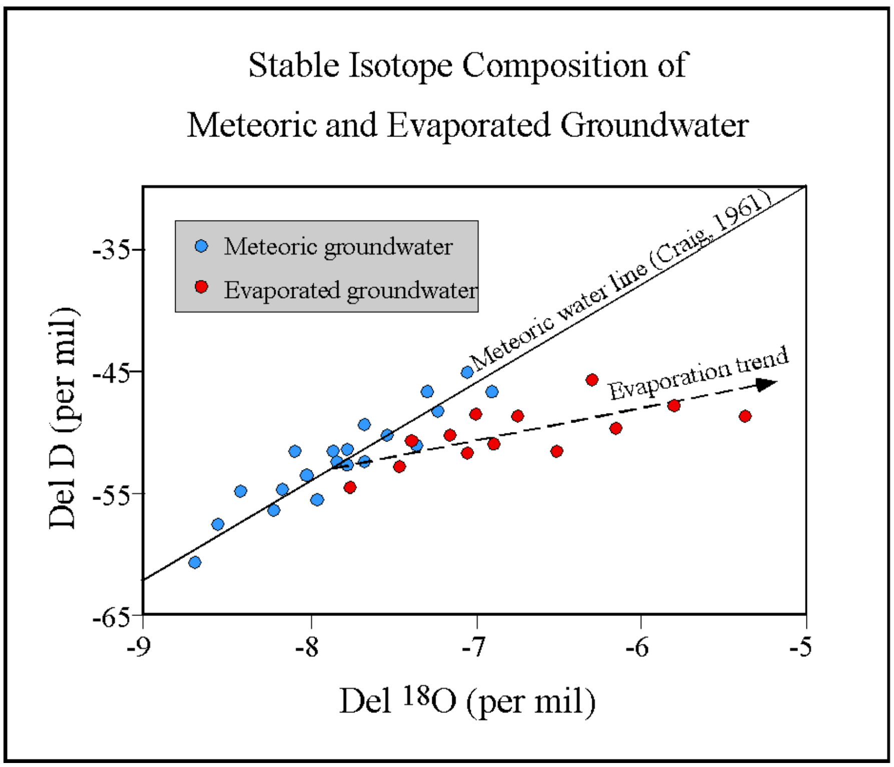


Figure 11.2 Meteoric groundwaters that have not evaporated or that have not fractionated due to interaction with rocks at relatively high temperatures plot close to the meteoric water line of Craig (1961). Groundwaters that have evaporated usually follow an evaporation trend away from the meteoric water line (data points are hypothetical).

Isotopes were sampled to determine if evaporation could account for concentration of salt and selenium in groundwater. Groundwater that has been recharged without evaporation will plot fairly close to the meteoric water line of Craig (1961) (Figure 11.2). Groundwater that has undergone considerable evaporation will plot along an evaporative trend (Figure 11.2). The water molecules containing the heavier stable isotopes (^{18}O and D) have a lower vapor pressure than the molecules containing the lighter stable isotopes (^{16}O and ^{1}H). The tendency during evaporation is for the heavier water molecules to remain in solution, and for the lighter water molecules to evaporate, leaving behind an "enriched" solution of heavier water molecules that follows the evaporation trend on a bivariate plot (Figure 11.2).

Groundwater samples are subgrouped according to sub-watershed areas from which they were collected, including Peters Canyon Wash-San Diego Creek area (PCW&SDC area), Lane Channel area (Lane), and Santa Ana Dehli Channel area (Santa Ana Dehli). Three of the groundwater samples were collected from water wells located near local channels; all other groundwater samples were collected from springs and weepholes that flowed directly into local surface channels and streams.

Samples collected near Peters Canyon Wash and San Diego Creek plot along an evaporation water line of locally derived water (Figure 11.3a). Most groundwater depths in the PCW&SDC area are shallow, sometimes only 6 to 8 feet beneath land surface. In these areas, groundwater may evaporate partially by a wicking effect as atmospheric winds cause venting of moisture vapor from the unsaturated zone, allowing physical evaporation of groundwater. Fine textured soils also allow capillary rise up to a few feet above the water table, which can accelerate evaporative effects. Evaporation of soil moisture or irrigation water is also possible prior to recharge, and may explain some of the evaporative effects shown in PCW&SDC samples (Figure 11.3a).

Partial evaporation of groundwater concentrates salts and trace elements in residual groundwater, and could cause accumulation of salts and trace elements (selenium and arsenic) in some parts of the watershed. However, previous analysis by the research team indicated that evaporation is not the primary source of elevated selenium, arsenic, and salt concentrations in groundwater in the PCW&SDC area (see for example, Hibbs and Lee, 2000 and all quarterly reports). The dissolution of soluble minerals and precipitates along groundwater flowpaths is cited as a more definitive cause of high salinity and high trace element concentrations in the shallow aquifer.

Lane Channel isotope data provide further evidence for mineral dissolution along flowpaths (Figure 11.3). These data plot along the global meteoric water line, showing no evidence of evaporation. Groundwater samples collected in the vicinity of Lane Channel contain some of the highest salinity concentrations in shallow groundwater in the watershed, normally 3800 to 5500 uS/cm. Salinity of groundwaters near Lane Channel can only be explained by water/soil interactions and mineral dissolution, not by groundwater evaporation. As postulated in the section on Lane Channel, local precipitation may leach evaporative salts from the vadose zone near Lane Channel; however the stable isotope data indicate local precipitation is not evaporated during recharge events in the Lane Channel area.

Santa Ana Dehli data show another significant trend, with several groundwater samples of high salinity plotting along a mixing and dilution line oriented between a saline and non-evaporated water (labeled 3921 uS for its specific conductance value) and a more dilute groundwater that is partly evaporated (labeled 813 uS) (Figure 11.3b). This dilute water is isotopically very light for groundwater in this watershed, and is clearly distinct from other shallow groundwater in the area. The dilute water certainly

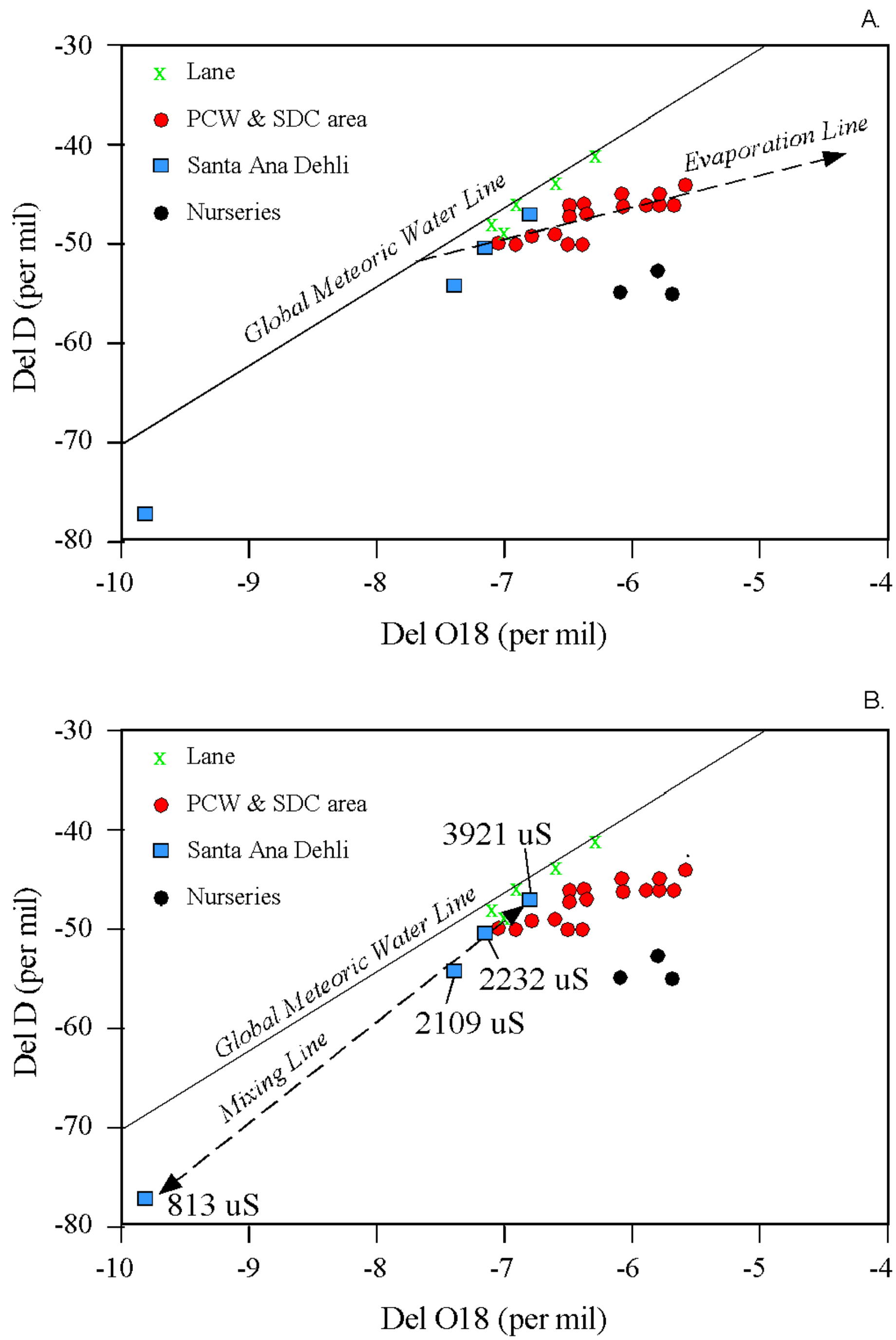


Figure 11.3 Oxygen and deuterium isotopes in shallow groundwater collected from three subwatershed areas, and from nurseries in the upper part of the watershed. Shallow groundwater collected from springs and weepholes in Peters Canyon Wash and San Diego Creek plot along an evaporation trend (Figure 11.3a). Lane Channel samples plot along the global meteoric water line. Santa Ana Dehli channels plot along a mixing line between dilute groundwater (813 uS) and saline groundwater (3921 uS) (Figure 11.3b).

originated in some other region, probably northern California (State Project Water). State Project waters presented in Reichard and others (2003) have almost identical stable isotope signatures (e.g., -9.8 $\delta^{18}O$‰, -78 δD‰). The non-native origin of this groundwater provides clear evidence of local recharge from a source other than local precipitation. To date, most of our data have pointed to local precipitation as the demonstrable source of recharge to the shallow aquifer. This single data point may provide a unique insight into other recharge mechanisms that are occurring, at least locally near Santa Ana Dehli Channel.

Nursery data include evaporated waters that show no generic relationship to shallow groundwater in the data set. While sources of irrigation water at the nurseries may change seasonally and annually, the three data points collected at the nurseries do not support the suggestion that nursery flows may have contaminated the shallow aquifer along losing reaches of Central Irvine Channel. More isotope data will be collected from the nurseries and from other endmember source waters (e.g., reclaimed water, agricultural water, urban runoff) so that sources of recharge to the shallow aquifer, and contamination processes, may be better understood.

Chapter 12 Surface Water - Fate and Transport of Groundwater Contaminants

Given the fact that a great deal of selenium, arsenic and nitrate are moving out of the groundwater system and into the surface waters of the San Diego Creek watershed it is critical to understand what happens to these contaminants once they are discharge to the surface channel system. Several questions need to be answered: how have changes in the channel system of the San Diego Creek watershed influenced how much nitrate and selenium reaches surface waters, how do surface channel conditions influence selenium speciation as water travels through the stream network and what is the overall impact if surface channel processes on the transport of selenium, arsenic and nitrogen? Each of these questions was the focus of an individual study within the watershed and each will be covered in turn.

12.1 Peepers- Stream Groundwater Interaction

Peepers are devices that sample subsurface waters by a dialysis method. Vials capped with a 0.45 um membrane filter are placed in the subsurface. These vials are then allowed to equilibrate with groundwater conditions over a one to two week time period. At the end of the period the vials are removed and returned to the lab for chemical analysis. Here peepers were used to determine regions of groundwater upwelling and to assess below stream biogeochemical conditions. Three sites were assessed: Peter's Canyon Wash below Como Channel, Peter's Canyon Wash below Interstate 5 and San Diego Creek above Jeffrey. These sites were chosen for having fine textured sediment with quicksand properties. This description is ideal for two reasons: 1. quicksand can indicate upwelling groundwater and 2. peepers can be inserted easily in these areas.

The two peeper studies along northern reaches of Peter's Canyon Wash showed similar results (Figs 12.1 and 12.2). Increased ammonium and manganese with depth indicate reducing conditions, whereas the presence of groundwater should show oxidizing conditions penetrating upward from depth. Nitrate and selenium are highest in the upper layers of sediment, indicating that the pore water concentrations are regulated from the surface water above. Therefore interactions between groundwater and surface water in these areas are limited, if not completely non-existent.

The peeper study (Figure 12.3) conducted on Upper San Diego Creek above Jeffrey Road was the only one to indicate gaining conditions in its particular reach. Nitrate concentrations are highest with depth and reach nearly as high as local groundwater thus indicating the influence of local groundwater at the bottom of these peepers. As the samplers come closer to the surface at this site nitrate concentrations decline indicating that nitrate concentrations are reduced and denitrification is likely occurring in these sediments. Also supporting localized reduction are maximums of ammonium and phosphate at approximately 2 cm below the sediment-water interface. However, because ammonium and phosphate do not increase with depth, these also indicate the presence of upwelling groundwater.

Taken together these results indicate that changes in channel structure particularly concrete lining may adversely affect the ability of below the stream sediments from processing contaminants being carried into the stream from groundwater. The two Peter's Canyon sites are in a region with lining of the channel and indicate no loss of nitrogen as water enters the surface waters and in fact display no interaction between surface and groundwaters. The San Diego Creek at Jeffrey location indicates that when sandy bottom streams are vegetated they are capable of removing nitrate and potentially selenium from groundwater seepage prior to entry into the surface channel (Figure 12.4).

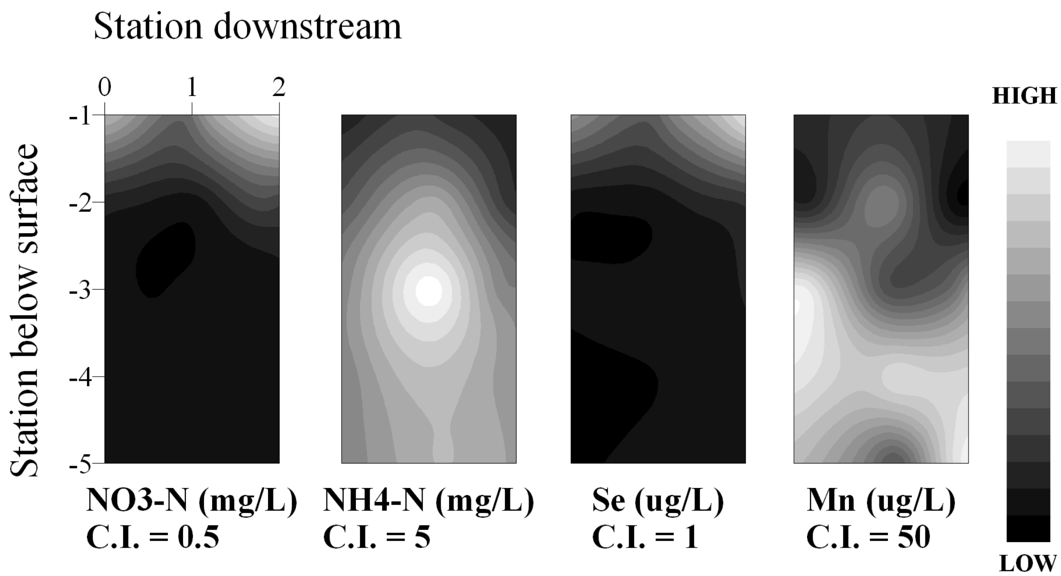


Figure 12.1 Peeper study conducted on Peter's Canyon Wash below Como Channel. Nutrient and trace metal results indicate no groundwater-surface water interaction in this area. Due to an oversight by field personnel the actual depths of the peeper vials were not recorded on this initial installation and so the vertical axis is merely a relative indicator of depth into the sediments for each peeper.

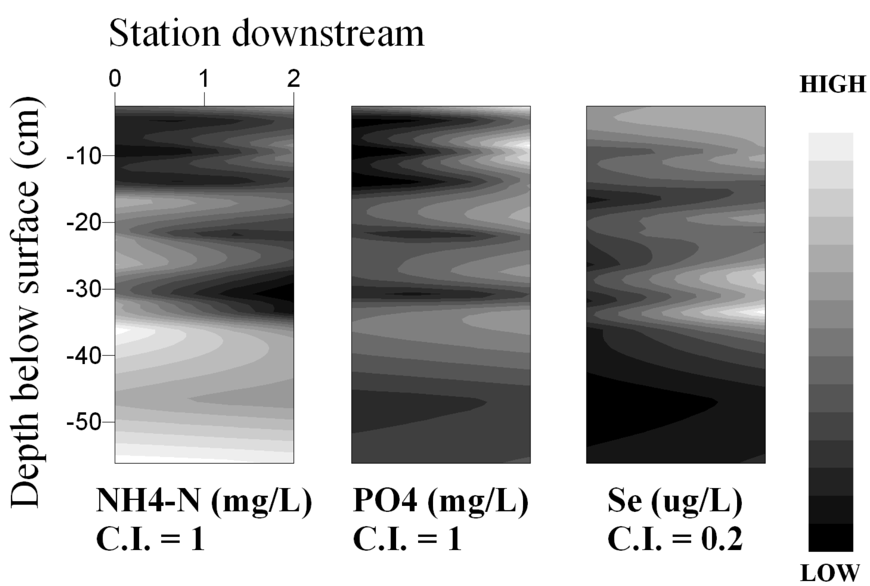


Figure 12.2 Peeper study conducted on Peter's Canyon Wash below Interstate 5. Nutrient and selenium results indicate no groundwater-surface water interaction in this area.

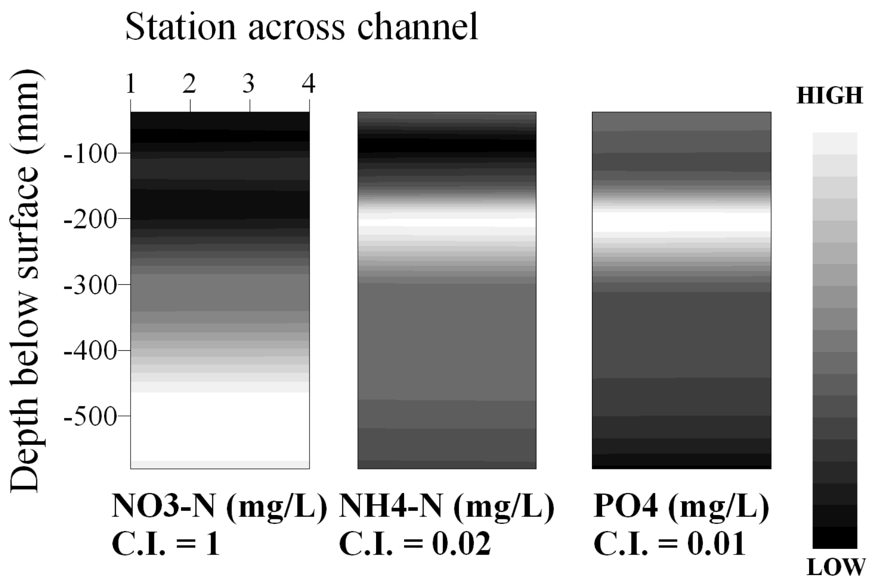


Figure 12.3 Peeper study conducted on Upper San Diego Creek above Jeffrey Road. Nutrient results indicate gaining conditions in this reach of the channel.

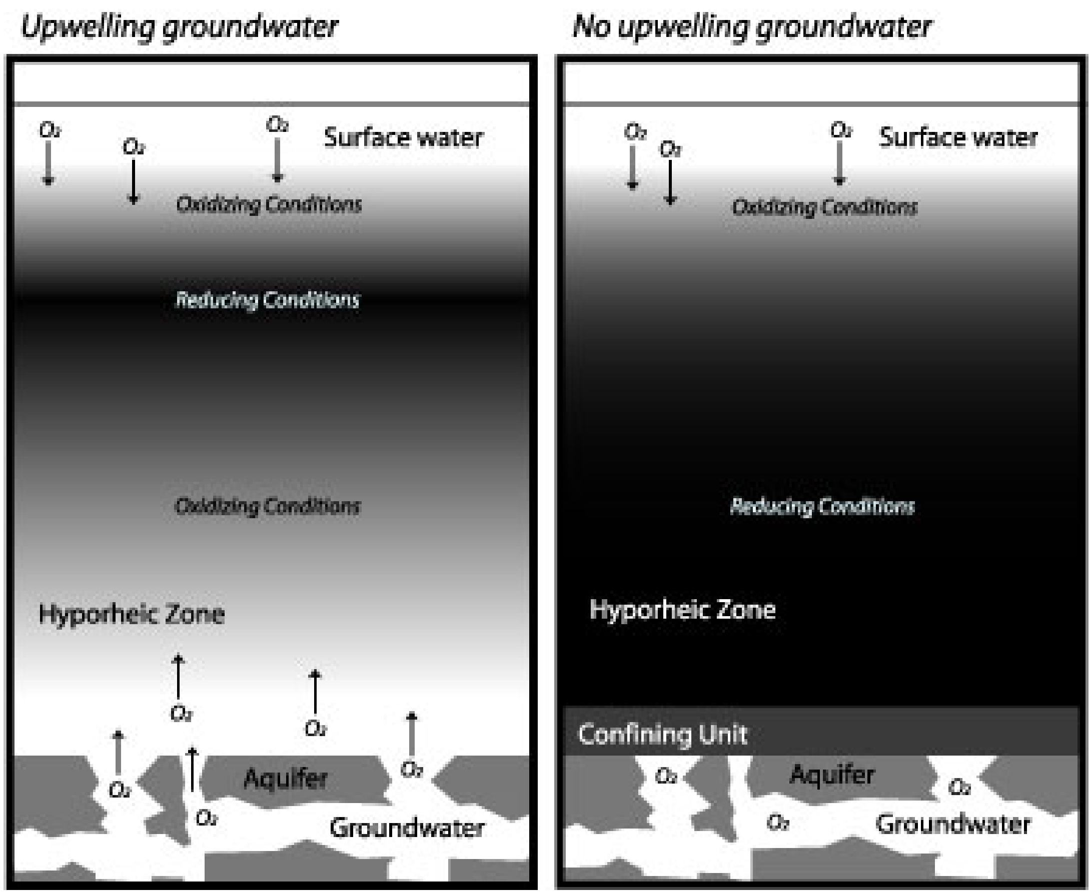


Figure 12.4 Conceptual diagram of subsurface conditions in the presence and in the absence of upwelling groundwater. With upwelling groundwater nitrate and selenium can be lost into the sediments without upwelling groundwater there is little opportunity for loss processes.

12.2 Selenium Speciation

Selenium has several redox species that can be found in natural waters and these different species are indicative of differing redox conditions on the source waters from which these samples originated. Filtered samples were analyzed for their dissolved content of the four selenium redox species as well as total selenium. Tables 12.1, 12.2, and 12.3 show the average totals and percentages broken down by site as well as overall averages for each water type. The average total selenium in groundwater was about 40 µg/L with nearly 90 percent of this in the form of selenate, the most oxidized form of selenium. Eight and two percent of selenium were found as selenite and organic selenium, respectively. The ratios were similar for surface water, which is expected since the base flow is groundwater dominated. However, the values do indicate that the surface water system is slightly less oxidized than the groundwater. The elevated levels of selenite are particularly evident downstream of areas that are heavily vegetated and have slow moving waters such as Peter's Canyon Wash at El Modena Irvine Channel (PCW@EMIC) and at San Diego Creek at Campus Drive (SDC@ Campus). This result suggests that the surface channels in particular locations have increased reducing conditions that may be creating more reduced selenium in surface waters. Additionally the increase in selenite may be indicative of increased retention of selenium in these areas of slow moving waters. This retention of selenium may be of biological concern as the increased selenium may lead to elevated selenium in the food web.

Except for surface water at Campus Drive on San Diego Creek, all storm flows contained small amounts of selenium (less than 3 µg/L) with 100 percent as selenate (Table 12.1). In contrast, the Campus Drive sample showed 22 percent of selenium as selenite. This result indicates that selenium in the form of selenite may be mobilized during storms from the retention basins located near the Campus Drive along San Diego Creek. The retention basins likely collect selenium during dry weather flows due to their relatively reduced conditions as evidenced by the elevated selenite levels observed at San Diego Creek at Campus Drive during dry weather flows (Table 12.3).

Table 12.1 Selenium speciation in storm water samples

Location	Total Se	% Se (IV)	% Se (VI)	% Org
CC @ PCW	0.00	0.00	0.00	0.00
EMIC @ PCW	1.96	0.00	100.00	0.00
PCW @ Moffett	1.93	0.00	100.00	0.00
SDC @ Campus	3.50	22.27	72.54	5.20
SFC @ PCW	2.75	0.00	100.00	0.00

Table 12.2 Selenium Speciation Groundwater Samples

Location	Total Se	% Se (IV)	% Se (VI)	% Org
CC @ Yale	20.19	4.57	94.19	1.24
DP @ PCW	38.33	18.51	78.37	3.12
Drain - PCW E. side N. of Warner	82.49	3.01	94.93	2.06
ECD @ PCW	129.08	0.99	97.27	1.73
PCW @ CC	114.04	8.04	91.05	0.91
PCW below CC	53.98	6.62	92.43	0.95
SDC @ Culver	4.47	20.87	79.11	0.00
SFC @ RR	19.59	3.66	95.10	1.24
Spring - PCW across from VD	20.24	4.24	93.93	1.82
Spring - SADC @ Irvine	8.99	11.42	84.06	4.52
Spring - SDC @ Culver	4.71	18.04	81.96	0.00
Spring - SDC @ Harvard	32.45	1.87	95.83	2.29
Spring - Seams - SDC @ Harvard	76.92	1.16	97.06	1.79
Sump - CC @ Culver	19.29	5.56	93.05	1.39
VD @ PCW	183.25	0.85	97.07	2.08
Weephole - CIC @ I3	13.34	5.23	90.66	4.11
Weephole - CIC @ I4	13.01	7.28	92.32	0.40
Weephole - CIC @ I5	13.87	5.05	92.58	2.37
Well - PCW N. of RR	47.23	8.95	90.71	0.34
Well 102N	2.17	29.48	70.52	0.00
Well 103N	13.15	7.05	91.70	1.25
Well 3 - LC @ Red Hill	24.85	2.43	80.34	17.23
Well 63S	44.20	3.75	94.21	2.04
Well 85W	12.04	13.02	85.58	1.40
Well 86N	26.54	3.39	94.94	1.67
Well 87N	7.31	9.99	90.01	0.00
AVERAGE	**39.45**	**7.89**	**89.96**	**2.15**

Table 12.3 Selenium Speciation Surface Water Average

Location	Total Se	% Se (IV)	% Se (VI)	% Org
BaC @ Alton	1.85	16.10	83.90	0.00
BaC @ Barranca	12.30	12.59	85.01	2.40
BaC @ Main	7.55	24.46	69.32	6.22
CC @ PCW	24.45	4.48	93.91	1.61
CC @ Yale	12.01	7.72	89.95	2.33
CIC @ Northwood Plaza on Trabuco	5.54	7.05	86.59	6.36
CIC @ PCW	6.32	6.18	59.12	1.37
Drain - CIC @ Yale	41.68	9.99	87.68	2.33
Drain - PCW @ Barranca	64.61	11.98	86.94	1.07
Drain - PCW @ Walnut	27.00	4.63	93.79	1.58
Drain - PCW W. side S. of Warner	41.73	4.51	93.96	1.53
Drain - SDC @ Harvard	33.62	2.09	96.24	1.67
EMIC @ 17th	3.95	11.58	82.61	5.83
EMIC @ El Camino Real	2.74	14.58	72.40	13.01
EMIC @ PCW	4.32	9.46	86.03	4.51
LC @ Main	14.50	8.36	90.61	1.03
LC @ McCabe/Jamboree	13.90	10.07	85.80	4.14
PCW @ Barranca	31.06	8.10	89.89	2.00
PCW @ EMIC	20.06	18.35	74.68	6.97
PCW @ I5	2.50	9.60	76.77	13.59
PCW @ Moffett	26.95	10.61	87.23	2.15
PCW below CC	18.82	19.59	75.10	5.31
PCW below SFC	27.43	14.07	84.01	1.92
SADC @ Irvine	8.43	11.78	82.84	5.38
SDC @ Alton	24.23	8.77	87.70	3.54
SDC @ Campus	17.23	19.05	76.76	4.19
SDC @ Coronado	24.60	7.64	89.49	2.87
SDC @ Harvard	4.26	11.77	88.23	0.00
SDC @ Marsh Inlet	21.14	11.92	82.88	5.20
SDC @ Michelson	21.98	9.50	86.82	3.68
SFC @ PCW	15.72	6.05	90.17	3.78
VD @ PCW	25.50	2.87	95.12	2.02
WD @ PCW	21.84	8.83	89.68	1.49
Well 5 - LC @ Red Hill	24.89	4.02	92.85	3.13
AVERAGE	**19.26**	**10.25**	**85.12**	**3.65**

12.3 Surface Water Fate of Selenium, Arsenic and Nitrate

The results of the peepers studies and the selenium speciation results both indicate that the surface channels of the San Diego Creek watershed are relatively reducing. Reducing conditions may cause a removal of nitrate from the water column of the stream of the watershed via the process of dentrification or through microbial and algal uptake. Selenium concentrations in the water column may also be reduced in the water column through the process of reduction and adsorption and precipitation or by microbial and algal uptake processes in the surface channels. To investigate this possibility we developed a simple mixing model of stream chemical composition for San Diego Creek at Campus Drive and have utilized this model to assess how much selenium, arsenic and nitrate is being lost from the water column of the streams of the San Diego Creek watershed as the water is transported from the groundwater and though the surface channels.

12.3.1 Description of Mixing Model Technique

Using the chemical composition of groundwater and surface water within the Newport Bay watershed it was possible to construct mixing models of stream chemical composition at San Diego Creek at Campus Drive. Traditionally median concentrations are used for mixing models [Hooper, 2003; Rice and Hornberger, 1998]. In order to keep the analysis as simple as possible groundwater was represented by a single groundwater composition for the entire basin using the median concentration from all samples taken. Identifying median "surface water" composition was more difficult. The intent of the analysis was to separate flow at SDC at Campus Drive into water exfiltrating from groundwater and urban or agricultural irrigation return flows. Preliminary analysis of the surface streams we have sampled indicated that Central Irvine channel at Peter's Canyon Wash and El Modena Irvine Channel at Peter's Canyon wash represented surface flows mostly influenced by irrigation (urban or agricultural) return flows since chemical analysis indicated little influence by the generally brackish groundwater. Additionally close surveys of both channels upstream of our collection points indicated that there was little groundwater influence.

The mixing models themselves were very simple. Essentially with only two end members the following two equations define a system of equations that can be solved.

$$1 = f_{sw} + f_{gw}$$

$$[K^+]_{tot} = f_{sw} * [K^+]_{sw} + f_{gw} [K^+]_{gw}$$

where f_{sw} and f_{gw} are the fraction of surface water and groundwater respectively at a given location and $[K^+]_{tot}$, $[K^+]_{sw}$, and $[K^+]_{gw}$ are the potassium concentration at the site and the potassium concentration in the surface water and groundwater end members. Since the chemical concentrations are known these two equations have two unknowns and are therefore solvable.

Several assumptions are inherent in this analysis. First, the assumption is made that the downstream site has a composition in between the two upstream sites. Second, it is assumed that the end members are stable in time and space. Third, it is assumed that the two end members are the only two end-members. It is rare for all of the assumptions to completely true. However the analysis affords several opportunities to verify the strength of these assumptions. For example ending up with a fraction greater than 1 or less than zero for the fraction from one end member indicates that the endmembers do not frame the sample collected at the downstream site. The end member analysis was done for several different species and the contrasting results afford the opportunity to investigate the assumptions made with this analysis and investigate the uncertainty in our analysis.

12.3.2 Mixing Model Results

Due to the very different chemical composition of groundwater and surface water in the San Diego Creek watershed it was possible to develop simple mixing models of the origin of water that is observed at San Diego Creek at Campus Drive (SDC). The purpose for this analysis was to identify how much of the export of nutrients and trace metals at Campus Drive was due to groundwater export versus surface water and also to identify what if any fraction of nutrients and trace metals exported from groundwater were lost, sequestered or retained in the surface water system after exfiltration from the groundwater.

The concept in these mixing models is that while we may not have solid flow numbers for all locations in the watershed we hypothesize that flow at SDC is some linear combination of two solutions one representing median surface water and one representing median groundwater. For our purposes median surface water was a combination of mean stream chemical composition for El Modena Irvine Channel at Peters Canyon Wash (EMIC) and Central Irvine Channel at Peter's Canyon Wash (CIC). EMIC is known to be dominated by urban flows while CIC is known to be dominated by urban as well as nursery runoff. The average of the two is assumed to be representative of all surface waters in the basin. Median groundwater was determined using the composition of all groundwater samples collected to date. Suitable chemicals to be used in the mixture modeling were then determined by graphical analysis. Chemical species for which the composition of groundwater and surface water did not bound the observations at SDC were ruled out as candidate species. Additionally species that were

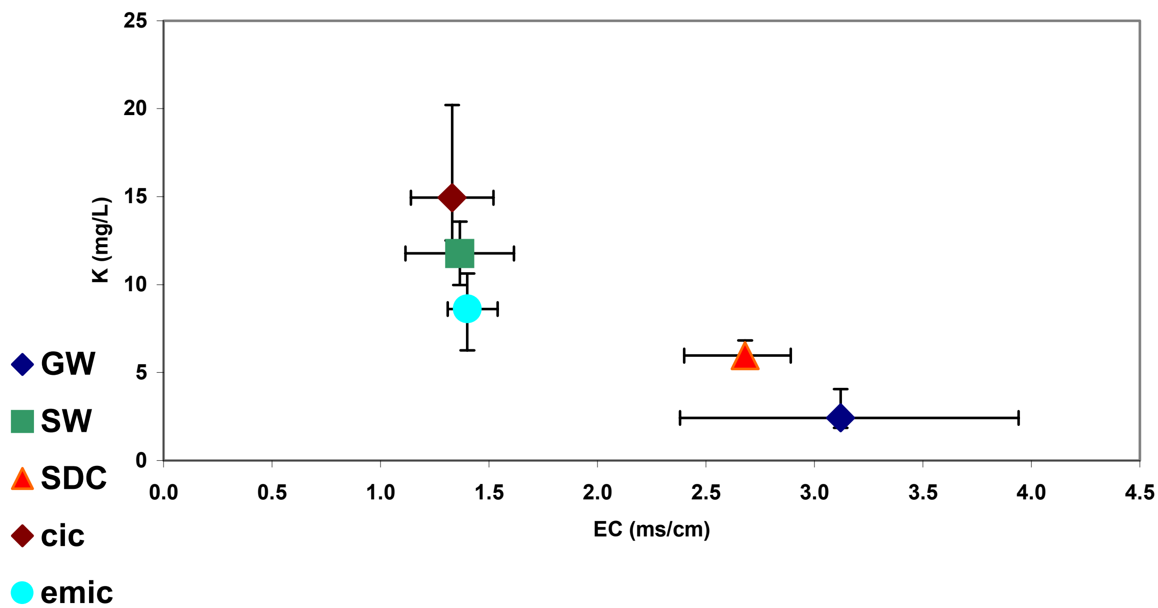


Figure 12.5 Graphical representation of mixing model for electrical conductivity and K^+ concentration. GW is median groundwater with error bars representin the first quartile of the data in each direction. SW is median surface water of EMIC and CIC channels with error bars of first quartile and SDC is median composition of SDC at Campus Drive.

not expected to be conservative, selenium, nitrogen, phosphorus, silica and arsenic were also ruled out for the mixing model.

Graphical display of the mixing models (Figure 12.5) aids in understanding the process at work in making our calculations. The mixing model results show that anywhere from 62 to 87% of the flow observed at SDC is coming from groundwater (Table 12.4). These estimates are an estimate but the number of chemicals used and the relative agreement between the results indicate that the groundwater contribution is a reasonable estimate of what is occurring in the basin. The overall calculations fit with what field observations indicate, that much of the water at SDC at Campus is from groundwater sources.

Table 12.4.. Median Groundwater, Surface Water and San Diego Creek at Campus Drive Composition

Type	EC (ms)	K (mg/L)	Mg (mg/L)	Na/Cl
Groundwater	3.1	2.4	99	1.18
Surface Water	1.4	11.8	37	0.90
San Diego Creek	2.7	6.0	91	1.13
Percent Groundwater at SDC@campus	75	62	87	83
Percent Surface Water at SDC @campus	25	38	12	17

Once the mixing analysis is completed it is then possible to estimate the percentages of non-conservative species such as nitrogen and selenium that are removed from stream flow between the surface water sources and groundwater sources and SDC at Campus. These estimates use the median composition of source waters (surface water and groundwater) and the assumed fractional contribution of groundwater and surface water to flow at SDC at Campus to predict what the composition at SDC at campus should be. These predictions are then compared to the composition observed at SDC at Campus Drive. The difference between the two is assumed to be a loss (gain) to stream chemical composition. The results from our mixing model showed a loss of about two thirds of the nitrogen, no loss for phosphorus, 48% for Si and 34% for selenium (Table 12.5). The size of the losses and the pattern of them indicate significant loss processes for nitrogen and Si in the watershed possibly mediated by denitrification in the case of nitrogen and algal production for Si. The smaller losses for selenium indicate that the selenium loss pathway differs at least somewhat from the loss pathway for nitrogen.

Table 12.5 Observed and Predicted Median Concentrations for Non-Conservative Constituents

Description	NO_3	TN	TP	Si	Se
Observed	5.3	6.4	0.14	9	15
Predicted	15	18	0.14	17	22
Consumed Mass (mg/L, ug/L)	9	11	0.00	8	8
Percent Consumed	64	64	0	48	34

Additionally since regulatory decision are made about total mass export (especially when it comes to nitrogen) the implications of the in-channel losses in the basin are significant since the channel losses may be ameliorating discharges of high nutrient groundwater and surface water. With an assumption that mean baseflow of streamflow at SDC at campus is approximately 8 cfs we can calculate how much mass of nitrogen is entering the bay. Using these assumptions and our median total nitrogen observation of 6.4 mg/L the result is current export to the bay is 50,000 lbs. Since groundwater contributed 76% of the flow and had a higher nitrogen concentration than the surface water sites we are using as an index 85% of the nitrogen in flow at SDC at campus can be ascribed to groundwater and thus ~42,500 lbs of nitrogen exported to the bay is from groundwater sources. Similarly for selenium calculations show that 96% of selenium arriving at the bay is from groundwater sources. This fraction is significantly higher than the number used in the original Toxics TMDL for the watershed (USEPA, 2002) that indicated perhaps 70% of the selenium in the watershed originated from groundwater. The results here indicate nearly all of the selenium in the watershed originates from the shallow groundwater source studied here. The cause of this is two fold, most of the water in the stream is from groundwater and the selenium concentrations in groundwater are significantly higher than the concentrations in urban, nursery or agricultural irrigation return flows.

We can also conduct a temporal analysis of the mixing models and thus determine how groundwater contribution and selenium and nitrogen loss varies across the seasons. These results indicate that groundwater contribution to surface flow at San Diego Creek at Campus peaks in the late fall and then declines during the winter and spring to rise the following fall (Figure 12.6). The loss pattern for nitrogen in the stream indicates the greatest losses are during the summer and that net loss of nitrogen occurs during the winter but is relatively small (Figure 12.7). The same result is also true of selenium. The summer period shows the greatest loss of selenium from the stream but during the winter there appears to be a net gain of selenium from the stream as water flows downstream (Figure 12.8). This mid-winter gain of selenium in the streams according to our calculations may explain the seasonal pattern of selenium concentration in San Diego Creek with peak selenium concentrations observed during the winter (Figure 12.9). The seasonal pattern for both indicates a biological loss pathway for nitrogen and selenium. The net gain during the winter for selenium however indicates that selenium is being immobilized in the watershed whereas nitrogen appears to being lost completely. This result indicates that most probably nitrogen loss is via denitrification whereas selenium loss is via temporary biological immobilization possibly via algae. We have limited algal data from samples collected in March of 2003 that indicates algae are taking up significant amounts of selenium with concentrations varying from 1.9 mg/kg dry weight to 5.9 mg/kg and an average composition of 3.7 mg/kg dry weight. This data is not exhaustive though and total selenium uptake in algae cannot be calculated. The data does indicate significant concentration of selenium in algae within the watershed. This algae may be a food source for insects and from there avian species and may represent a cause for concern in the watershed. Further studies on algal uptake in the watershed are warranted.

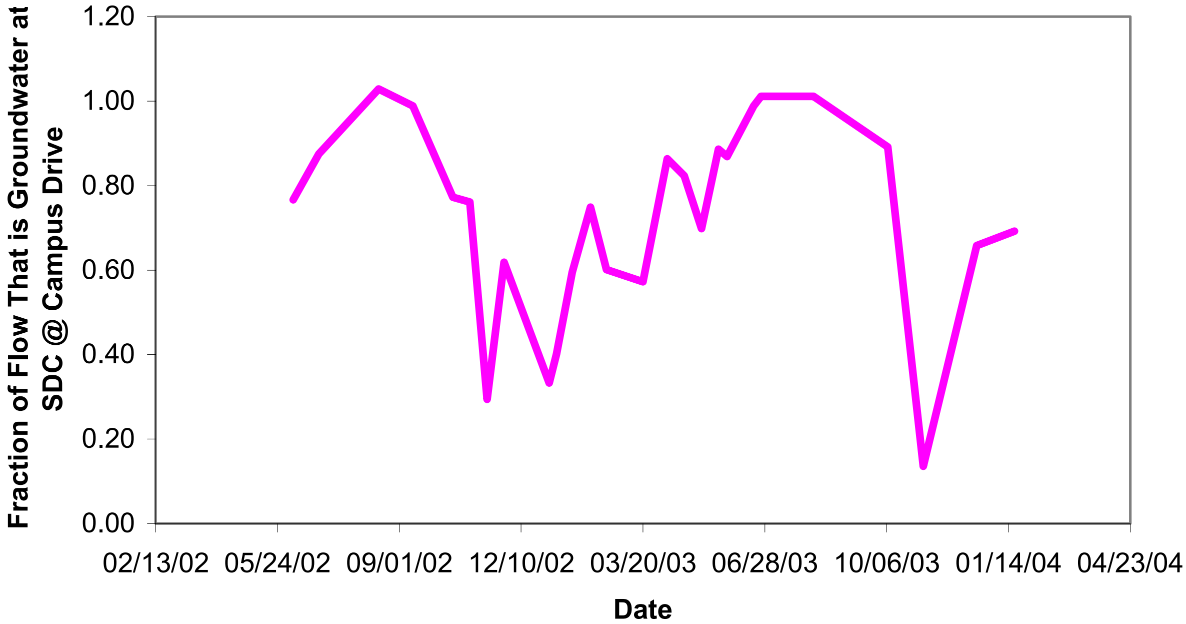


Figure 12.6 Figure shows fraction of flow at San Diego Creek at Campus Drive sampling site that is derived from groundwater . Contribution peaks in the summer and late fall and declines in winter especially during storm events.

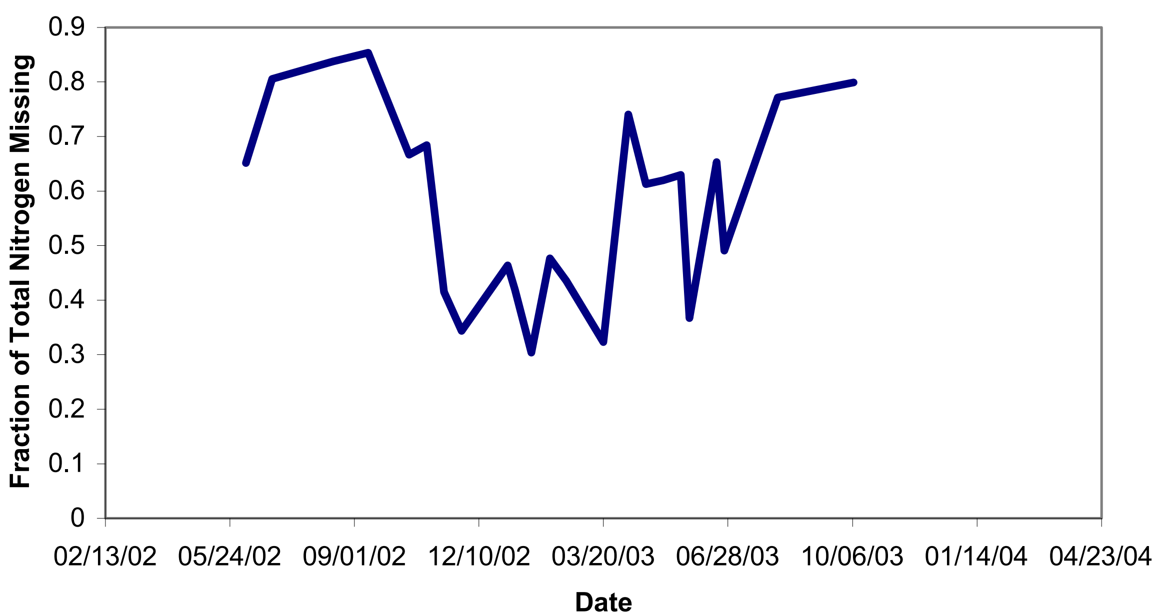


Figure 12.7 Graph shows fraction of predicted nitrogen that does not appear at San Diego Creek at campus drive a low value indicates most of nitrogen expected at the sampling site is present in the actual sample collected. Peak losses are in summer indicating a biological pathway somehow connected to sunlight and temperature

The implications of the in-stream losses are important. If there were no in-stream losses, as we have calculated, the bay would be receiving 125,000 lbs of nitrogen per year during baseflow conditions (since wet weather flows are excluded this is all that really matters) and selenium concentrations would be 22 ppb as opposed to the observed 14 ppb. Thus these in-stream loss of nitrogen and selenium are important and relevant to any regulatory decisions made in the basin. The in-stream losses are also important to contemplate as decisions are made about the form and nature of the streams and channels of the watershed. As a side note our analysis does not indicate where the selenium and nitrogen are going. Based on communications with IRWD (presentation Sept. 10 to watershed stakeholders) it is likely that a significant fraction of the nitrogen and selenium lost is occurring in the IRWD treatment wetlands. Also while the loss of nitrogen should probably considered a net positive to water quality in the basin the loss of selenium is more worrisome as it may indicate the buildup of selenium within the and the possible effects that that may have on the food web. Additionally the restoration of relatively natural stream conditions through an active restoration program might increase the amount of nitrogen removed from the water column and thus improve water quality in the watershed. It should not be forgotten however that restoration might also increase selenium loss, which due to possible biological impacts may not be such a good thing. We have collected very limited data on in-stream sediments and algae but the data we do have indicate that selenium concentrations are elevated in the algae collected within the watershed and thus some level of biococentration occurring via algal uptake of selenium from the water column.

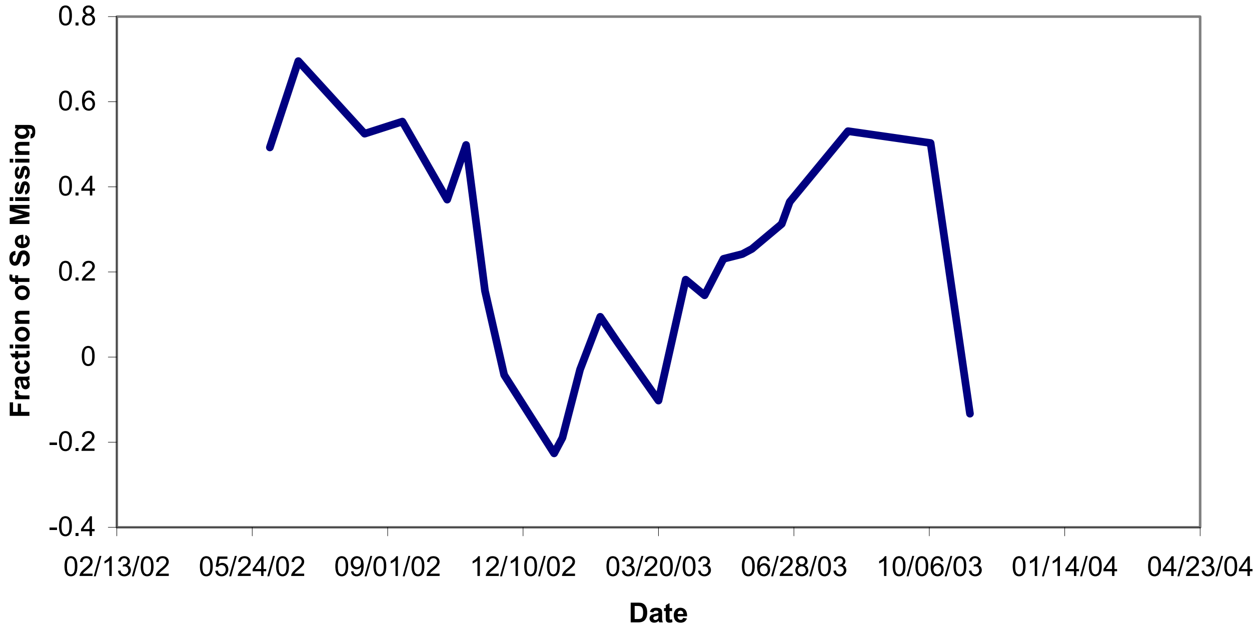


Figure 12.8 Graph shows fraction of predicted Se that does not appear at San Diego Creek at campus drive a low value indicates most of Se expected at the sampling site is present in the actual sample collected. Peak losses are in summer indicating a biological pathway somehow connected to sunlight and temperature. Winter values indicate production of Se in the stream during the summer indicating a remobilization of Se fixed during the summertime

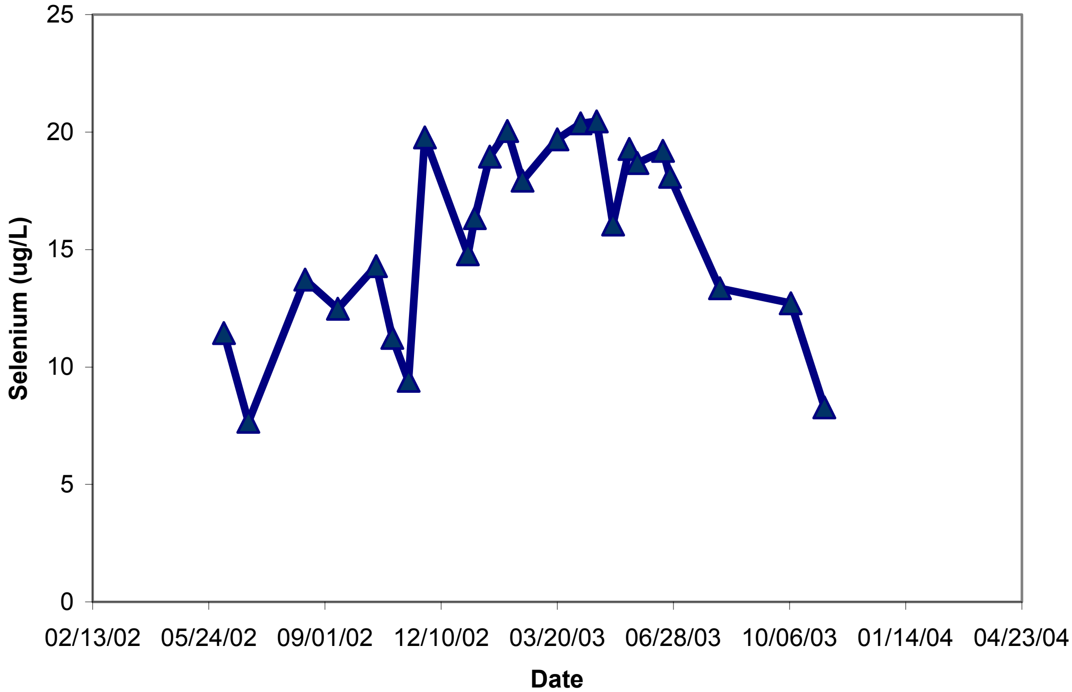


Figure 12.9 Time series of Selenium concentration for San Diego Creek at Campus Drive

Chapter 13 Integrating the Groundwater Story

A large majority of the selenium, arsenic and nitrogen reaching Newport Bay originates as groundwater within the basin. We set out to answer four questions regarding these contaminants and their origin in groundwater. These questions were –

1) Where do the selenium, arsenic, and nutrients originate from spatially?
2) What processes mobilize these out of the subsurface?
3) Where does the water come from that transports these contaminants?
4) What is the fate of these mobilized contaminants?

In this discussion of our results we will take each one of the questions in turn. Additionally our study has lead to significant questions regarding specific detailed questions among the broader themes represented by these four questions and we will outline these areas in need of further study at the end of this chapter.

13.1 Spatial Origin of Selenium, Arsenic and Nitrogen

Within this shallow groundwater system however the concentrations and thus loading of selenium, arsenic and nitrogen are significantly variable and it this variability that is critical to understanding the impact of the shallow groundwater system on surface water quality in San Diego Creek and Newport Bay. The variability is also important in any active or passive decisions that might be made to manage surface water quality in the watershed. The variability of nitrogen in the groundwater system appears to be somewhat independent of the variability in the two trace elements under study, selenium and arsenic. The on exception to this general independence for nitrogen concentrations is the negative correlation between nitrate concentrations and selenium arsenic concentrations in Figure 6.6.

Other than this exception the general pattern of inorganic nitrogen (since ammonium and organic nitrogen are almost non-detectable in groundwater samples within the basin inorganic nitrogen is roughly equal to nitrate nitrogen concentrations) is that the highest concentrations of nitrogen are generally located at the positions in the watershed with the lowest elevation and hydraulic head (Figure 6.4). Additionally the groundwater residence time results Table 11.1 indicate that the groundwater being released in the seeps, springs and wells sampled at these lowest locations is also among the oldest within the watershed. Together these observations indicate that nitrate contamination in the groundwater system is a result of historic agricultural and land conversion practices within the watershed. Fortunately this result indicates that nitrate concentrations are likely to decrease in the groundwater released to surface waters over time. This trend may be even more dramatic in the future as the nitrogen in the groundwater probably originated during historical agricultural production of citrus in the basin. Since agricultural area in the watershed is decreasing it might also be expected that recharge of nitrate rich waters is also decreasing. However existing agriculture in the watershed and the industrial nursery operations in the watershed may still be recharging relatively nitrate rich waters to the groundwater (Hibbs, 2000, and French 2003). However due to the location of the nurseries and remaining agriculture it is likely that these waters recharge deeper aquifers than the shallow one studied here.

As for selenium and arsenic the origin of these trace elements within the watershed and their exact prevalence in the groundwaters of the basin is considerably more complicated. The spatial location of high arsenic and selenium concentrations within the watershed (Figures 6.2 and 6.3) supports the prior and herein supported hypothesis that the majority of the selenium and arsenic in groundwater originate in sediments in and around the historic Swamp of the Frogs (Figures 1.2, 6.2, and 13.1). Portions of our story indicate though that particularly the areas with the highest arsenic and selenium concentrations are actually in areas that were on the fringe of the historic Swamp of the Frogs (Figurse 6.6, 13.1) and in particular these areas on the fringe appear to be areas that were variably saturated during the period prior to development due to the presence of brown and yellow mottling in the soils at the fringe (Orange County Soil Survey, 1976).

These areas on the fringe of the swamp are generally denoted as the Omni soil series while the soils in the heart of the swamp are in the Chino series. The mottles indicate that along with variable saturation came varying redox conditions as is also evidenced by the boundary between positive and negative δS values at the boundary between the Omni and Chino soil series

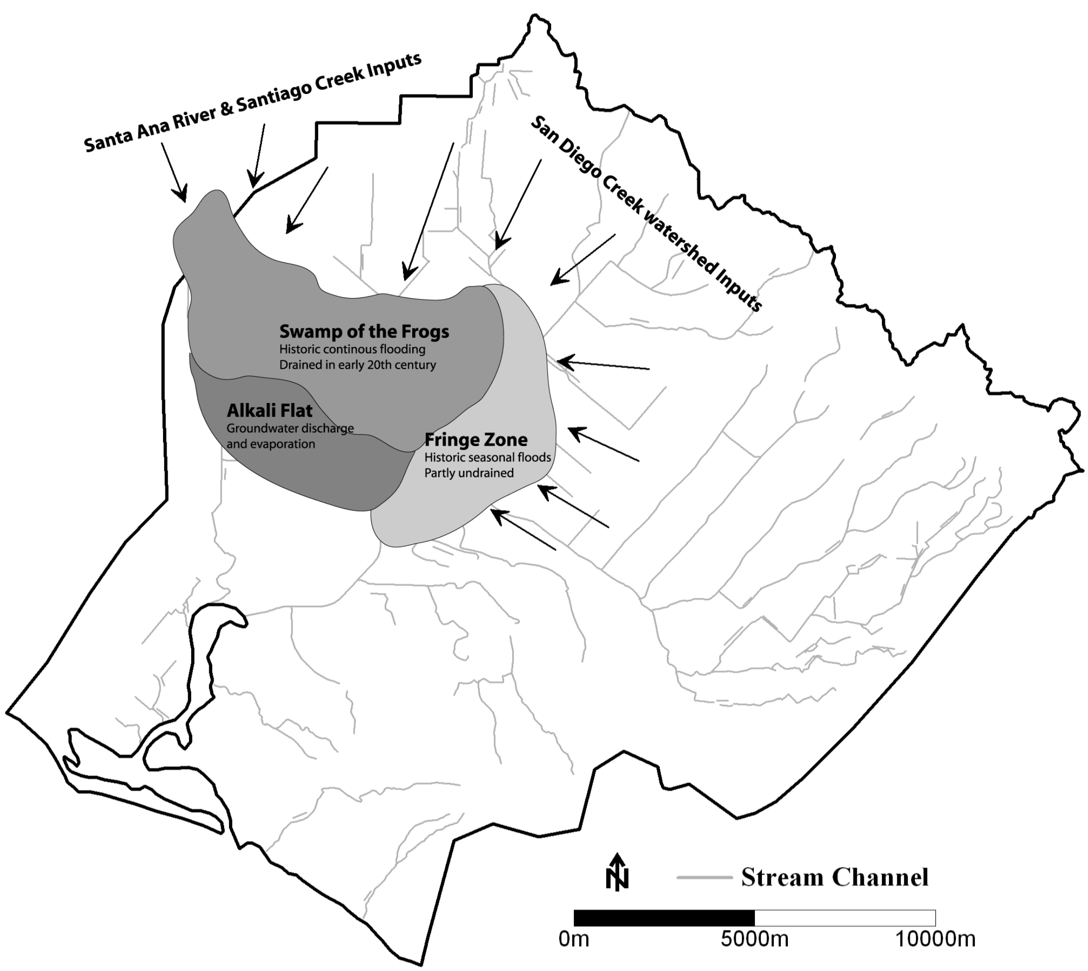


Figure 13.1 Diagram of possible historic conditions in the San Diego Creek Newport Bay watershed. Alkali flats are located where Lane chanell is today. Peters Canyon wash runs along the boundary between the fringe zone and the Swamp of the frogs. Boundaries and shapes of areas largely determined using Chino and Omni soils series in 1978 Orange County Soil Survey.

(Figure 13.2). The Chino series is dominated by negative δS values while the Omni is dominated by positive values. The exception for the Omni series is the area of Omni that coincides with the alkali flat area described by Trimble and that the evidence from along Lane Channel that illustrates that this area was the discharge zone of the groundwater within the Swamp of the Frogs (Figure 13.2). Additionally the areas of either Chino or Omni that were not drained prior to the 1976 soil survey are the areas where we generally see the highest selenium and arsenic concentrations (Figure 13.3).

These characteristics then define where high concentrations of selenium and arsenic are found within the San Diego Creek watershed. The historic swamp has elevated concentrations but the areas of Omni either the alkali flats or the fringe area of the historic swamp have the highest concentrations of selenium in groundwater with the area along Lane Channel not having high arsenic concentrations and the area along Peters Canyon Wash having high concentrations of arsenic. We should note however that nearly all groundwaters sampled in the basin have concentrations of selenium about 5 ppb and thus the entire groundwater body is of concern to surface water quality and biotic health. Some areas are merely of more concern than others.

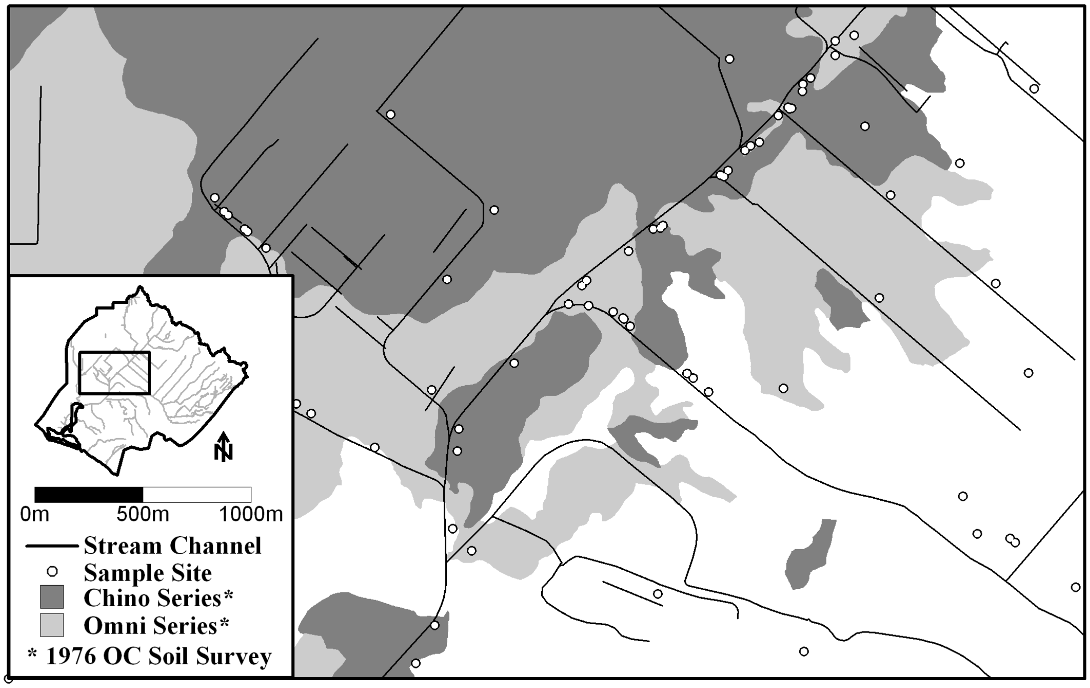


Figure 13.2 Mapped areas of Chino and Omni soil series. Chino was a grey soil wheras Omni had prominent brown and yellow mottles indicating that the Chino soil was continuously reducing during formation wheras the Omni soil underwent both reducing and oxidizing conditions during formation.

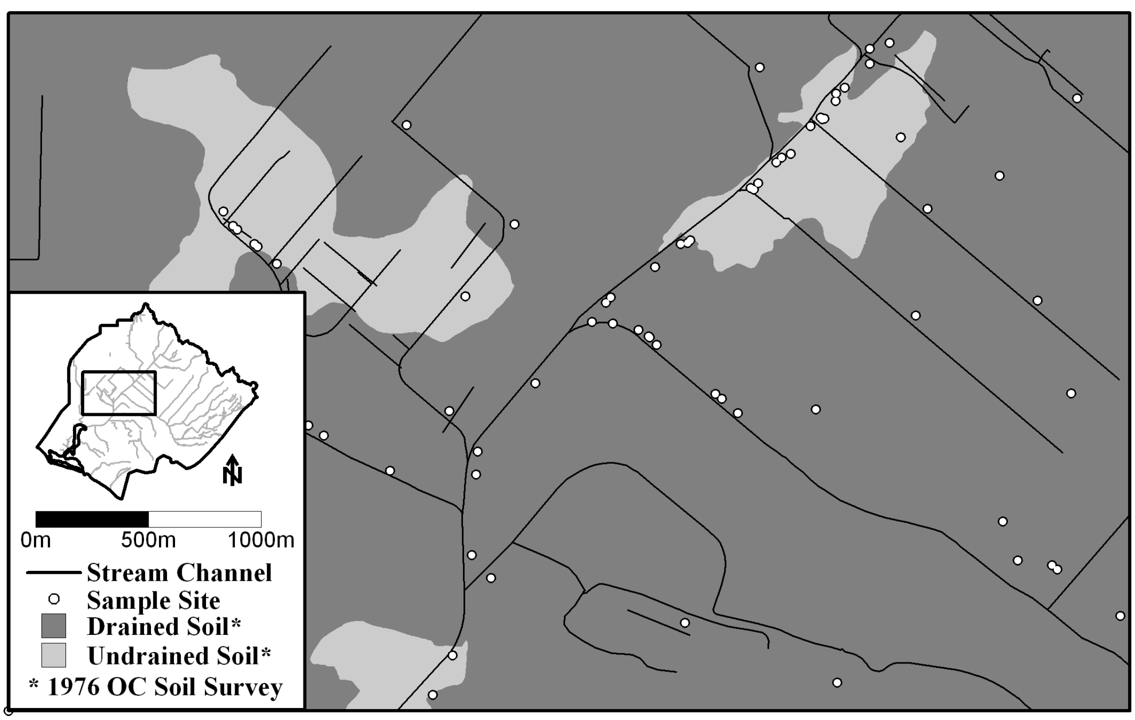


Figure 13.3 Map shows areas of drained and undrained soils in the heart of the watershed. Soils that were undrained as recently as 1976 also show up prominently in our groundwater sampling data as areas where significant quantities of selenium and/or arsenic are being released into the groundwater and surface waters of the watershed (Figure 3.3.1 and 3.3.2).

13.2 Processes Mobilizing Selenium, and Arsenic

While knowing where high selenium, arsenic and nutrient concentrations are found within the watershed is valuable it is also important to understand what are the processes mobilizing these contaminants into surface waters. As already discussed the nitrogen in groundwater is likely a historic agricultural problem with some indications from others that the high nitrate recharged to groundwater may be continuing (French, 2003).

The evidence in this study supports the prior hypothesis that pyrite oxidation is the ultimate source of much of the selenium and arsenic within the watershed. This result is supported by the correlation between sulfate and selenium where concentrations are high (Figure 10.6) and the collocation of high selenium concentrations with the negative δS values found in the historic Swamp of the Frogs and the alkali flats that were located in the area not dissected by Lane Channel (Figure 9.7). This story however does not help to fully explain the high selenium and arsenic found in areas with positive δS values where in fact the highest concentrations are found (Figures 6.2, 6.3, 10.13, and 10.15). This portion of the story seems to be better supported by dynamic conditions in the fringe of the historic swamp which might have encouraged cycling between reduced and oxidized states of selenium and arsenic that others have shown can accumulate both selenium and arsenic [Frankenberger and Benson, 1994; Polizzotto et al., 2003].

Conditions today support that most of the selenium and arsenic that is being mobilized is coming from vadose zone flushing as opposed to mobilization by the groundwater as it moves through the aquifer material. This hypothesis is supported by our results but certainly not conclusively proven. The redox chemistry of selenium and arsenic as well as the sorption preferences of arsenic both appear to be playing a role in the when and where of mobilization of selenium and arsenic in the subsurface. Mobilization of the arsenic in this area appears to be fostered by competitors with arsenic for adsorption sites in the vadose zone particularly in the area of highest arsenic concentrations in the subsurface where silica concentrations are also high (Figures 6.3 and 10.3). Additionally preliminary extraction results (Table 10.2 and 10.3) for the soils in this area indicate that most of the selenium is in the residual extractions (possibly pyrite or elemental selenium) and much of the arsenic is found in the adsorbed fraction. The results along Lane channel further support these conclusions as they show that the selenium appears to simply be leached out of the soil while the arsenic while present does not appear to be mobilized but without adsorption site competitors appears to stay in place (Figure 9.6 and Tables 9.1 and 9.2).

While the groundwaters of the watershed are somewhat oxidizing the presence of trace metals generally mobile under reduced conditions (molybdenum and vanadium) appears to indicate that the groundwater is at least somewhat reducing. Since the selenium in groundwater is mostly in the form of selenate (Table 12.1) it appears likely that this selenium was mobilized out of the vadose zone where oxygen is significantly more plentiful. The vadose zone flushing hypothesis is further supported by our results showing an dramatic increase in selenium and arsenic in the groundwater around Valencia drain after the winter of 2003's significant rain event. These samples showed an increase in selenium to the highest levels observed at this location coincident with the peak groundwater stage at well 103N (Figure 7.6).

13.3 Water Mobilizing Selenium, Arsenic and Nutrients

Given our hypothesis that most of the selenium and arsenic being mobilized in the subsurface of the watershed is being flushed out of the vadose zone the important question then becomes where is the water coming from that is recharging the groundwater system of the watershed. This story appears to be a much simpler story than the story of what processes are mobilizing the selenium and arsenic out of the groundwater. Collectively our evidence points to the groundwater being from pluvial recharge directly to the aquifer surface. The two main pieces of evidence are the fact that groundwater responds rapidly to winter rains (Figure 8.4) and the fact that the isotopic signature of groundwater in the basin is generally similar to that of mean annual local rainfall Figure 11.3 [Williams, 1997; Williams and Rodoni, 1997]. In general the samples do not show evidence of imported or outside of basin water except for a few samples along Santa Ana Dehli Channel and Lane Channel which indicate some influence of Colorado River water. The Irvine Ranch Water District imports this water into the watershed and the occurrence of this water in the groundwater system does indicate that irrigation water has the potential to recharge the groundwater system.

Still the overall conclusion to be drawn from our results is that for the most part the water found in the groundwater system originated from pluvial recharge of rain water that infiltrates directly to the land surface. There is some uncertainty over the fact that the recharge might either occur at the mountain front of Loma Ridge and the coast range since these would likely result in similar isotopic signatures but the rapid response of the groundwater system to rainfall indicates a more vertical structure to the recharge and flow system since recharge at the mountain front would not be expected to result in the relatively instantaneous response that we observe in groundwater elevations within the watershed. Additionally the mountain front areas where nursery operations and agricultural operations in the watershed occur likely deliver recharge to deeper aquifers and not the shallow aquifer studied here due to the likely coarse-grained sediments located in this area.

13.4 Fate of Mobilized Contaminants

The final important question that can be addressed with our results is what happens to the selenium, arsenic and nutrients once they are mobilized from the subsurface of the groundwater system. For this question we have shown that the groundwater contribution to surface water increases during the rainy season through our baseflow studies which showed a significantly contribution of groundwater to gaining baseflow in the area around Peters Canyon wash and Como channel than the same reach during the rainy season (Figure 8.2 versus Figures 8.1 and 8.3). This result along with the results from our mixing model results indicate that winter rains increase groundwater recharge and then cause an increase in the degree of groundwater influence on the surface system (Figure 12.6). The mixing model results showed the least influence of the groundwater on the surface water system during the late fall and early winter (low groundwater combined with storm event dilution most notable around December 10th). And the greatest groundwater contribution in early summer no storm water dilution and high groundwater stage and contribution.

This pattern of higher groundwater contribution in early summer should result in the maximum selenium concentrations also occurring at this same time. This is not the case however (Figure 12.9) since our data shows that selenium concentrations appear to peak in the late winter. This result is best explained by referring back to the mixture modeling results again and seeing that during the winter we showed the surface water system (stream and near stream area most likely) acting as a source of selenium to the stream at San Diego Creek at Campus Drive (Figure 12.8). Additionally the stream appears to act as a significant sink for selenium during the summer time. This pattern of wintertime source not explained by the mixing model and summer time sink similarly not explained indicates that there is some loss process in the stream system that is consuming selenium in summer and releasing it in winter. Our limited algae data (averaging 3.7 mg/kg dry weight in the algae) and the well known literature supported result (e.g. [Riedel et al., 1991]) that algae can bioaccumulate selenium indicates that the summer time sink is likely assimilation by the productive algal communities in the streams of the watershed. The results for silica also support the algal hypothesis since some species of algae are known to take up silica to develop their cellular structure. It is also possible that some of the selenium lost in the summer and re-released in the winter is bound in stream sediments of the watershed but this was not investigated in this study. This pathway is somewhat supported by the greater presence of selenite than selenate in the surface waters of this watershed than what was seen in groundwater (Tables 12.1 and 12.3). The presence of selenite indicates at least somewhat reducing conditions that might encourage the loss of dissolved selenium to sorption processes or possibly to reduction and immobilization to elemental selenium. Arsenic does not have a general sink between being released from the groundwater and arriving at the Campus Drive sampling location so whatever the removal process is for selenium it does not appear active with arsenic (results not shown).

Nitrogen shows a somewhat different pattern than selenium. The sink for nitrogen in the stream system of the watershed is significantly larger with 64% of the nitrogen removed as opposed to only 34% of the selenium (Table 12.4). Additionally the nitrogen sink does not completely disappear in winter and is much stronger in summer with the sink removing almost 90% of the nitrogen that we would expect to see at Campus Drive (Figure 12.6). This difference indicates that the nitrogen loss process is most likely a denitrification loss process that would be a permanent loss of nitrogen from the stream system. This hypothesis is additionally supported since the results for phosphorus (Table 12.5) indicate no loss of phosphorus in the stream system indicating that the algal pool is not significantly decreasing the phosphorus load which it would if the loss of nitrogen were all form algal uptake since algae must take up phosphorus as well as nitrogen during their growth.

As a whole these results on the fate of selenium and nitrogen in the stream system of the San Diego Creek watershed have a positive value for stakeholders in the watershed and a negative value. On the positive side the loss of nitrogen in the stream system (which includes the Irvine Ranch Water Districts treatment wetlands next to the Michaelson treatment plant) significantly improves surface water quality and helps the basin reach the TMDL standards that have been set. The sink and re-release of selenium however is a cause for concern. Along with our limited algae data our results indicate a potential bioaccumulation of selenium within the stream system including the treatment wetlands. This accumulation does not appear to have yet affected biota (personal communication Jim Baird) but the problem should be carefully watched as the potential damage to threatened and endangered species and public good will might be significant if a problem were to develop. Additionally just because we do not observe impacts on biota does not mean they are not occurring as impacts on reproduction may not always be readily apparent as the only impact may be reduced fertility but complete elimination of fertility in many bird species.

13.5 Possible actions to improve water quality

The results presented here and the hypothesized mechanisms controlling the release, transport and fate of selenium, arsenic and nitrogen in the San Diego Creek watershed indicate several actions that could be taken to improve the water quality of the watershed and reduce adverse impacts on the biota of the watershed and Newport Bay. The possible actions fall into several categories including: hydrologic mechanisms of reducing selenium, arsenic and nitrogen mobility, biogeochemical mechanisms for limiting mobility or preventing arrival in surface channels, development of sink processes in the watershed for selenium and separate sink systems for nitrogen. Discussion of each of these alternatives will be taken in turn.

Decreasing infiltration and recharge within the watershed would probably result in a similar decrease in recharge to the groundwater and thus smaller volumes of groundwater would have to be dealt with by the other means mentioned above. Decreased recharge might also result in decreased availability of oxygen to weather pyrite and thus decrease delivery of selenium, arsenic and nitrogen to the groundwater system. This decrease in oxygen would be because a decreased flux of recharge water will not be able to carry as much oxygen into the groundwater system as the current higher rates of recharge. The question is how to decrease recharge in the most effective and efficient manner. One of the most effective strategies would probably be to effectively cap the entire watershed with asphalt. This approach would obviously be an extreme solution and not one that would be recommended for other reasons, such as increased flood hazard. However in the areas overlying the Chino and Omni soil series it is probably reasonable to request that development include the maximum area of impervious cover and reduce the area that is vegetated to a minimum. These two soil series intersect with much of the shallow groundwater and seem to be the source of much of the selenium and arsenic arriving in surface waters. Anecdotally it appears that construction of the Irvine/Tustin Marketplace may have decreased recharge in this area of the basin and lead to less export of selenium out of the subsurface (this is based on comparisons with the data from Hibbs and Lee 2000). Obviously keeping impervious surfaces to a maximum needs to be weighed against the other environmental consequences of such an action.

Changing biogeochemical conditions in the subsurface or before water reaches the surface channels would also be a mechanism for less release of selenium, arsenic and nitrogen to surface waters. Two main mechanisms exist for achieving this goal. First increase electron donor concentrations in the aquifer. Second reducing dewatering operations and cement lining of channels to permit contact of groundwater with the reducing conditions present in the subsurface of the channels prior to release into the surface channels. Current dewatering operations take water from the aquifer and deliver it directly into the channels decreasing groundwater residence time and decreasing contact with reducing conditions in the aquifer. Increasing electron donors in the aquifer would probably cause more reducing conditions to exist in the aquifer and since selenium and arsenic are immobile when reduced and nitrogen undergoes denitrifcation in reducing conditions either mechanism would reduce selenium, arsenic and nitrogen concentrations in the surface streams. Adding electron donors to the subsurface would be difficult and we know of no attempts to actively encourage this to happen. However it has been shown that dissolved organic carbon (DOC) concentrations do increase where soil organic matter is higher. Therefore within the watershed use of dairy manure and other organic amendments should be encourage as it is at least conceivable that this might increase DOC and therefore electron donor concentrations in the subsurface. Additionally the reduction of dewatering operations and the limiting of full concrete channel lining would allow more water to come into contact with the known reducing conditions in the near channel environments (Figures 12.1, 12.2, and 12.3). However it is not known if selenium that would be immobilized in this zone would remain out of contact with biota and so the question should be investigated further.

Finally, the construction of sinks for nitrogen and selenium in the watershed should be considered since some nitrogen and selenium will continue to reach the surface waters of the watershed no matter what actions are taken. Construction of selenium sinks should take into account the need to keep the selenium removal system out of contact with land surface biological activity. Such a project is currently under investigation by the Irvine Ranch water District (the Natural Treatment System) and should be pursued with all due care. Nitrogen sinks in areas where selenium concentrations are low could be above ground and simply be well vegetated riparian buffers and ponds not to dissimilar from the current IRWD wetlands adjacent to the Michaelson plant.

13.6 Questions in Need of Further Study

Several questions were either beyond the scope of this study for scientific or operational reasons. Each of the following areas is in need of further study considering our results.

1) The in stream loss of nitrogen and selenium in the watershed appears to be significant. Some future study should at least try to tentatively quantify the relative importance of temporary biological assimilation to denitrification and also try to quantify how much of the selenium is bound in sediments and removed from biological activity and how much is later re-released to the water column as our results here indicate.
2) Additionally with the above study the stream sediments of the basin should be characterized to investigate where and how much selenium might be located in these sediments. Given the similarity in methods the same study should try to do a more exhaustive investigation of selenium and arsenic contents and forms in the sediments that makeup and overly the shallow San Diego creek aquifer.
3) For access reasons this study was not able to access the Tustin Marine Corps base. Due to different climate conditions it is difficult to compare the base closure data and the data we have collected. Still from the base closure reports it is apparent that the base does have elevated selenium and arsenic concentrations. The pattern of their data does not match well with the hypotheses we have put forward here so a more detailed investigation possibly limited to the base closure documents should be pursued to understand what the geochemical and hydrologic mechanisms of selenium and arsenic mobility on the base might be.
4) Finally, there is a need for a detailed coupled groundwater/biogeochemical model of the groundwater system linked to the surface streams to understand how different possible management regimes and hydrologic and biogeochemical hypotheses might impact surface water quality in the basin. Such a study is currently underway using Proposition 13 funds as such a coupled model would a useful piece of scientific and technical infrastructure for the Newport Bay/ San Diego Creek watershed.

Chapter 14 Overall Conclusions

The sources of selenium, arsenic and nitrogen were carefully investigated within the San Diego creek Newport Bay watershed. Much of the selenium, arsenic and nitrogen that flows through San Diego Creek at Campus Drive appears to be derived from a large shallow groundwater aquifer located in the heart of the basin. The nitrogen from this aquifer appears to be a legacy contamination issue from historical agricultural practices in the watershed. The selenium and arsenic appear to be flushed out of the vadose zone during recharge events and then gradually travel through the aquifer before arriving at the surface channels. Elimination of stream buffers or diversion of water from the aquifer directly to the surface channels for the purposes of dewatering decrease the likelihood that export of selenium, arsenic or nitrogen can be diminished by processes prior to arrival in the stream. Immobilization and elimination processes in the streams do appear to dramatically reduce loadings at San Diego Creek at Campus Drive of nitrogen and selenium. The nitrogen loss is all for the good while the selenium lost may be accumulating in the watershed only to create biotic problems at a later date. As for the other two major unaccounted for sources of nitrogen, selenium and arsenic atmospheric deposition and open space: atmospheric deposition appears to play a minor role in loading of nitrogen to the bay surface, while open space does not appear to be of great concern at this time.

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Appendix A List of Channel Names and Acronyms

BaC Barranca Channel

BoC Bonita Creek

CC Como Channel

CIC Central Irvine Channel

DP Denitrification Plant

ECD Edinger Circular Drain

EMIC El Modena Irvine Channel

GWD Groundwater Discharge

HCW Hick's Canyon Wash

IRWD Irvine Ranch Water District

LC Lane Channel

PCW Peter's Canyon Wash

SADC Santa Ana Delhi Channel

SCW Sand Canyon Wash

SDC San Diego Creek

SFC Santa Fe Channel

SJC San Joaquin Channel

VD Valencia Drain

WD Warner Drain

Appendix B - Chemical and Physical Analyses for This Study
Data is also available on a read only basis at https://soilsa120a.ucr.edu/data

First set of sheets is for commonly assessed parameters.

Second set of sheets is for chemical and physical parameters assessed less frequently.

sample id	site	location	Sample Date	Type	Temp	pH	EC (ms)	D.O.	Q	alk	Ca	K	Mg	Na	Sr	Si	Se	As	Cl	SO4	NO3-N	NH4-N	PO4-P	TN	TP	volume
			mm/dd/yyyy hh:mm		deg_c		ms/cm	mg/L	CFS	mg CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml
2060013	SDC @ Campus	SDC @ Campus	06/06/2002 11:00	su	24.00	8.15	2.71			248.73	120.16	11.49	88.00	387.79		4.24	11.45	3.28	312.76	783.03	3.16	0.20	-0.02	5.63	0.06	
2060014	SDC @ Culver	SDC @ Culver	06/06/2002 11:42	su	26.00	8.19	2.16			284.69	172.28	4.31	55.78	241.32	1.04	19.45	2.74	3.10	282.34	397.37	17.61	0.05	0.05	18.05	0.02	
2060015	PCW below SFC	CC @ PCW	06/06/2002 13:30	su	28.90	8.60	2.60		0.58		113.73	4.01	104.47	349.44	1.22	21.03	17.64	13.57	274.18	613.24	13.83	0.08	0.05			
2060016	PCW @ CC	PCW @ CC	06/06/2002 13:00	su	27.90	8.72	1.79				102.43	10.42	52.27	275.98	0.84	12.38	14.69	2.44	182.12	440.86	4.91	0.07	0.33			
2060017	PCW @ CC	Weephole 1	06/06/2002 13:00	gw	23.60	7.46	3.66				122.25	4.06	115.32	613.63		20.96	102.12	27.33	294.31	936.36	9.74	0.02	0.12			
2060018	PCW @ CC	Weephole 2	06/06/2002 13:00	gw	24.30	7.25	3.87				196.84	5.73	119.98	564.79		17.75	59.08	12.78	371.24	1203.56	9.59	0.05	0.09			
2060019	SFC @ RR	Weephole - first under road	06/06/2002 14:10	gw	23.60	6.86	2.78				336.23	4.38	103.75	187.52		11.84	26.46	0.13	182.95	1054.68	21.51	0.02	0.04			
2060021	SDC @ Valley Oak	SDC @ Valley Oak	06/13/2002 11:00	su	23.30	7.41	2.00			264.59	153.29	9.14	51.54	228.69	0.96	18.22	0.71	6.01	281.62	321.21	10.39	0.00	0.47	23.53	0.33	
2060023	Spring - SDC @ Culver	Spring - SDC @ Culver	06/13/2002 11:55	gw	23.70	7.06	2.48	1.45		391.60	240.20	4.75	64.10	267.40	1.32	31.39	2.13	4.14	317.85	464.11	21.85	0.32	0.08	22.66	0.07	
2060024	SDC 300 m below Culver	SDC 300 m below Culver	06/13/2002 12:20	su	27.30	8.24	2.21	15.08		262.68	178.63	4.39	60.02	271.82	1.12	19.79	1.77	3.34	293.64	421.90	17.78	0.28	0.14	18.47	0.01	
2060025	Spring - SDC @ Harvard	Spring - SDC @ Harvard	06/13/2002 12:40	gw	22.40	7.19	3.81			328.85	283.62	4.58	108.63	534.16		30.11	29.55	4.51	338.36	1171.12	55.05	0.29	0.17	49.14	0.04	
2060026	SDC @ Harvard	SDC @ Harvard	06/13/2002 13:00	su	26.70	8.42	2.47			279.79	195.40	4.22	70.49	322.19	1.34	19.15	6.56	4.13	324.65	591.88	18.70	0.03	0.02	20.80	0.01	
2060027	ECD @ PCW	ECD @ PCW	06/20/2002 10:20	gw	23.10	7.96	3.16	6.79		483.80	128.64	3.53	140.49	444.75		37.58	100.22	33.72	273.98	874.95	11.21	0.05	0.17	12.76	0.22	
2060028	VD @ PCW	VD @ PCW	06/20/2002 11:00	su	21.90	8.24	3.08	8.07		396.90	206.47	5.51	112.37	363.56		30.70	16.04	9.03	319.34	814.16	18.10	0.04	0.21	22.02	0.18	
2060029	VD @ PCW	Spring	06/20/2002 11:10	gw	21.20	7.30	4.86	3.30			255.88	4.38	204.17	617.12		40.90	141.96	28.71								
2060030	Spring - PCW across from VD	Spring - PCW across from VD	06/20/2002 11:40	gw	21.60	7.16	2.72	0.48		348.73	306.85	4.25	113.66	249.92		14.67	11.36	0.21	255.62	865.24	16.79	0.03	0.05	19.69	0.02	
2060031	PCW @ Moffett	PCW @ Moffett	06/20/2002 12:00	su	23.60	8.29	2.19	11.63		339.08	154.68	17.82	81.33	308.75	1.33	16.06	17.86	6.51	225.48	555.96	9.86	0.18	0.30	12.25	0.28	
2060032	WD @ PCW	WD @ PCW	06/20/2002 12:50	su	21.90	7.97	2.68	6.08		361.57	218.27	6.27	83.95	336.96		31.64	9.96	7.15	312.97	638.87	12.24	0.12	0.23	14.99	0.20	
2060034	Drain - PCW W side S of Warner	Drain - PCW W side S of Warner	06/20/2002 13:30	su	20.10	8.02	5.43	5.53		323.93	431.65	26.91	218.15	997.99		13.37	16.28	3.27	494.82	2580.13	20.04	0.70	0.19	25.43	0.14	
2060035	PCW 350 m below Warner	PCW 350 m below Warner	06/20/2002 14:00	su	25.90	8.74	2.34	16.90		329.50	152.76	13.39	82.29	305.56	1.14	12.94	19.06	6.76	239.00	601.00	9.55	0.03	0.18	11.80	0.16	
2060036	SDC @ Campus	SDC @ Campus	06/27/2002 11:25	su	24.60	8.07	2.90	5.74	8.18	270.64	135.47	13.55	95.76	431.06		5.39	7.67	3.94	341.34	840.43	2.04	0.19	0.02	3.29	0.06	
2060038	SDC @ Michelson	SDC @ Michelson	06/27/2002 12:50	su	28.40	8.79	2.53	Satd	20.96	293.23	147.65	10.97	87.57	390.75	1.11	9.52	9.18	6.63	273.02	690.27	5.27	0.06	0.10	6.01	0.08	
2060039	SDC @ Coronado	SDC @ Coronado	06/27/2002 14:15	su	30.20	8.94	1.92	Satd	16.58	277.23	124.87	9.12	66.87	267.08	0.91	11.56	9.45	6.36	331.13	726.81	5.76	0.05	0.14	6.48	0.09	
2060040	Dry Collector	Dry Collector	06/27/2002 0:00	cd							0.05						-0.85	0.71	0.43	0.51	0.20	0.14	0.01	0.49	0.03	925
2060041	Dry Collector	Dry Collector	07/02/2002 9:30	cd													-1.09	0.79	0.40	0.60	0.15	0.12	0.05	0.26	0.03	1220
2060042	SDC @ Alton	SDC @ Alton	07/02/2002 10:30	su	26.20	8.54	2.43	17.89	8.95	353.59	157.17	8.39	82.58	327.18		8.81	15.91	7.66	256.70	610.00	7.98	0.04	0.08	9.09	0.07	
2060043	PCW @ Barranca	PCW @ Barranca	07/02/2002 11:15	su	27.20	8.70	2.35	Satd	4.92	338.21	149.69	9.26	84.51	316.74	1.12	9.51	17.78	7.70	235.68	610.56	6.60	0.03	0.13	7.61	0.13	
2060044	SDC @ Harvard	SDC @ Harvard	07/02/2002 12:00	su	26.70	8.33	2.30	17.75	1.02	289.24	190.25	2.89	63.06	281.66	1.05	16.60	2.43	5.95	295.06	474.16	15.75	0.03	0.01	16.92	0.01	
2060045	PCW @ Moffett	PCW @ Moffett	07/02/2002 12:45	su	27.00	8.43	2.18	12.80		339.30	139.70	12.00	76.66	303.06	1.05	13.22	20.01	10.88	213.39	530.55	7.12	0.05	0.21	7.85	0.19	
2060046	PCW @ CC	PCW @ CC	07/02/2002 13:15	su	29.40	8.67	1.89	16.08	2.59	298.76	112.72	11.85	57.33	276.72	0.82	11.76	14.98	5.42	184.80	443.71	6.00	0.08	0.23	7.62	0.20	
2060047	PCW @ Bryan	PCW @ Bryan	07/02/2002 14:30	su	34.70	10.57	1.41	13.90	0.31	135.36	99.42	15.95	17.31	194.25	0.67	3.82	0.10	5.85	185.00	303.01	0.17	0.03	0.01	2.53	0.22	
2060048	SFC @ Red Hill	SFC @ Red Hill	07/10/2002 9:30	su	22.40	8.15	1.17	6.31		184.44	80.42	14.64	25.51	147.95	0.86	8.83	1.00	2.41	165.03	172.83	0.15	0.42	0.83	2.06	1.05	
2060049	SFC @ RR	SFC @ RR	07/10/2002 10:20	su	24.70	8.27	1.48	8.68		230.71	123.37	9.83	39.13	163.22	1.06	9.34	5.00	3.25	214.98	293.13	1.06	0.07	0.53	1.96	0.57	
2060050	SFC @ RR	Weephole 10N	07/10/2002 10:30	gw	22.70	6.82	2.06	1.96	0.02	367.58	131.07	1.32	38.33	73.83	0.79	6.43	18.00	0.98	178.78	500.82	17.96	0.02	0.04	19.07	0.05	
2060051	EMIC @ El Camino Real	EMIC N of El Camino Real	07/10/2002 11:10	su	29.50	9.15	1.07	14.43	0.60	200.73	95.11	8.03	35.76	123.90	0.78	10.09	2.00	4.00	116.67	230.58	0.57	0.12	0.20	1.88	0.21	
2060052	CIC @ Northwood Plaza on Trab.	CIC @ Northwood Plaza on Trab.	07/10/2002 12:00	su	32.30	9.60	2.00	13.90	0.23	237.30	113.56	6.80	76.04	258.18	0.94	13.22	79.84	3.76	233.06	445.61	21.68	0.03	0.16	21.31	0.23	
2060053	PCW @ Irvine	PCW @ Irvine	07/10/2002 12:40	su	32.80	10.15	1.35	16.74	0.44	209.93	93.58	12.75	41.54	166.75	0.80	8.91	24.66	5.27	167.04	285.17	1.06	0.12	0.20	2.07	0.18	
2060061	BoC @ MacArthur	BoC @ MacArthur	07/18/2002 10:20	su	20.70	7.86	3.28	6.01	0.50	439.41	171.11	10.25	117.22	433.74	0.88	18.01	3.00	3.12	609.14	427.52	0.43	0.03	0.13	0.90	0.17	
2060062	SCW @ Harvard	SCW @ Harvard	07/18/2002 11:45	su	22.00	8.12	2.63	4.84	2.49	408.32	125.33	11.32	96.95	353.37	0.78	18.50	4.00	4.55	440.03	325.97	2.65	0.23	0.62	4.04	0.79	
2060063	SCW @ Harvard	Drain	07/18/2002 12:00	su	30.60	7.86	1.10	5.21	0.04	190.11	50.38	41.55	19.74	183.76	0.46	12.79	2.00	5.57	145.88	176.21	6.58	0.24	2.44	9.23	3.10	
2060064	SJC @ Harvard	SJC @ Harvard	07/18/2002 12:45	su	24.40	7.59	1.39	2.79	0.29	249.52	88.82	12.17	29.62	193.20	0.67	7.99	2.00	5.01	166.31	222.98	1.66	0.12	0.32	2.69	0.33	
2060065	LC @ McCabe/Jamboree	LC @ McCabe/Jamboree	07/18/2002 13:50	su	31.30	8.66	5.23	16.23	1.23	239.00	219.72	8.93	160.14	906.39	2.38	7.72	13.00	2.49	340.07	1777.66	4.06	0.04	0.06	4.82	0.12	
2060066	BaC @ Alton	BaC @ Alton	07/18/2002 15:00	su	27.80	8.20	4.53	7.53	0.11	187.33	171.80	10.96	133.06	820.18	2.41	4.75	4.00	4.33	475.69	1734.46	0.18	0.07	0.13	0.85	0.16	
2060162	EMIC @ Newport	EMIC @ Newport	07/25/2002 9:40	su	25.40	8.24	1.13	4.41		208.20	73.87	8.18	45.80	122.88	0.67	9.32	1.00	2.55			0.29	0.51	0.15	1.51	0.19	
2060163	EMIC @ Newport	Drain B - EMIC @ Newport	07/25/2002 9:40	su	25.90	8.14	0.81	5.10		193.81	69.44	12.48	11.35	102.25	0.45	12.46	1.00	3.20			0.91	0.07	0.27	2.03	0.34	
2060164	HCW @ Culver	HCW @ Culver	07/25/2002 11:30	su	26.60	7.69	0.86	1.88		224.11	59.46	16.88	20.22	108.69	0.60	9.90	2.00	8.64			0.74	1.67	2.30	5.24	4.24	
2060165	CC @ Yale	CC @ Yale	07/25/2002 13:15	su	38.50	9.24	1.12	8.55		200.73	42.04	6.10	12.76	73.30	0.39	4.89	2.00	7.66			0.15	0.04	0.36	1.54	0.46	
2060166	CC @ Yale	Spring	07/25/2002 13:15	gw	24.40	7.28	2.78	1.04		565.12	163.39	1.84	82.94	417.14	1.05	27.94	16.00	4.51			13.85	0.04	0.06	14.45	0.09	
2060167	CC @ Yale	Drain	07/25/2002 13:15	su	24.70	7.45	1.77	2.38	0.37	431.81	99.04	8.80	46.31	263.47	0.67	19.53	6.00	4.85			5.92	0.07	0.72	6.78	0.55	
2060254	Dry Collector	Dry Collector	08/01/2002 9:15	cd						11.10	0.77	4.00		2.29		0.22	0.00	0.38			0.51	0.14	0.07	3.58	0.40	762
2060255	PCW below SFC	CC @ PCW	08/01/2002 10:25	su	25.00	8.34	2.68	14.20	0.49	490.42	145.29	4.80	119.12	401.37	1.76	21.27	25.00	15.85			12.77	0.06	0.15	13.55	0.15	
2060256	Weephole - PCW @ Harvard	Weephole - PCW @ Harvard	08/01/2002 11:00	gw	22.50	7.95	3.04	1.75		484.82	100.15	1.90	84.40	618.51	1.53	18.03	2.60	4.00			39.63	0.05	0.13	36.44	0.09	
2060257	EMIC @ PCW	EMIC @ PCW	08/01/2002 11:00	su	26.10	9.22	1.22	11.48	0.46	209.93	106.35	9.84	41.96	156.74	0.94	12.30	26.09	4.08			1.09	0.15	0.09	2.63	0.35	
2060259	PCW @ EMIC	PCW @ EMIC	08/01/2002 11:30	su	23.90	7.90	2.02	6.70	2.15	348.84	137.15	11.45	67.28	337.80	1.29	14.72	20.00	5.14			11.67	0.15	0.38	12.43	0.40	
2060260	DP @ PCW	DP @ PCW	08/01/2002 12:15	gw	23.50	7.68	2.47	6.10	1.07	475.11	158.46	1.90	75.72	431.19	1.26	17.51	36.00	1.74			7.14	0.01	0.10	6.48	0.14	
2060261	Drain - GWD @ SDC	Drain - GWD @ SDC	08/01/2002 12:30	su	23.30	7.75	3.10	5.99		394.36	204.38	8.15	64.48	454.77	1.78	11.20	3.00	0.91			0.88	0.28	0.03	1.37	0.04	
2060262	SFC @ RR	SFC @ RR	08/01/2002 13:15	su	30.50	8.80	1.32	14.60	0.21	206.37	107.20	8.52	34.15	127.12	0.91	9.14	5.00	3.50			1.67	0.13	0.07	2.75	0.27	
2060263	Drain - PCW @ CC	Drain - PCW @ CC	08/01/2002 13:30	su	23.50	8.52	1.95	8.37		322.62	102.90	15.18	41.53	291.44	1.16	14.41	5.00	11.81			3.93	1.60	0.41	7.05	0.37	
2060264	SFC @ PCW	SFC @ PCW	08/01/2002 14:15	su	28.30	8.84	2.00	14.52	0.37	284.47	208.57	5.80	68.87	161.33	1.50	8.51	14.00	2.02			10.90	0.12	0.14	10.38	0.13	
2060265	ECD @ PCW	ECD @ PCW	08/01/2002 14:30	gw	23.70	8.18	3.48	7.43	0.15	513.99	138.33	2.34	153.89	462.01	2.47	36.26	141.12	34.65			12.97	0.02	0.13	12.65	0.12	
2060266	SDC @ Campus	PCW below SFC	08/01/2002 14:50	su	28.20	8.39	2.29	10.62	5.13	347.21	135.52	8.56	75.81	280.56	1.24	13.87	27.37	7.31			9.50	0.12	0.25	9.30	0.29	
2060267	Well 63S	Well 63S	08/08/2002 10:00	gw	21.60		3.28	0.25		559.90	117.21	1.47	131.72	496.36	2.15	30.53	56.98	11.50	374.87	784.52	23.39	0.05	0.09	23.01	0.11	
2060268	Well 85W	Well 85W	08/08/2002 10:50	gw	26.80		3.39			567.77	182.26	2.63	128.95	472.91	1.64	28.35	169.12	11.21	485.26	673.91	21.62	0.05	0.11	20.01	0.11	
2060269	Well 86N	Well 86N	08/08/2002 12:45	gw	24.20		4.15	0.71		480.53	236.05	3.46	132.94	592.13	2.23	32.32	32.00	12.49	412.34	1547.58	18.56	0.04	0.10	18.30	0.08	
2060270	Well 103N	Well 103N	08/08/2002 14:15	gw	21.00		3.18	1.56		574.44	166.67	2.28	88.51	484.29	1.26	22.73	15.00	12.23	370.36	720.87	25.12	0.03	0.08	25.85	0.07	
2060271	VD @ PCW	Spring	08/08/2002 10:00	gw	21.50	7.03	5.05	2.84		456.51	252.45	4.25	209.60	631.21	4.45	36.42	169.12	29.32	584.96	1920.05	12.31	0.05	0.08	12.79	0.06	
2060272	VD @ PCW	VD @ PCW	08/08/2002 10:00	su	22.40	8.00	3.12	6.97	0.90	394.78	195.30	5.30	107.52	358.99	1.85	27.73	26.05	10.13	367.92	872.36	19.07	0.06	0.20	17.06	0.20	
2060273	SFC @ RR	Weephole 7S	08/08/2002 11:00	gw	21.80	6.85	2.12	2.04	0.02	372.41	237.92	2.73	68.40	150.38	1.54	12.47	16.00	0.94	210.22	523.49	19.14	0.03	0.04	18.02	0.06	
2060274	SFC @ RR	Spring 7-8R	08/08/2002 11:00	gw	21.90	6.81	2.14	2.20		375.72	221.46	2.75	63.22	132.07	1.35	11.55	17.00	0.87	209.31	524.37	18.71	0.03	0.04	18.52	0.05	
2060275	SFC @ RR	Weephole 19S	08/08/2002 11:30	gw	24.40	6.86	2.87	1.40		321.86	326.72	3.60	101.38	172.57	2.25	11.33	35.00	1.11	209.22	1094.03	19.43	0.05	0.04	19.59	0.05	
2060276	SFC @ RR	Weephole 23S	08/08/2002 11:45	gw	23.70	6.83	2.55	1.60		341.47	307.23	3.47	92.45	177.68	2.10	12.77	29.00	0.95	203.70	840.47	18.71	0.03	0.04	18.29	0.06	
2060277	SFC @ RR	Weephole 4N	08/08/2002 12:00	gw	21.90	6.85	2.11	2.00		375.83	259.70	2.66	73.39	154.04	1.57	13.41	17.00	0.97	204.50	515.07	18.92	0.02	0.03	18.90	0.05	

sample id	site	location	Sample Date	Type	Temp	pH	EC (ms)	D.O.	Q	alk	Ca	K	Mg	Na	Sr	Si	Se	As	Cl	SO4	NO3-N	NH4-N	PO4-P	TN	TP	volume
			mm/dd/yyyy hh:mm		deg_c		ms/cm	mg/L	CFS	mg CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml
2060278	SFC @ RR	Weephole 9N	08/08/2002 12:00	gw	23.10	6.84	2.26	2.14		363.61	255.00	2.13	74.06	153.93	1.66	13.21	21.00	0.92	201.55	605.59	17.79	0.03	0.04	15.86	0.05	
2060279	SFC @ RR	Drain	08/08/2002 12:00	su	21.80	8.02	0.71	5.61		214.85	51.45	7.56	15.75	83.30	0.44	11.38	2.00	3.52	30.31	106.53	0.70	0.08	0.57	1.76	0.62	
2060280	SFC @ RR	Weephole 23N	08/08/2002 12:20	gw	23.70	6.88	2.53	1.62	0.17	350.46	289.18	2.38	85.81	155.44	1.87	12.31	28.00	1.11	205.61	815.66	18.11	0.03	0.04	19.11	0.08	
2060281	SFC @ RR	Weephole 33N	08/08/2002 12:30	gw	23.30	6.85	2.49	2.01		352.08	268.38	2.16	78.76	144.97	1.68	11.87	25.00	0.77	209.57	766.06	19.68	0.02	0.05	20.63	0.05	
2060282	PCW @ CC	Weephole 1N	08/08/2002 14:00	gw	26.10	7.34	4.28	1.12		519.61	133.89	1.99	120.23	622.84	2.24	19.90	123.52	27.59	430.96	1314.81	8.44	0.03	0.11	8.98	0.14	
2060283	PCW @ CC	Weephole 2N	08/08/2002 14:00	gw	27.30	7.25	4.52	2.35		415.89	242.55	3.06	123.34	519.52	2.65	14.29	62.88	9.33	479.38	1491.04	9.16	0.04	0.07	9.38	0.07	
2060284	PCW @ CC	Weephole 3N	08/08/2002 14:15	gw	29.10	7.53	5.32	1.97		481.15	180.71	13.51	125.07	829.04	2.44	15.55	29.00	32.87	482.64	1407.84	2.71	0.04	0.15	3.04	0.18	
2060285	EMIC above PCW (S)	EMIC above PCW (S)	08/08/2002 15:15	su	20.90	8.90	2.12	2.50		261.23	153.24	5.48	91.61	239.42	1.96	14.10	66.52	17.70	147.03	794.25	13.56	0.05	0.18	12.20	0.27	
2060293	Well 87N	Well 87N	08/15/2002 12:20	gw	21.40		2.50	0.33		460.94	202.22	1.74	54.72	322.40	1.22	30.48	7.90	3.73	376.56	417.31	21.18	0.03	0.05	20.66	0.33	
2060294	Well 102N	Well 102N	08/15/2002 14:15	gw			1.00			365.65	138.79	5.00	38.71	63.10	0.86	14.84	1.44	1.65	93.59	136.66	1.59	0.07	0.14	2.18	0.18	
2060295	Dry Collector	Dry Collector	08/15/2002 9:15	cd						4.87	0.64	0.77	-0.25	1.43	-0.01	0.10	0.38	0.53	0.94	2.18	0.36	0.27	0.05	1.61	0.15	1475
2060296	SDC @ Campus	SDC @ Campus	08/15/2002 10:50	su	24.90	8.19	3.17	4.80	6.22	303.07	139.74	7.01	93.95	408.95	1.44	6.81	13.72	6.35	386.76	900.69	1.59	0.09	0.02	2.92	0.12	
2060297	SADC @ Irvine	SADC @ Irvine	08/15/2002 12:20	su	27.50	8.82	2.52	17.26	1.39	239.23	169.44	6.15	69.09	245.19	1.65	3.80	6.07	2.73	297.77	717.58	1.86	0.04	0.07	2.67	0.10	
2060298	SADC @ Irvine	Spring	08/15/2002 13:00	gw	26.00	6.99	2.38	0.81		431.39	179.92	5.78	51.75	247.60	1.76	12.57	6.42	4.03	284.69	418.25	2.36	0.02	0.06	2.60	0.06	
2060299	LC @ Main	LC @ Main	08/15/2002 14:30	su	32.90	8.40	3.93	13.81		189.19	228.29	4.67	114.89	338.73	1.98	9.10	13.80	3.05	256.10	1425.21	7.81	0.17	0.09	8.54	0.12	
2060301	LC @ McCabe/Jamboree	Spring	08/22/2002 10:15	gw	21.80	7.09	8.50	1.89		306.60	191.95	4.28	199.82	1830.77	2.53	9.89	9.94	2.98	1344.76	3885.53	0.66	0.06	0.14	0.74	0.14	
2060302	BaC @ Jamboree	BaC @ Jamboree	08/22/2002 11:30	su	25.90	8.17	3.77	7.59		225.59	127.57	6.79	95.88	512.73	1.61	4.28	2.03	4.99	371.06	1329.90	0.09	0.01	0.08	0.48	0.07	
2060303	BaC @ Barranca	Drain	08/22/2002 12:10	su	23.70	7.75	8.73	5.91		277.00	422.68	4.22	227.61	1287.18	4.55	11.89	14.72	2.60	882.17	4367.97	4.80	0.03	0.07	4.90	0.05	
2060304	BaC @ Barranca	BaC @ Barranca	08/22/2002 12:15	su	21.80	7.90	1.89	5.79		154.92	150.43	9.11	70.32	262.08	1.91	5.51	4.12	4.95	333.88	582.63	0.42	0.26	0.20	0.43	0.04	
2060305	BaC @ Red Hill	IRWD Pipe	08/22/2002 13:00	su	25.80	8.28	0.46	6.79	0.01	182.23	30.21	1.50	5.90	65.69	0.28	9.04	1.12	3.78	24.00	42.79	0.20	0.37	0.04	0.45	0.04	
2060306	BaC @ Red Hill	BaC @ Red Hill	08/22/2002 13:30	su	25.50	7.67	1.60	5.18		118.62	128.55	12.10	45.87	142.61	1.58	8.97	2.05	2.80	268.38	315.55	1.69	0.13	0.22	2.73	0.18	
2060307	SFC @ PCW	SFC @ PCW	08/22/2002 14:20	su	26.90	7.74	2.03	9.59	0.59	296.88	213.98	4.67	66.98	158.33	1.62	10.32	3.85	3.74	174.72	513.45	10.32	0.69	0.22	0.26	0.20	
2060308	SDC @ Campus	PCW below SFC	08/22/2002 14:30	su	27.20	8.45	2.35	10.85	5.95	357.91	133.02	4.88	73.15	291.72	1.25	14.56	24.86	8.48	231.43	547.85	5.06	0.07	0.23	3.59	0.23	
2060309	EMIC @ PCW	EMIC @ PCW	08/22/2002 15:40	su	26.50	10.13	1.28	6.48	0.53	172.93	97.72	10.51	21.37	150.63	0.84	6.97	3.44	5.19	167.66	279.25	0.65	0.21	0.10	2.57	0.11	
2060310	PCW @ EMIC	PCW @ EMIC	08/22/2002 16:00	su	25.30	8.10	2.16	9.04	2.10	357.69	115.72	5.04	59.42	308.34	1.01	15.94	20.56	5.50	212.96	516.51	2.75	0.05	0.34	3.41	0.40	
2060311	PCW below SFC	CC @ PCW	08/22/2002 16:15	su	31.50	8.54	3.38	14.66	0.38	372.62	91.84	2.25	115.74	418.69	1.34	21.88	27.72	16.47	370.23	766.74	15.53	0.04	0.04	16.66	0.04	
2060312	SDC @ Campus	PCW below SFC	08/26/2002 10:00	su	21.80	7.98	2.22	7.81	4.95	375.72	139.48	4.51	76.69	302.80	1.31	15.07	30.58	7.55	241.15	571.94	8.61	0.39	0.20	10.01	0.30	
2060313	SFC @ PCW	SFC @ PCW	08/26/2002 10:30	su	23.10	7.42	1.85	5.57	0.62	345.92	208.80	4.54	65.79	155.56	1.53	11.31	15.29	2.90	188.86	494.75	8.05	0.04	0.10	2.17	0.07	
2060314	PCW below SFC	CC @ PCW	08/26/2002 11:00	su	31.00	8.47	3.28	Satd	0.42	419.78	110.39	2.28	116.15	400.09	1.47	20.37	28.55	16.67	309.20	658.75	14.01	0.03	0.02	14.66	0.03	
2060315	PCW @ EMIC	PCW @ EMIC	08/26/2002 11:30	su	23.70	8.06	2.22	13.76	1.74	370.91	110.99	4.79	56.70	302.96	0.99	13.49	27.37	5.38	209.45	509.66	7.73	0.12	0.26	8.58	0.35	
2060316	EMIC @ PCW	EMIC @ PCW	08/26/2002 12:00	su	24.30	9.51	1.27	11.01	0.50	200.73	92.91	7.06	33.71	139.86	0.77	8.92	2.78	4.62	172.53	261.83	0.82	0.10	0.14	1.89	0.18	
2060317	SFC @ PCW	Auto	08/22/2002 15:45	ai			1.79				214.91	4.30	64.55	148.78	1.52	10.61	2.60	2.01	167.60	507.23	0.11	0.39	0.04		0.26	
2060318	SFC @ PCW	Auto	08/22/2002 18:45	ai			1.65				187.53	4.85	58.92	140.32	1.39	10.83	8.12	2.22	163.23	455.16	0.10	1.08	0.01	2.99	0.17	
2060319	SFC @ PCW	Auto	08/22/2002 21:45	ai			1.64				172.38	6.39	57.30	142.79	1.34	10.23	6.95	2.29	158.69	406.87	0.11	1.13	0.01	3.94	0.26	
2060320	SFC @ PCW	Auto	08/23/2002 0:45	ai			1.68				184.53	6.25	60.26	149.66	1.44	10.60	8.45	2.42	179.78	469.52	0.10	1.18	0.01	3.56	0.09	
2060321	SFC @ PCW	Auto	08/23/2002 3:45	ai			1.64				175.01	6.16	59.48	145.62	1.38	10.97	7.20	2.82	177.96	459.17	0.10	2.22	0.01	4.00	0.16	
2060322	SFC @ PCW	Auto	08/23/2002 6:45	ai			1.64				180.11	5.35	61.43	145.13	1.44	11.48	12.28	2.66	164.05	475.84	1.92	1.13	0.07	3.90	0.11	
2060323	SFC @ PCW	Auto	08/23/2002 9:45	ai			1.56				164.82	4.51	56.73	135.86	1.30	10.75	9.51	2.51	155.55	444.06	0.14	1.62	0.00	2.79	0.05	
2060324	SFC @ PCW	Auto	08/23/2002 12:45	ai			1.68				189.68	4.23	61.42	140.10	1.37	10.47	0.07	2.86	161.38	476.32	0.11	0.07	0.00		0.17	
2060325	SFC @ PCW	Auto	08/23/2002 15:45	ai			1.74				210.53	4.06	62.88	141.79	1.52	10.95	2.37	2.47	156.16	476.21	0.13	0.34	0.01		0.24	
2060326	SFC @ PCW	Auto	08/23/2002 18:45	ai			1.87				221.34	4.00	66.47	146.00	1.56	11.38	3.23	2.76	170.45	512.85	0.11	0.19	0.02	0.09	0.19	
2060327	SFC @ PCW	Auto	08/23/2002 21:45	ai			1.88				211.90	4.12	67.10	143.89	1.53	12.44	8.48	1.89	181.89	549.73	0.11	1.00	0.01	2.79	0.14	
2060328	SFC @ PCW	Auto	08/24/2002 0:45	ai			1.84				209.60	4.56	66.55	146.05	1.54	12.60	7.19	2.06	178.08	537.85	0.11	0.87	0.00	2.66	0.14	
2060329	SFC @ PCW	Auto	08/24/2002 3:45	ai			1.82				207.57	4.55	65.81	148.66	1.52	12.48	7.29	2.24	183.13	521.68	0.11	0.78	0.01	2.42	0.14	
2060330	SFC @ PCW	Auto	08/24/2002 6:45	ai			1.90				207.17	6.65	66.70	174.07	1.59	13.73	6.40	2.73	195.74	566.06	0.11	1.41	0.10	2.94	0.20	
2060331	SFC @ PCW	Auto	08/24/2002 9:45	ai			1.81				194.59	4.68	64.67	162.02	1.47	12.12	7.98	2.59	219.55	564.58	0.16	1.11	0.09	2.19	0.10	
2060332	SFC @ PCW	Auto	08/24/2002 12:45	ai			1.80				199.35	4.70	65.00	149.53	1.50	11.55	13.32	2.34	181.62	512.98	3.16	1.13	0.23	5.06	0.30	
2060333	SFC @ PCW	Auto	08/24/2002 15:45	ai			1.82				204.40	4.26	67.58	149.49	1.58	11.37	8.33	2.37	179.27	534.12	0.16	1.42	0.16	2.55	0.21	
2060334	SFC @ PCW	Auto	08/24/2002 18:45	ai			1.90				218.92	4.12	70.95	154.74	1.63	12.38	7.37	2.47	188.15	564.40	0.13	1.01	0.03	2.20	0.19	
2060335	SFC @ PCW	Auto	08/24/2002 21:45	ai			1.97				223.62	4.53	71.29	158.16	1.66	12.76	16.26	2.52	198.69	589.47	6.82	0.84	0.16	8.26	0.16	
2060336	SFC @ PCW	Auto	08/25/2002 0:45	ai			1.89				216.92	5.11	68.31	149.85	1.59	12.50	15.18	2.65	180.64	528.50	6.27	0.68	0.15	7.66	0.18	
2060337	SFC @ PCW	Auto	08/25/2002 3:45	ai			1.90				213.00	5.47	67.69	152.45	1.56	12.38	14.74	1.69	200.08	556.56	5.51	0.66	0.17	6.19	0.18	
2060338	SFC @ PCW	Auto	08/25/2002 6:45	ai			1.91				210.37	5.29	66.76	146.20	1.51	12.38	14.75	1.74	199.36	558.57	7.35	0.46	0.15	8.03	0.17	
2060339	SFC @ PCW	Auto	08/25/2002 9:45	ai			1.94				213.76	4.81	67.81	153.30	1.62	12.19	16.10	1.58	190.53	581.01	8.43	0.51	0.16	9.64	0.20	
2060340	SFC @ PCW	Auto	08/25/2002 12:45	ai			1.98				215.97	4.96	71.90	160.29	1.69	11.79	16.68	1.59	171.20	535.13	9.54	0.59	0.16	11.30	0.18	
2060341	CC @ PCW	Auto	08/22/2002 16:30	ai			2.73				89.02	2.22	112.41	388.94	1.29	22.09	27.59	16.18	310.24	650.19	14.48	0.07	0.02	16.17	0.02	
2060342	CC @ PCW	Auto	08/22/2002 19:30	ai			2.75				103.73	1.96	111.26	379.24	1.40	22.54	26.88	15.92	309.85	641.83	15.09	0.08	0.03	16.09	0.02	
2060343	CC @ PCW	Auto	08/22/2002 22:30	ai			2.80				122.98	2.32	116.20	388.54	1.56	22.53	27.08	16.65	310.94	650.79	15.41	0.07	0.02	16.72	0.03	
2060344	CC @ PCW	Auto	08/23/2002 1:30	ai			2.77				125.15	2.74	111.90	382.17	1.60	21.68	26.80	16.92	308.11	646.06	15.39	0.05	0.02	16.07	0.03	
2060345	CC @ PCW	Auto	08/23/2002 4:30	ai			2.66				124.66	3.12	105.73	343.18	1.48	21.22	25.00	16.33	295.80	617.22	14.00	0.04	0.02	15.05	0.05	
2060346	CC @ PCW	Auto	08/23/2002 7:30	ai			2.69				125.47	2.83	107.42	351.71	1.53	21.69	26.47	16.15	302.01	638.30	14.05	0.05	0.03	14.76	0.05	
2060347	CC @ PCW	Auto	08/23/2002 10:30	ai			2.70				111.38	2.60	112.05	371.65	1.46	20.29	26.02	15.73	309.99	659.83	14.69	0.14	0.03	15.40	0.03	
2060348	CC @ PCW	Auto	08/23/2002 13:30	ai			2.69				88.17	2.57	111.69	382.32	1.28	20.06	26.33	16.17	347.82	744.64	14.54	0.11	0.02	15.52	0.02	
2060349	CC @ PCW	Auto	08/23/2002 16:30	ai			2.73				82.80	2.04	110.14	363.70	1.18	22.13	27.77	14.45	363.78	765.38	15.51	0.08	0.02	16.63	0.03	
2060350	CC @ PCW	Auto	08/23/2002 19:30	ai			2.80				106.15	1.89	114.91	384.75	1.41	21.84	27.29	14.76	328.99	698.75	15.68	0.11	0.03	16.73	0.03	
2060351	CC @ PCW	Auto	08/23/2002 22:30	ai			2.84				121.68	2.03	113.99	374.04	1.49	21.88	27.47	15.28	322.70	685.18	16.11	0.08	0.03	17.03	0.02	
2060352	CC @ PCW	Auto	08/24/2002 1:30	ai			2.77				119.09	2.12	104.13	333.45	1.37	20.17	25.71	14.58	319.71	666.75	15.29	0.09	0.02	16.28	0.03	
2060353	CC @ PCW	Auto	08/24/2002 4:30	ai			2.70				118.98	2.25	100.89	305.25	1.30	19.60	25.74	14.65	311.94	659.82	14.45	0.09	0.03	14.78	0.03	
2060354	CC @ PCW	Auto	08/24/2002 7:30	ai			2.78				122.05	2.00	104.39	321.07	1.36	21.53	26.33	15.12	319.96	680.22	15.23	0.08	0.03	15.76	0.04	
2060355	CC @ PCW	Auto	08/24/2002 10:30	ai			2.73				101.60	1.86	106.31	348.39	1.31	20.97	27.28	14.28	325.70	690.53	14.59	0.07	0.02	15.76	0.03	
2060356	CC @ PCW	Auto	08/24/2002 13:30	ai			2.70				83.45	1.86	105.84	350.84	1.14	21.33	27.13	15.49	332.49	706.67	14.53	0.02	0.02	15.74	0.02	
2060357	CC @ PCW	Auto	08/24/2002 16:30	ai			2.75				80.93	1.82	103.92	342.48	1.09	22.47	26.52	14.49	340.72	716.11	14.79	0.08	0.02	16.47	0.03	

sample id	site	location	Sample Date	Type	Temp	pH	EC (ms)	D.O.	Q	alk	Ca	K	Mg	Na	Sr	Si	Se	As	Cl	SO4	NO3-N	NH4-N	PO4-P	TN	TP	volume
			mm/dd/yyyy hh:mm		deg_c		ms/cm	mg/L	CFS	mg CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml
2060358	CC @ PCW	Auto	08/24/2002 19:30	ai			2.82				101.74	1.78	109.97	363.35	1.32	23.00	27.18	14.88	336.37	709.62	14.81	0.04	0.02	16.61	0.03	
2060359	CC @ PCW	Auto	08/24/2002 22:30	ai			2.82				114.94	1.82	106.64	325.20	1.28	21.91	26.79	15.02	343.54	720.21	14.82	0.03	0.01	16.59	0.03	
2060360	CC @ PCW	Auto	08/25/2002 1:30	ai			2.82				124.24	1.93	109.06	324.31	1.33	20.90	26.22	14.89	334.07	698.48	15.06	0.02	0.02	16.63	0.03	
2060361	CC @ PCW	Auto	08/25/2002 4:30	ai			2.74				127.61	2.35	107.31	355.09	1.50	20.24	24.60	14.50	396.68	832.27	14.61	0.05	0.01	15.60	0.02	
2060362	CC @ PCW	Auto	08/25/2002 7:30	ai			2.72				123.34	2.21	103.66	331.02	1.41	21.08	25.32	13.75	312.64	664.03	13.82	0.00	0.01	15.40	0.04	
2060363	CC @ PCW	Auto	08/25/2002 10:30	ai			2.69				108.86	2.14	112.55	377.48	1.40	20.28	26.53	14.10	327.33	696.62	13.86	0.02	0.01	18.00	0.02	
2060364	CC @ PCW	Auto	08/25/2002 13:30	ai			2.70				87.85	2.01	115.05	385.89	1.21	20.07	27.22	14.68	342.87	728.35	13.50	0.02	0.00	15.18	0.03	
2060365	PCW @ EMIC	Auto	08/22/2002 14:02	ai			1.90				100.55	4.23	50.45	265.24	0.85	14.80	19.90	4.69	209.99	500.76	2.72	0.04	0.30	15.81	0.40	
2060366	PCW @ EMIC	Auto	08/22/2002 17:02	ai			1.96				102.97	3.83	51.74	263.30	0.84	14.53	19.53	4.75	197.37	479.82	2.18	0.03	0.30	3.56	0.44	
2060367	PCW @ EMIC	Auto	08/22/2002 20:02	ai			2.00				109.86	3.60	53.76	266.51	0.85	14.53	19.36	4.36	202.54	502.45	1.80	0.03	0.28	2.87	0.40	
2060368	PCW @ EMIC	Auto	08/22/2002 23:02	ai			2.02				100.78	3.02	48.04	245.40	0.78	14.04	27.37	3.42	224.25	505.33	5.02	0.03	0.24	2.39	0.37	
2060369	PCW @ EMIC	Auto	08/23/2002 2:02	ai			2.05				112.14	3.86	55.19	294.26	0.92	13.98	22.11	3.37	207.86	521.02	2.46	0.12	0.30	5.35	0.41	
2060370	PCW @ EMIC	Auto	08/23/2002 5:02	ai			1.97				105.99	4.53	51.64	281.30	0.87	12.87	19.92	3.96	214.54	520.95	2.70	0.03	0.27	3.41	0.37	
2060371	PCW @ EMIC	Auto	08/23/2002 8:02	ai			1.84				98.73	5.33	48.70	270.38	0.86	12.80	17.69	4.75	233.43	538.70	3.04	0.03	0.29	3.78	0.38	
2060372	PCW @ EMIC	Auto	08/23/2002 11:02	ai			1.78				104.52	5.53	52.57	262.16	0.89	13.27	18.11	5.01	198.23	461.88	3.54	0.03	0.27	4.24	0.39	
2060373	PCW @ EMIC	Auto	08/23/2002 14:02	ai			1.85				110.05	5.16	54.87	261.91	0.92	14.92	16.64	4.85	200.62	487.28	2.17	0.03	0.33	2.86	0.44	
2060374	PCW @ EMIC	Auto	08/23/2002 17:02	ai			1.93				114.81	4.65	56.29	267.45	0.94	14.89	18.91	4.87	192.57	484.85	1.91	0.03	0.34	2.24	0.35	
2060375	PCW @ EMIC	Auto	08/23/2002 20:02	ai			1.97				111.99	4.21	53.81	256.39	0.90	14.56	23.41	4.76	205.90	519.80	3.74	0.02	0.29	4.22	0.40	
2060376	EMIC @ PCW	Auto	08/22/2002 14:00	ai			1.16				92.51	9.01	21.68	128.13	0.74	7.50	2.89	3.19	177.62	296.74	0.65	0.61	0.23	2.84	0.33	
2060377	EMIC @ PCW	Auto	08/22/2002 17:00	ai			1.44				99.01	9.97	21.24	166.68	0.82	6.13	2.98	2.57	249.49	277.59	1.74	0.49	0.22	4.76	0.35	
2060378	EMIC @ PCW	Auto	08/22/2002 20:00	ai			1.90				109.74	11.70	34.28	236.58	0.91	7.05	3.33	3.61	386.85	289.61	2.48	0.58	0.21	5.94	0.24	
2060379	EMIC @ PCW	Auto	08/22/2002 23:00	ai			1.71				99.05	10.49	42.49	203.81	0.84	9.25	3.71	5.50	293.03	286.64	3.55	0.18	0.40	5.84	0.46	
2060380	EMIC @ PCW	Auto	08/23/2002 2:00	ai			1.47				96.84	9.07	48.14	150.27	0.80	11.74	3.65	8.79	211.41	263.95	3.79	0.08	0.29	4.85	0.67	
2060381	EMIC @ PCW	Auto	08/23/2002 5:00	ai			1.47				103.89	9.62	49.32	162.98	0.91	12.79	2.79	5.49	213.52	256.10	3.39	0.07	0.29	4.20	0.63	
2060382	EMIC @ PCW	Auto	08/23/2002 8:00	ai			1.38				103.76	8.26	45.45	152.65	0.86	11.82	2.54	6.33	210.84	288.60	2.51	0.06	0.40	3.60	0.49	
2060383	EMIC @ PCW	Auto	08/23/2002 11:00	ai			1.23				94.59	8.07	34.13	150.71	0.79	9.15	2.57	4.43	170.38	242.60	0.98	0.27	0.26	2.48	0.31	
2060384	EMIC @ PCW	Auto	08/23/2002 14:00	ai			1.10				89.73	9.00	21.05	145.11	0.76	7.02	3.42	3.49	157.48	254.94	0.63	0.43	0.21	2.29	0.20	
2060385	EMIC @ PCW	Auto	08/23/2002 17:00	ai			1.17				98.32	10.89	20.23	153.76	0.83	5.54	3.45	2.76	165.42	283.54	1.00	0.24	0.15	2.71	0.24	
2060386	EMIC @ PCW	Auto	08/23/2002 20:00	ai			1.29				102.93	12.05	34.15	162.07	0.89	6.52	3.45	3.46	175.41	287.60	1.33	0.34	0.23	3.17	0.20	
2060387	EMIC @ PCW	Auto	08/23/2002 23:00	ai			1.40				105.53	10.85	48.98	159.48	0.91	8.26	2.91	3.99	198.26	283.50	1.21	0.25	0.36	2.61	0.32	
2060388	EMIC @ PCW	Auto	08/24/2002 2:00	ai			1.45				107.77	9.76	57.57	164.08	0.96	11.82	3.23	4.91	204.32	264.87	2.08	0.11	0.32	3.26	0.71	
2060389	EMIC @ PCW	Auto	08/24/2002 5:00	ai			1.38				107.22	10.14	52.37	154.47	0.93	12.70	2.82	4.65	175.70	264.43	2.54	0.21	0.31	3.58	0.73	
2060390	EMIC @ PCW	Auto	08/24/2002 8:00	ai			1.36				108.53	8.92	49.33	154.31	0.96	12.06	2.44	4.57	198.91	317.19	2.10	0.12	0.47	3.37	0.56	
2060391	EMIC @ PCW	Auto	08/24/2002 11:00	ai			1.20				98.02	8.96	35.85	142.54	0.83	9.46	2.68	3.20	158.18	278.01	0.81	0.23	0.23	2.24	0.32	
2060392	EMIC @ PCW	Auto	08/24/2002 14:00	ai			1.14				97.47	11.51	20.57	146.31	0.82	6.10	2.96	2.11	144.27	270.67	0.65	0.31	0.17	2.41	0.22	
2060393	EMIC @ PCW	Auto	08/24/2002 17:00	ai			1.36				118.89	11.05	31.93	158.03	0.99	6.19	3.32	1.51	256.24	358.15	3.51	0.40	0.15	5.28	0.15	
2060394	EMIC @ PCW	Auto	08/24/2002 20:00	ai			1.60				123.41	9.50	57.19	167.30	1.05	8.81	3.36	2.80	283.08	289.87	4.89	0.40	0.24	6.03	0.27	
2060395	EMIC @ PCW	Auto	08/24/2002 23:00	ai			1.50				114.04	9.05	64.13	153.16	1.00	11.41	3.63	4.50	245.90	382.54	2.10	0.23	0.35	3.24	0.44	
2060396	EMIC @ PCW	Auto	08/25/2002 2:00	ai			1.56				122.27	9.44	64.30	141.48	1.01	13.83	4.37	3.85	195.74	339.55	3.32	0.14	0.19	4.12	0.42	
2060397	EMIC @ PCW	Auto	08/25/2002 5:00	ai			1.51				116.67	9.11	56.50	152.16	0.97	13.57	3.53	3.60	199.20	300.98	2.74	0.16	0.20	3.91	0.44	
2060398	EMIC @ PCW	Auto	08/25/2002 8:00	ai			1.49				115.17	7.82	49.63	160.19	0.94	12.84	3.30	4.23	208.67	286.87	2.31	0.34	0.28	4.31	0.37	
2060399	EMIC @ PCW	Auto	08/25/2002 11:00	ai			1.28				97.48	8.03	34.81	146.93	0.80	9.77	2.86	4.02	178.17	271.73	1.01	0.35	0.16	3.41	0.05	
2060405	Sump - CC @ Culver	Sump - CC @ Culver	08/29/2002 12:00	gw	23.90	7.50	3.24	6.40		502.28	57.99	1.57	124.09	381.92	1.30	31.12	21.85	23.21	360.96	820.75	21.38	0.78	0.04	10.71	0.09	
2060406	Dry Collector	Dry Collector	08/29/2002 15:00	cd							0.62	0.55		2.06		0.01	0.39	0.35			0.42	1.58	0.04	2.56	0.15	1770
2090001	SDC @ Campus	SDC @ Campus	09/12/2002 10:40	su	23.30	8.22	3.10	7.94	11.24	326.56	135.44	6.63	94.34	438.23	1.44	5.15	12.48	4.22	384.43	879.06	1.48	0.05	0.01	2.60	0.10	
2090002	SCW @ SDC	SCW @ SDC	09/12/2002 12:10	su	20.10	7.95	2.87	4.14	0.03	428.26	120.52	7.83	99.06	402.66	0.74	19.08	3.65	4.10	595.74	387.05	2.77	0.08	0.45	3.67	0.58	
2090003	SJC @ Harvard	SJC @ Harvard	09/12/2002 12:50	su	21.90		1.35	6.86	0.44	256.95	81.35	7.55	27.60	185.17	0.56	10.31	2.69	5.36	183.69	223.36	2.31	0.15	0.38	3.00	0.40	
2090004	LC @ McCabe/Jamboree	LC @ McCabe/Jamboree	09/12/2002 14:00	su	29.80	8.68	7.15	Satd	1.30	269.52	201.19	7.21	166.96	1044.37	2.28	5.89	14.08	2.08	344.15	816.89	2.81	0.08	0.08	3.66	0.16	
2090005	BaC @ Main	BaC @ Main	09/12/2002 14:40	su	30.00	8.53	4.87	14.67	0.27	206.60	142.76	7.53	117.16	717.15	1.93	3.78	2.36	3.60	910.09	3287.99	0.08	0.04	0.12	0.65	0.13	
2090006	Dry Collector	Dry Collector	09/12/2002 10:00	cd							1.10	0.65	0.01	3.96			0.71	0.15			0.34	0.56	0.18	8.80	0.15	1830
2090007	SDC @ Michelson	SDC @ Michelson	09/19/2002 10:10	su	22.60	8.33	3.11	15.30	9.67	361.89	161.09	4.43	94.59	423.70	1.50	8.10	21.60	4.65	354.29	888.06	6.61	0.07	0.08	7.29	0.14	
2090008	SDC @ Coronado	SDC @ Coronado	09/19/2002 11:00	su	24.90	8.40	2.03	11.93	8.22	361.35	154.16	3.79	79.00	304.16	1.34	10.24	23.93	5.26	287.40	635.57	8.09	0.08	0.09	8.92	0.17	
2090009	SDC @ Alton	SDC @ Alton	09/19/2002 11:50	su	26.70	8.50	2.73	18.00	7.48	355.00	154.04	3.61	79.28	296.61	1.32	10.23	23.52	6.34	293.00	646.00	8.70	0.07	0.09	9.61	0.18	
2090010	SDC above PCW	SDC above PCW	09/19/2002 12:40	su	26.40	8.32	2.81	16.76	1.70	325.80	189.52	2.80	67.85	282.90	1.36	16.40	14.44	4.57	334.62	591.48	20.77	0.05	0.04	22.71	0.08	
2090011	PCW @ Barranca	PCW @ Barranca	09/19/2002 13:50	su	29.60	8.66	2.72	Satd	2.39	310.78	119.34	3.88	80.00	296.38	1.20	11.69	27.57	6.41	257.10	618.16	6.48	0.04	0.06	6.94	0.11	
2090012	Dry Collector	Dry Collector	09/19/2002 9:30	cd													1.15	0.59			0.15	0.13	0.03	0.50	0.09	3260
2100001	PCW @ Moffett	PCW @ Moffett	10/01/2002 10:30	su	19.40	7.97	2.09	6.95	5.23	381.28	133.89	5.66	72.55	269.04	1.20	14.87	25.37	6.25	204.99	513.81	5.84	0.22	0.21	6.91	0.22	
2100003	SFC @ PCW	SFC @ PCW	10/01/2002 11:30	su	19.20	7.58	1.81		0.59	318.79	209.21	4.10	67.02	141.05	1.46	10.87	16.01	1.63	154.26	492.67	11.09	0.08	0.14	11.87	0.13	
2100005	EMIC @ PCW	EMIC @ PCW	10/01/2002 12:10	su	18.10	9.03	1.22	11.07	0.79	223.42	97.84	10.73	38.45	133.09	0.78	11.07	2.85	4.64	7.86	13.06	2.29	0.11	0.28	3.69	0.35	
2100006	PCW @ EMIC	PCW @ EMIC	10/01/2002 12:30	su	20.50	7.75	1.99	3.79	2.84	355.00	108.50	5.04	55.27	276.65	0.94	15.74	24.45	3.81	169.07	472.52	5.23	0.07	0.22	6.19	0.28	
2100007	PCW below SFC	CC @ PCW	10/01/2002 13:10	su	19.70	8.50	2.64	14.92	0.25	448.44	133.71	2.72	108.76	339.53	1.51	21.26	25.31	17.40	203.70	467.23	14.00	0.05	0.07	14.82	0.08	
2100008	Dry Collector	Dry Collector	10/01/2002 9:30	cd						6.24	0.25	0.29					0.56	0.46	0.79	1.41	0.25	0.49	0.11	1.84	0.19	2650
2100009	PCW @ CC	Weephole 3S	10/08/2002 9:45	gw	24.00	7.48	4.93	2.00		560.78	174.74	9.90	119.64	746.15	2.33	14.12	28.52	24.51	281.00	862.88	4.68	0.06	0.09	4.56	0.14	
2100010	PCW @ CC	Weephole 1N	10/08/2002 10:00	gw	23.70	7.46	4.08	1.83		585.48	115.46	1.76	111.65	606.59	2.01	19.41	31.85	23.15	354.11	1156.37	8.51	0.06	0.13	7.93	0.12	
2100011	PCW @ CC	Weephole 2N	10/08/2002 10:10	gw	24.60	7.35	4.45	2.78		449.17	212.20	2.72	120.96	549.16	2.49	15.30	34.39	11.08	447.32	1491.81	8.28	0.06	0.08	9.98	0.21	
2100012	CIC @ Northwood Plaza on Trabuco	CIC @ Northwood Plaza on Trabuco	10/08/2002 11:00	su	24.80	8.08	1.52	9.67	0.88	158.44	91.52	8.19	45.83	139.08	0.86	7.62	22.47	7.02	159.01	378.11	10.45	0.13	15.89	10.16	18.90	
2100013	Drain - CIC @ Yale	Drain - CIC @ Yale	10/08/2002 11:45	su	21.70	8.19	1.46	8.34		172.11	113.84	8.79	47.15	129.66	1.03	6.35	7.05	1.21	152.65	409.24	7.02	0.12	1.10	7.58	1.21	
2100014	PCW @ Bryan	PCW @ Bryan	10/08/2002 12:40	su	30.30	9.52	1.75	18.32	0.28	125.87	78.98	8.32	42.15	170.19	0.75	6.14	0.09	0.09	239.71	323.02	0.09	0.05	0.09	1.00	0.09	
2100015	HCW @ PCW	HCW @ PCW	10/08/2002 13:15	su	19.80	7.93	1.28	6.94	0.05	221.60	83.19	11.58	27.82	139.89	0.67	11.26	1.20	6.03	141.10	246.39	2.86	0.38	1.36	4.86	1.19	
2100016	PCW @ RCW	PCW @ RCW	10/08/2002 14:00	su	19.80	8.51	1.65	7.12	0.27	294.23	114.58	6.85	53.46	169.89	0.83	8.13	2.50	3.54	250.03	344.26	1.72	0.06	0.33	1.41	0.36	
2100023	SDC @ Campus	SDC @ Campus	10/15/2002 10:15	su	19.60	8.25	2.72	8.69	7.25	324.26	132.81	6.52	86.35	365.79	1.34	6.90	14.30	5.11	313.38	791.15	4.21	0.05	0.11	5.40	0.10	
2100024	Spring - SDC @ Harvard	Spring - SDC @ Harvard	10/15/2002 11:30	gw	22.80	7.00	3.98	0.74		382.66	250.95	2.12	99.05	472.64	2.34	27.15	37.21	6.05	329.15	1203.20	48.88	0.05	0.07	50.10	0.07	

sample id	site	location	Sample Date	Type	Temp	pH	EC (ms)	D.O.	Q	alk	Ca	K	Mg	Na	Sr	Si	Se	As	Cl	SO4	NO3-N	NH4-N	PO4-P	TN	TP	volume
			mm/dd/yyyy hh:mm		deg_c		ms/cm	mg/L	CFS	mg CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml
2100025	SDC @ Harvard	SDC @ Harvard	10/15/2002 11:30	su	19.20	8.19	2.25	14.88	1.41	367.90	185.86	2.91	57.13	251.10	1.19	16.04	5.00	4.78	320.62	494.23	16.78	0.06	0.07	17.05	0.11	
2100026	Drain - SDC @ Harvard	Drain - SDC @ Harvard	10/15/2002 11:45	su	24.00	7.31	3.59	4.66	0.10	403.57	221.21	1.91	101.54	395.16	2.11	31.12	37.54	8.85	331.39	985.74	26.07	0.07	0.10	27.37	0.09	
2100027	Spring - Seams - SDC @ Harvard	Seam 7	10/15/2002 12:00	gw	23.50	7.09	4.29			395.74	269.66	2.72	111.95	492.72	2.78	28.13	102.16	4.35	452.44	1195.74	44.38	0.09	0.10	44.20	0.11	
2100028	SDC @ Culver	Drain	10/15/2002 12:15	su	21.80	8.03	1.33	8.29		158.56	68.36	22.88	31.72	154.94	0.70	8.06	2.11	2.77	73.03	88.00	6.38	0.09	1.54	7.64	1.62	
2100029	CC @ Yale	CC @ Yale	10/15/2002 14:00	su	24.50	8.54	1.45	10.15		240.48	82.75	21.92	32.56	156.42	0.65	11.20	2.30	9.00	63.47	114.02	3.04	2.17	0.45	6.39	0.57	
2100030	CC @ Yale	Spring	10/15/2002 14:00	gw	21.80	7.21	2.77	0.88		641.37	142.66	0.87	74.63	378.37	0.86	28.83	14.85	6.93	206.34	585.48	14.54	0.07	0.06	13.48	0.02	
2100031	CC @ Yale	Drain	10/15/2002 14:00	su	23.50	7.22	2.24	3.79		543.87	110.41	2.63	56.08	306.95	0.71	21.92	7.90	6.75	174.22	467.98	8.81	0.10	0.17	8.56	0.28	
2100032	Dry Collector	Dry Collector	10/22/2002 9:30	cd						4.37	0.31	0.13	-0.54	0.76	-0.01	0.18	0.34	0.70	0.48	1.21	0.26	0.31	0.11	1.18	0.14	2890
2100033	SFC @ Red Hill	SFC @ Red Hill	10/22/2002 10:27	su	18.00	7.85	1.02	9.01	0.15	196.23	76.07	11.37	30.13	110.66	0.81	7.44	0.69	2.24	133.50	221.88	0.28	0.93	0.82	2.26	0.89	
2100033H	SFC @ Red Hill	Hyporheic	10/22/2002 0:00	hy													0.74	7.56	121.97	202.13	0.13	3.46	0.29			
2100034	SFC @ RR	Weephole 7S	10/22/2002 11:30	gw	21.60	6.77	2.11	2.29	0.02	392.24	223.48	2.06	65.52	137.83	1.38	12.24	17.93	2.05	198.62	542.19	19.73	0.10	0.07	18.38	0.05	
2100035	SFC @ RR	Spring 7-8S	10/22/2002 11:40	gw	21.40	6.81	2.11	2.21		386.60	211.62	1.73	61.72	124.67	1.24	12.09	17.64	-0.30	197.51	537.91	20.94	0.06	0.06	18.44	0.04	
2100036	SFC @ RR	Weephole 19S	10/22/2002 12:00	gw	23.70	6.76	2.73	1.76		343.64	283.27	2.46	88.49	150.39	1.89	11.38	37.58	-0.18	172.22	894.13	18.66	0.05	0.05	18.94	0.02	
2100037	SFC @ RR	Weephole 23S	10/22/2002 12:10	gw	22.70	6.85	2.50	1.95		355.32	266.41	2.12	81.01	139.90	1.63	11.72	28.17	-0.28	174.75	757.04	20.45	0.06	0.05	18.53	0.04	
2100038	SFC @ RR	Weephole 4N	10/22/2002 12:30	gw	21.90	6.82	2.12	2.28		379.46	234.02	1.99	68.48	142.52	1.43	13.05	18.34	-0.41	199.89	542.63	18.69	0.05	0.05	19.23	0.03	
2100039	SFC @ RR	Weephole 9N	10/22/2002 13:00	gw	23.40	6.82	2.27	1.98	0.01	369.94	245.11	1.97	71.51	136.10	1.42	12.76	22.44	-0.33	190.56	625.78	18.78	0.05	0.07	17.55	0.03	
2100041	SFC @ RR	Weephole 23N	10/22/2002 13:25	gw	23.10	6.78	2.48	1.91	0.01	360.28	285.11	2.40	85.99	151.67	1.74	12.22	25.55	1.65	172.81	722.08	20.66	0.07	0.06	18.34	0.04	
2100042	SFC @ RR	Weephole 33N	10/22/2002 13:40	gw	22.20	6.79	2.42	2.42	0.01	367.58	280.75	2.51	84.96	159.12	1.80	13.57	26.03	1.39	178.96	697.93	20.35	0.06	0.08	19.35	0.04	
2100043	SFC @ RR	SFC @ RR	10/22/2002 12:50	su	19.10	8.16	1.33	13.07	0.43	225.25	133.18	8.27	46.46	118.71	1.10	7.23	4.93	3.01	134.43	372.70	2.45	0.12	0.29	2.84	0.33	
2100044	SFC @ PCW	SFC @ PCW	10/22/2002 14:41	su	19.90	7.52	1.91	13.66		334.95	225.45	4.30	73.44	160.67	1.65	10.88	17.59	2.65	175.20	590.66	13.12	0.09	0.12	12.02	0.11	
2100050	SDC @ Campus	SDC @ Campus	10/29/2002 10:30	su	18.00	8.24	2.70	10.61	6.09	343.31	153.08	6.65	92.88	394.43	1.48	7.03	11.24	6.33	335.84	843.32	3.81	0.14	0.06	5.09	0.16	
2100051	BaC @ Main	BaC @ Main	10/29/2002 11:15	su	19.10	7.76	3.72	4.02		283.91	165.39	10.35	111.83	604.09	1.89	5.75	2.51	4.97	391.96	1396.30	1.48	2.87	0.10	6.54	0.18	
2100052	BaC @ Jamboree	BaC @ Jamboree	10/29/2002 11:45	su	19.10	7.65	3.88	3.31	0.03	245.91	172.15	11.29	115.89	650.12	2.01	5.55	2.48	5.17	403.62	1455.24	1.29	3.13	0.07	6.88	0.29	
2100053	BaC @ Alton	BaC @ Alton	10/29/2002 13:00	su	19.10	7.88	3.81	4.81		255.15	157.27	7.67	112.95	650.98	1.89	6.59	2.07	3.68	510.23	1777.88	0.64	2.20	0.19	4.20	0.45	
2100054	BaC @ Barranca	BaC @ Barranca	10/29/2002 14:30	su	17.50	8.12	1.33	7.04		176.19	123.91	8.95	49.08	139.47	1.35	4.76	2.83	4.20	157.30	460.63	0.55	0.62	0.10	2.44	0.19	
2100055	BaC @ Barranca	Drain	10/29/2002 14:30	su	21.50	7.84	8.40	5.92		303.51	Satd	3.48	209.42	1149.59	4.13	11.85	14.31	1.42	784.68	3942.93	5.23	0.11	0.07	4.96	0.05	
2100056	BaC @ Red Hill	BaC @ Red Hill	10/29/2002 15:00	su	19.60	7.86	1.56	6.22		212.33	163.74	7.71	53.06	121.99	1.90	6.71	0.96	2.40	150.40	557.69	1.29	0.26	0.37	3.17	0.78	
2100057	Wet Collector	Wet Collector	10/29/2002 9:30	cw							1.47	0.37	0.23	2.35		0.09	0.18	1.62	2.14	3.12	1.31	0.61	0.05	2.13	0.04	63.5
2100058	Dry Collector	Dry Collector	10/29/2002 9:30	cd							0.20	0.11	0.12	0.47			0.22	1.59	1.29	0.99	0.20	0.24	0.08	1.06	0.10	3345
2110001	SFC @ PCW	SFC @ PCW	11/05/2002 10:55	su	19.40	7.90	1.79	16.60		337.13	189.90	3.15	61.95	125.59	1.26	9.01	15.81	2.68	161.11	526.09	11.28	0.11	0.12	11.92	0.10	
2110002	ECD @ PCW	ECD @ PCW	11/05/2002 11:10	gw	22.70	7.94	3.60	7.18		597.04	134.95	1.22	143.42	398.93	2.16	34.95	116.72	9.00	314.24	994.28	12.43	0.14	0.15	13.57	0.13	
2110003	SDC @ Campus	PCW below SFC	11/05/2002 11:30	su	19.30	8.17	2.23	10.60		411.69	134.80	4.10	76.64	261.29	1.15	12.77	29.66	8.39	258.82	680.00	7.25	0.19	0.51	8.54	0.65	
2110004	PCW below SFC	CC @ PCW	11/05/2002 12:00	su	24.50	8.77	2.88	Satd		379.14	88.50	1.58	104.39	330.54	1.20	17.85	27.80	17.02	310.54	706.28	14.31	0.11	0.06	15.66	0.05	
2110005	PCW @ Walnut	PCW @ Walnut	11/05/2002 12:25	su	16.50	8.75	1.82	7.02		371.98	104.99	6.21	56.94	221.80	0.88	6.73	12.26	6.19	234.58	431.25	7.97	0.10	0.41	9.55	0.44	
2110007	DP @ PCW	DP @ PCW	11/05/2002 13:00	gw	22.60	7.50	2.68	7.65		451.44	142.12	0.71	69.24	351.82	1.01	16.02	46.30	2.98	201.56	670.38	18.39	0.23	0.54	20.36	0.81	
2110008	EMIC @ PCW	EMIC @ PCW	11/05/2002 13:30	su	21.90	10.03	1.29	9.62		106.79	104.56	7.11	33.74	131.77	0.81	6.03	3.14	2.90	162.37	313.73	1.03	0.13	0.09	2.31	0.19	
2110009	SFC @ PCW	SFC @ PCW	11/05/2002 14:20	su	22.20	8.11	1.99	15.74		329.18	207.74	3.58	70.95	142.27	1.44	8.82	15.32	2.60	169.74	591.84	11.62	0.11	0.13	12.40	0.16	
2110010	SDC @ Campus	PCW below SFC	11/05/2002 14:30	su	21.90	8.34	2.35	13.60		397.54	131.75	4.45	75.95	258.30	1.11	12.31	30.62	5.76	235.42	627.95	8.19	0.18	0.56	9.01	0.62	
2110011	ECD @ PCW	ECD @ PCW	11/05/2002 14:45	gw	23.10	7.80	3.54	6.96		557.43	134.36	1.71	141.29	384.09	2.07	34.90	117.84	27.79	315.09	992.50	11.00	0.13	0.17	12.75	0.13	
2110012	PCW below SFC	CC @ PCW	11/05/2002 15:00	su	23.60	8.74	2.77	Satd		342.66	82.42	1.71	109.59	351.97	1.17	17.73	23.35	26.31	288.09	641.60	14.63	0.11	0.05	15.22	0.04	
2110013	EMIC @ PCW	EMIC @ PCW	11/05/2002 15:30	su	20.00	9.98	1.39	7.63		116.35	109.14	12.61	37.15	160.38	0.86	6.38	3.48	2.59	195.55	394.92	2.82	0.13	0.14	4.55	0.75	
2110014	PCW @ EMIC	PCW @ EMIC	11/05/2002 16:00	su	20.10	7.92	2.35	6.74		436.08	125.66	3.18	64.18	293.47	0.97	12.43	29.86	4.16	249.35	716.17	7.12	0.21	0.43	8.23	0.49	
2110015	DP @ PCW	DP @ PCW	11/05/2002 16:20	gw	22.00	7.60	2.67	7.75		593.74	136.53	1.22	67.28	326.89	0.96	15.72	43.81	2.30	206.34	685.36	9.08	0.18	0.54	9.89	0.56	
2110016	PCW @ Walnut	PCW @ Walnut	11/05/2002 16:40	su	17.60	8.02	1.76	5.79		322.08	101.85	6.79	56.05	221.14	0.87	7.02	11.39	5.92	235.26	442.92	6.74	0.11	0.44	8.39	0.45	
2110017	Drain - PCW @ Walnut	Drain - PCW @ Walnut	11/05/2002 16:50	su	20.70	8.22	2.49	5.96		632.90	87.26	1.00	89.23	341.59	1.19	24.97	30.12	13.33	164.72	520.48	12.74	0.11	0.14	13.37	0.10	
2110019	SDC @ Campus	SDC @ Campus	11/12/2002 10:30	su	17.20	7.87	1.88	6.67	5.86	267.62	119.79	7.65	60.21	219.15	0.93	10.72	9.41	7.35	236.06	487.76	6.32	0.53	0.42	7.51	0.55	
2110020	SDC @ Michelson	SDC @ Michelson	11/12/2002 11:30	su	19.50	8.04	2.88	8.32		369.41	167.02	5.14	87.66	337.53	1.38	15.05	23.30	6.87	331.21	830.35	11.26	0.31	0.33	11.00	0.37	
2110021	SDC @ Alton	SDC @ Alton	11/12/2002 12:30	su	21.50	8.08	2.52	8.54	8.30	361.24	157.46	4.57	77.02	252.67	1.21	17.15	25.95	7.05	284.30	647.30	12.62	0.24	0.35	12.56	0.39	
2110022	PCW @ Barranca	PCW @ Barranca	11/12/2002 13:30	su	23.30	8.11	2.71	8.42	4.89	407.16	149.08	3.83	81.50	272.37	1.25	17.17	30.84	8.17	263.40	692.10	12.25	0.20	0.37	13.29	0.37	
2110023	SDC @ Harvard	SDC @ Harvard	11/12/2002 14:15	su	22.00	8.03	2.06	9.65	1.38	300.09	154.78	5.18	50.01	171.52	0.84	17.26	3.85	6.58	297.30	374.70	13.38	0.18	0.28	13.38	0.30	
2110024	Spring - SDC @ Harvard	Spring - SDC @ Harvard	11/12/2002 15:00	gw	22.50	7.05	3.92	0.71		363.18	262.75	1.94	103.58	469.93	2.32	29.92	37.41	5.37	338.30	1229.10	47.54	0.10	0.08	47.85	0.08	
2110025	Wet Collector	Wet Collector	11/12/2002 9:30	cw							0.06		0.08	1.00			-0.15	0.01		0.20	0.13	0.13	0.01	0.29	0.04	1730
2110026	Dry Collector	Dry Collector	11/12/2002 9:30	cd							0.37	0.04	0.13	0.30		0.10	-0.32	0.68	1.51	0.97	0.18	0.26	0.03	0.78	0.08	3590
2110039	SFC @ RR	Weephole 10N	11/19/2002 10:16	gw	22.60	6.75	2.21	2.24	0.02	230.37	210.36	1.88	62.54	125.54	1.27	11.79	16.78	0.86	176.55	509.66	17.63	0.08	0.06	19.46	0.04	
2110040	EMIC @ PCW	EMIC @ PCW	11/19/2002 10:55	su	17.50	9.20	1.31	16.90	0.73	188.26	127.92	5.47	45.00	125.75	1.07	6.88	3.39	2.17	168.00	276.77	2.08	0.15	0.12	3.20	0.19	
2110041	PCW @ EMIC	PCW @ EMIC	11/19/2002 11:32	su	17.20	7.89	1.71	9.04		357.69	90.03	5.00	50.49	249.52	0.75	12.54	15.33	4.60	165.14	365.09	4.27	0.11	0.37	5.56	0.44	
2110042	PCW below SFC	CC @ PCW	11/19/2002 12:20	su	23.20	8.42	2.93	Satd	1.02	369.51	110.01	2.38	95.44	354.98	1.22	23.23	23.19	13.09	365.72	606.54	16.74	0.13	0.05	20.89	0.15	
2110044	PCW @ Moffett	PCW @ Moffett	11/19/2002 14:32	su	20.40	8.64	2.10	Satd	5.17	356.29	111.26	3.85	70.03	253.20	1.00	13.65	24.61	7.18	209.96	488.52	7.18	0.10	0.18	8.41	0.25	
2110045	SDC @ Campus	SDC @ Campus	11/26/2002 10:30	su	13.50	8.42	2.45	11.37	6.62	298.54	158.19	7.02	92.01	376.23	1.47	8.20	19.77	5.14	325.91	858.81	8.09	0.09	0.08	9.92	0.14	
2110045B	SDC @ Campus	sediment	11/26/2002 10:30	se																						
2110045H	SDC @ Campus	Hyporheic	11/26/2002 10:30	hy													1.20	6.20	612.07	1520.03	0.24	1.26	0.45			
2110046	SDC @ Marsh Inlet	SDC @ Marsh Inlet	11/26/2002 13:00	su	15.80	8.54	2.46	9.04		306.71	160.14	6.88	91.97	378.90	1.49	10.20	21.47	5.73	328.72	828.30	9.52	0.23	0.09	11.29	0.14	
2110046B	SDC @ Marsh Inlet	sediment1	11/26/2002 13:00	se																						
2110046H	SDC @ Marsh Inlet	Hyporheic	11/26/2002 13:00	hy													1.51	25.12	354.81	32.47	0.40	3.92	0.05			
2110047	PCW @ CC	PCW below CC	11/26/2002 15:20	su	16.60	8.55	1.65	10.51		275.89	128.21	8.03	60.22	190.78	1.09	12.50	11.26	6.80	328.88	820.41	8.81	0.49	0.31	10.34	0.63	
2110047B	PCW below CC	sediment	11/26/2002 15:20	se																						
2110049	Dry Collector	Dry Collector	11/26/2002 9:30	cd						6.87	1.19	1.38		1.27			0.19	0.67	1.37	1.39	0.23	0.10	0.09	7.35	0.27	
2120001	PCW @ CC	PCW below CC	12/03/2002 13:00	su	19.50	8.15	2.00	10.68		327.10	122.48	8.65	63.18	262.87	1.08	14.00	16.62	5.40	204.23	447.60	7.76	1.54	0.51	11.19	0.62	
2120003	Dry Collector	Dry Collector	12/03/2002 10:00	cd						4.87	0.37	0.14					0.19	-0.14	0.39	0.53	0.14	0.06	0.01	0.20	0.06	3580
2120004	Wet Collector	Wet Collector	12/03/2002 10:00	cw						2.75		0.14					0.20	0.05	0.33	0.72	0.28	0.31	0.02	0.69	0.05	320
2120005	PCW below CC	Well 2(B)	12/03/2002 14:00	hy	18.70		3.70				139.25	14.24	101.69	544.86	1.46	25.90	1.52	13.50	340.15	223.39	0.58	45.38	6.07			
2120009	PCW below CC	1A1	12/17/2002 11:30	pe							38.23	4.10	25.96	66.46	0.42	3.81										

sample id	site	location	Sample Date	Type	Temp	pH	EC (ms)	D.O.	Q	alk	Ca	K	Mg	Na	Sr	Si	Se	As	Cl	SO4	NO3-N	NH4-N	PO4-P	TN	TP	volume
			mm/dd/yyyy hh:mm		deg_c		ms/cm	mg/L	CFS	mg CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml
2120010	PCW below CC	1A2	12/17/2002 11:30	pe							41.72	4.01	23.98	66.53	0.38	3.60										
2120011	PCW below CC	1A3	12/17/2002 11:30	pe							25.96	1.95	14.84	38.68	0.22	3.80										
2120012	PCW below CC	1A4	12/17/2002 11:30	pe							16.54	1.15	9.10	30.00	0.14	1.06										
2120013	PCW below CC	1B1	12/17/2002 11:30	pe							36.23	4.47	25.54	68.17	0.44	3.41										
2120014	PCW below CC	1B2	12/17/2002 11:30	pe							47.74	4.08	28.41	70.83	0.44	4.12										
2120015	PCW below CC	1B3	12/17/2002 11:30	pe							52.00	3.70	29.76	66.24	0.40	5.24										
2120016	PCW below CC	1B4	12/17/2002 11:30	pe							20.34	1.81	10.93	34.26	0.16	3.86										
2120017	PCW below CC	1B5	12/17/2002 11:30	pe							17.43	1.26	8.81	27.53	0.13	1.48										
2120018	PCW below CC	2A1	12/17/2002 11:30	pe							21.28	1.05	17.26	90.98	0.26	4.08										
2120019	PCW below CC	2A2	12/17/2002 11:30	pe							31.56	1.17	25.89	107.92	0.37	7.25										
2120020	PCW below CC	2A3	12/17/2002 11:30	pe							24.85	1.39	20.88	103.87	0.28	4.94										
2120021	PCW below CC	2A4	12/17/2002 11:30	pe							26.36	1.62	19.94	103.42	0.28	5.34										
2120022	PCW below CC	2A5	12/17/2002 11:30	pe							26.30	1.82	25.36	112.65	0.33	6.55										
2120023	PCW below CC	2B1	12/17/2002 11:30	pe							23.52	1.21	18.09	94.80	0.25	4.06										
2120024	PCW below CC	2B2	12/17/2002 11:30	pe							20.05	0.91	19.54	93.23	0.29	3.59										
2120025	PCW below CC	2B3	12/17/2002 11:30	pe							22.52	0.97	21.22	99.10	0.30	4.23										
2120026	PCW below CC	2B4	12/17/2002 11:30	pe							22.22	0.71	16.48	87.55	0.24	3.91										
2120027	PCW below CC	2B5	12/17/2002 11:30	pe							20.86	1.40	14.91	86.69	0.21	4.38										
2120028	PCW below CC	2B6	12/17/2002 11:30	pe							25.40	1.70	21.28	104.32	0.30	5.04										
2120029	PCW below CC	2B7	12/17/2002 11:30	pe							15.67	2.02	19.59	83.39	0.24	4.26										
2120030	PCW below CC	3A1	12/17/2002 11:30	pe							54.05	4.00	27.07	50.46	0.45	4.25										
2120031	PCW below CC	3A2	12/17/2002 11:30	pe							48.94	4.05	22.35	39.76	0.36	2.67										
2120032	PCW below CC	3A3	12/17/2002 11:30	pe							37.71	2.42	19.68	35.04	0.31	3.94										
2120033	PCW below CC	3A4	12/17/2002 11:30	pe							17.60	1.42	7.83	22.19	0.13	1.99										
2120034	PCW below CC	3A5	12/17/2002 11:30	pe							19.74	1.36	10.95	32.99	0.15	1.25										
2120035	PCW below CC	3B1	12/17/2002 11:30	pe							49.52	3.92	22.51	41.24	0.37	3.06										
2120036	PCW below CC	3B2	12/17/2002 11:30	pe							18.64	1.57	8.54	31.67	0.14	2.39										
2120037	PCW below CC	3B3	12/17/2002 11:30	pe							24.35	1.32	13.95	47.31	0.20	2.20										
2120038	PCW below CC	4A1	12/17/2002 11:30	pe							49.87	5.05	31.12	55.36	0.54	3.62										
2120039	PCW below CC	4A2	12/17/2002 11:30	pe							52.12	4.92	30.47	53.70	0.48	3.42										
2120040	PCW below CC	4A3	12/17/2002 11:30	pe							70.55	5.51	36.49	58.76	0.51	4.21										
2120041	PCW below CC	4A4	12/17/2002 11:30	pe							30.41	2.76	14.06	27.14	0.22	2.37										
2120042	PCW below CC	4A5	12/17/2002 11:30	pe							35.72	2.01	19.34	40.29	0.28	2.89										
2120043	PCW below CC	4B1	12/17/2002 11:30	pe							23.69	5.11	30.27	57.09	0.43	3.36										
2120044	PCW below CC	4B2	12/17/2002 11:30	pe							54.96	4.56	29.49	49.28	0.44	3.23										
2120045	PCW below CC	4B3	12/17/2002 11:30	pe							40.22	4.45	33.53	49.84	0.37	3.89										
2120046	PCW below CC	4B4	12/17/2002 11:30	pe							33.18	2.94	15.88	32.27	0.25	2.92										
2120047	PCW below CC	4B5	12/17/2002 11:30	pe							18.34	1.38	9.70	29.51	0.14	1.40										
2120049	SDC @ Campus	SDC @ Campus	12/17/2002 10:30	sm	14.10	7.77	0.82		70.66	123.85	64.42	6.80	26.52	98.05	0.47	5.36	2.99	5.55	113.21	203.91	5.02	0.77	0.46	7.51	0.76	
2120050	EMIC @ El Camino Real	EMIC @ El Camino Real	12/17/2002 13:35	sm	13.20	6.86	0.08			26.11	7.13	2.43	1.12	8.15	0.04	0.67	0.12	2.05	9.87	9.70	0.59	0.35	0.26	2.00	0.64	
2120051	PCW @ El Camino Real	PCW @ El Camino Real	12/17/2002 14:00	sm	14.50	8.08	0.30			92.99	27.94	4.83	8.40	29.38	0.15	3.04	0.37	4.50	32.84	60.70	2.93	0.52	0.56	5.34	1.59	
2120052	Dry Collector	Dry Collector	12/17/2002 9:45	cd						4.25		0.28				-0.25	0.08	0.14	0.62	0.63	0.13	0.16	0.02	0.61	0.12	3660
2120053	Wet Collector	Wet Collector	12/17/2002 9:45	cw						3.12		0.21				-0.24	0.09	-0.01	1.59	1.28	0.06	0.16	0.01	0.26	0.05	1820
3010001	SDC @ Campus	SDC @ Campus	01/02/2003 10:00	su	11.80	8.16	1.95	11.69	5.69	265.94	133.98	5.41	76.99	295.98	1.17	8.75	14.80	3.43	269.52	603.26	5.33	0.08	0.17	7.03	0.13	
3010002	CIC @ Northwood Plaza on Trabuco	CIC @ Northwood Plaza on Trabuco	01/02/2003 11:10	su	14.10	8.06	1.32	12.18	0.77	109.31	105.08	17.13	46.85	133.11	1.05	3.73	5.97	5.68	130.22	350.35	36.73	8.34	3.11	47.44	3.52	
3010003	BaC @ Alton	BaC @ Alton	01/02/2003 12:00	su	16.40	7.96	2.02	12.20		165.11	128.35	4.76	74.53	254.35	1.77	5.44	1.07	0.39	187.87	723.06	0.37	0.33	0.15	1.02	0.38	
3010004	EMIC @ 17th	EMIC @ 17th	01/02/2003 13:00	su	16.70	8.62	1.34	16.25	0.28	277.78	112.60	4.03	74.08	104.80	0.78	22.70	5.69	1.39	161.69	286.33	4.08	0.02	0.07	5.00	0.09	
3010005	Dry Collector	Dry Collector	01/02/2003 9:45	cd						4.00		0.74		0.28			0.13	-0.27	0.80	0.57	0.13	0.10	0.06	0.45	0.13	3530
3010006	Wet Collector	Wet Collector	01/02/2003 9:45	cw						4.25		0.18					0.52	0.63	1.06	0.61	0.11	0.06	0.01	0.23	0.04	2340
3010007	SFC @ Red Hill	SFC @ Red Hill	01/07/2003 9:40	su	15.50	7.92	0.89	9.80	0.09	167.57	83.52	7.04	30.15	83.23	0.83	5.64	1.48	1.53	112.12	181.12	1.51	0.11	0.08	2.44	0.17	
3010008	SFC @ RR	SFC @ RR	01/07/2003 10:15	su	16.10	7.72	1.28	13.17	0.16	215.88	148.30	4.90	48.70	98.11	1.18	6.59	7.80	1.22	121.85	385.32	3.84	0.04	0.06	5.30	0.22	
3010010	SFC @ RR	Weephole 10N	01/07/2003 10:52	gw	22.50	6.77	2.20	2.55	0.01	366.51	245.29	2.21	70.51	139.66	1.47	14.20	17.86	0.07	182.10	553.22	16.30	0.03	0.04	20.07	0.04	
3010011	SFC @ RR	Weephole 33N	01/07/2003 11:12	gw	21.20	6.87	2.38	2.81	0.00	359.63	272.27	2.64	81.94	151.57	1.77	13.50	23.96	1.01	185.65	734.50	17.65	0.02	0.05	21.24	0.05	
3010012	SFC @ RR	Weephole 7S	01/07/2003 11:45	gw	22.00	6.82	2.13	2.42	0.02	375.94	236.01	2.37	68.81	139.77	1.43	14.50	15.15	0.20	181.71	507.16	17.81	0.02	0.03	21.03	0.04	
3010013	SFC @ RR	Spring 7-8S	01/07/2003 11:50	gw	21.60	6.79	2.12	2.26		365.97	233.92	2.30	67.81	138.95	1.42	14.40	15.38	1.25	182.37	508.87	18.22	0.02	0.03	21.48	0.04	
3010014	SFC @ RR	Weephole 21S	01/07/2003 12:15	gw	22.40	6.80	2.64	1.65	0.01	350.46	296.11	3.01	92.09	164.50	2.10	12.80	31.73	1.14	190.27	943.49	18.33	0.02	0.04	21.03	0.05	
3010015	SFC @ RR	Drain	01/07/2003 12:20	su	17.10	8.27	1.60	8.52	0.00	317.48	165.60	9.93	56.89	149.60	1.22	12.30	13.17	1.16	113.76	434.80	7.07	0.02	0.11	8.14	0.17	
3010016	SFC @ PCW	SFC @ PCW	01/07/2003 14:00	su	19.40	8.02	1.92	Satd	0.37	294.56	210.43	3.46	70.08	136.89	1.51	11.20	16.24	1.54	164.98	567.17	13.01	0.01	0.01	16.08	0.05	
3010018	SDC @ Campus	SDC @ Campus	01/08/2003 10:00	su	13.30	8.29	2.07	9.88	4.47	271.53	139.18	5.73	79.48	304.40	1.22	9.12	16.34	4.01	277.02	681.97	5.58	0.10	0.01	7.90	0.10	
3010019	SDC @ Coronado	SDC @ Coronado	01/08/2003 11:15	su	15.10	8.34	2.20	14.05	8.47	319.23	164.45	5.64	84.40	296.55	1.42	14.00	23.43	6.10	279.54	689.90	11.82	0.03	0.12	14.91	0.24	
3010020	SDC @ Michelson	SDC @ Michelson	01/08/2003 10:45	su	14.90	8.23	2.55	11.82		309.68	171.06	5.93	96.30	373.49	1.55	12.00	22.00	5.14	326.24	886.48	11.21	0.04	0.10	13.74	0.18	
3010021	SDC @ Alton	SDC @ Alton	01/08/2003 12:00	su	16.40	8.46	2.21	16.32	6.76	334.08	159.36	5.36	81.61	285.42	1.38	14.80	24.50	5.61	286.53	722.78	11.05	0.02	0.13	14.67	0.27	
3010022	SFC @ PCW	SFC @ PCW	01/08/2003 14:00	sm	18.00	7.82	0.35	8.02		76.68	37.79	2.95	10.08	25.02	0.23	1.85	1.93	1.45	24.90	68.21	2.25	0.68	0.08	4.94	0.78	
3010023	PCW @ Moffett	PCW @ Moffett	01/08/2003 14:30	sm	17.40	8.19	0.38	8.45		70.98	27.15	4.63	10.95	39.16	0.22	2.03	1.21	2.47	34.64	72.34	2.65	0.79	0.24	6.29	1.30	
3010024	PCW below SFC	CC @ PCW	01/08/2003 14:45	sm	17.50	7.65	1.38	8.29		32.04	9.39	2.71	2.88	13.42	0.08	1.01	0.66	1.97	10.22	21.69	1.34	0.73	0.24	3.68	0.78	
3010025	PCW @ EMIC	PCW @ EMIC	01/08/2003 15:00	sm	17.20	8.38	0.20	6.69		48.65	16.57	4.28	4.55	17.50	0.11	1.36	0.27	1.75	15.71	34.81	2.49	1.06	0.29	5.51	0.84	
3010026	DP @ PCW	DP @ PCW	01/08/2003 15:15	gw	20.80	7.45	0.24	5.56	1.90	439.93	139.67	1.41	65.06	349.17	1.04	17.00	36.93	1.90	195.22	584.05	6.12	0.05	0.25	7.21	0.32	
3010027	EMIC @ PCW	EMIC @ PCW	01/08/2003 15:40	sm	17.80	8.17	1.55	7.50		30.32	13.79	4.49	3.11	12.14	0.09	0.91	0.42	1.10	12.94	22.96	1.29	0.26	0.13	3.74	0.68	
3010028	PCW @ Barranca	PCW @ Barranca	01/14/2003 10:20	su	16.10	8.48	2.34	Satd	5.49	370.80	163.10	4.29	90.41	300.74	1.40	16.20	30.93	6.44	249.11	725.34	8.84		0.16	10.06	0.19	
3010030	Drain - PCW W side S of Warner	Drain - PCW W side S of Warner	01/14/2003 11:15	su	19.00	7.90	6.01	8.02	0.07	278.90	294.96	18.18	161.80	884.82	3.04	27.40	13.07	2.50	1050.65	1723.22	18.20	0.47	0.22	23.12	0.23	
3010031	WD @ PCW	WD @ PCW	01/14/2003 11:30	su	18.50	7.65	2.75	5.01	0.48	377.65	219.86	2.87	85.60	315.01	1.74	34.40	18.96	7.46	359.94	730.33	13.31	0.10	0.18	15.69	0.19	
3010032	PCW @ Moffett	PCW @ Moffett	01/14/2003 12:05	su	18.30	8.39	2.18	Satd	3.62	373.05	135.13	4.32	77.67	278.13	1.16	15.30	28.11	6.21	217.26	574.85	8.11		0.21	8.95	0.24	

sample id	site	location	Sample Date	Type	Temp	pH	EC (ms)	D.O.	Q	alk	Ca	K	Mg	Na	Sr	Si	Se	As	Cl	SO4	NO3-N	NH4-N	PO4-P	TN	TP	volume
			mm/dd/yyyy hh:mm		deg_c		ms/cm	mg/L	CFS	mg CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml
3010034	VD @ PCW	VD @ PCW	01/14/2003 12:40	su	19.30	8.07	3.47	8.50	2.11	378.18	207.71	4.22	109.26	427.33	1.77	31.90	24.68	8.33	500.14	815.72	19.42		0.15	21.47	0.15	
3010035	VD @ PCW	Spring	01/14/2003 12:55	gw	18.80	7.08	4.75	2.82		441.91	253.85	2.89	204.61	563.99	4.03	42.30	168.15	23.11	537.25	1860.99	11.64	0.09	0.09	13.38	0.07	
3010036	Spring - PCW across from VD	Spring - PCW across from VD	01/14/2003 13:10	gw	21.20	7.02	2.67	2.24		344.83	263.71	2.52	98.89	198.49	1.97	13.80	20.47	1.32	242.18	796.42	16.88		0.03	20.85	0.03	
3010037	Dry Collector	Dry Collector	01/14/2003 9:30	cd							0.44	2.15		1.19			0.20	-0.41	1.00	1.09	0.16	0.16	0.17	1.06	0.73	3030
3010038	Wet Collector	Wet Collector	01/14/2003 9:30	cw															4.50	3.88	1.19	1.29	0.05	0.00		15
3010039	PCW below CC	Well A	01/15/2003 10:20	hy	18.00	7.02	5.01	0.43			52.40	27.49	132.11	560.85	1.31	25.20	1.20	14.00	307.61	9.58	0.12	100.43	0.03	76.40	12.16	
3010040	PCW below CC	Well B	01/15/2003 10:30	hy	17.20	6.88	3.75	0.38		1637.08	189.64	21.10	82.21	468.74	1.34	27.30	1.02	7.47	325.65	17.39	0.04	76.78	2.19	52.71	12.48	
3010041	PCW below CC	Well C	01/15/2003 10:45	hy	15.90	7.59	2.16	0.68		473.68	63.76	5.08	90.21	247.47	1.08	21.30	1.09	4.18	159.34	372.31	0.03	4.90	1.26	8.42	2.10	
3010042	PCW below CC	Well D	01/15/2003 11:15	hy	16.60	7.77	2.92			835.16	112.25	10.01	84.12	429.32	1.40	26.20	1.00	13.77	250.83	326.14	0.03	14.37	5.59	17.53	6.61	
3010043	PCW @ CC	Weephole 1N	01/15/2003 12:05	gw	20.40	7.52	4.07	1.73		530.13	142.79	3.24	123.60	675.86	2.23	22.80	120.24	24.07	437.45	1448.26	8.13	0.07	0.13	8.33	0.13	
3010044	Drain - PCW @ CC	Drain - PCW @ CC	01/15/2003 12:20	su	16.10	8.31	1.28	9.27		245.79	80.40	10.83	29.15	209.03	0.72	13.80	1.81	6.58	149.02	250.36	4.47	0.56	1.04	8.25	1.64	
3010045	PCW below SFC	CC @ PCW	01/15/2003 13:10	su	20.10	8.48	2.87	Satd	0.39	451.44	136.29	2.15	118.86	369.46	1.56	29.90	25.96	16.62	325.87	739.96	17.68	0.12	0.06	17.67	0.05	
3010046	SDC @ Harvard	SDC @ Harvard	01/15/2003 14:15	su	17.00	8.73	2.00	Satd	1.79	242.06	163.91	3.76	57.05	241.07	1.11	20.40	3.85	2.88	286.80	440.14	20.88		0.13	22.10	0.07	
3010047	Spring - Seams - SDC @ Harvard	Seam 8N	01/15/2003 14:40	gw	16.20	7.13	3.65	1.24		326.45	297.42	3.46	117.66	473.72	2.70	30.50	80.40	4.07	415.66	1274.52	49.88	0.09	0.20	54.40	0.11	
3010048	Drain - SDC @ Harvard	Drain - SDC @ Harvard	01/15/2003 15:00	su	23.00	7.53	3.54	6.50	0.15	331.14	234.46	2.33	106.58	405.24	2.20	35.60	35.97	6.74	324.78	976.45	24.52	0.13	0.07	25.99	0.07	
3010050	Spring - SDC @ Culver	Spring - SDC @ Culver	01/15/2003 15:45	gw	18.50	6.97	2.40	1.44		378.29	234.53	2.73	63.51	248.76	1.37	32.60	4.28	4.80	357.36	522.82	21.42	0.01	0.08	23.87	0.08	
3010051	SDC @ Culver	SDC @ Culver	01/15/2003 15:40	su	17.70	8.60	1.95	18.83	1.36	257.29	158.32	4.57	54.73	223.83	1.04	19.30	3.41	3.92	279.01	395.74	20.12	0.03	0.05	21.76	0.08	
3010062	SDC @ Campus	SDC @ Campus	01/21/2003 9:45	su	15.50	8.35	2.41	10.55	12.74	284.13	152.31	5.73	89.43	361.72	1.38	9.27	18.96	4.27	307.99	779.63	9.98	0.09	0.07	10.41	0.15	
3010064	LC @ Main	LC @ Main	01/21/2003 11:50	su	22.50	8.34	2.30	16.28	1.20	194.50	194.69	3.94	70.92	211.10	1.71	9.37	14.52	1.51	149.61	497.35	5.39	0.07	0.04	6.17	0.07	
3010066	BaC @ Main	BaC @ Main	01/21/2003 12:35	su	19.80	8.34	4.93	13.89	0.24	199.58	186.99	6.11	141.84	828.93	2.41	1.65	4.13	3.94	553.61	2300.62	0.13	0.12	0.02	0.68	0.07	
3010067	BaC @ Alton	BaC @ Alton	01/21/2003 13:45	su	17.80	8.87	5.87	9.40	0.13	263.81	206.93	6.22	156.20	1071.85	2.85	5.10	3.43	2.49	595.19	2587.24	0.55	14.83	0.10	13.52	0.17	
3010068	BaC @ Jamboree	BaC @ Jamboree	01/21/2003 14:20	su	20.00	8.36	4.80	13.04	0.04	175.96	181.05	5.59	135.22	770.94	2.25	1.11	4.17	2.22	491.43	1939.70	0.16	0.03	0.01	0.89	0.11	
3010069	BaC @ Barranca	BaC @ Barranca	01/21/2003 15:00	su	18.90	8.65	1.58	19.21	0.08	144.81	123.61	5.09	55.52	171.82	1.42	1.00	4.86	1.53	189.08	519.20	0.32	0.05	0.01	1.02	0.07	
3010070	Dry Collector	Dry Collector	01/28/2003 9:40	cd						3.00	0.22	0.95	0.05	1.44		0.06	0.33	0.93	0.31	0.64	0.19	0.20		0.57	0.04	3000
3010071	ECD @ PCW	ECD @ PCW	01/28/2003 10:10	gw	21.20	7.05	3.47	7.70	0.19	550.41	133.44	1.19	146.25	434.15	2.30	39.99	126.12	29.81	355.37	974.25	12.93	0.08	0.10	14.74	0.10	
3010071D	ECD @ PCW	ECD @ PCW	01/28/2003 10:10	D	21.20	7.05	3.47	7.70		511.37	134.46	1.26	147.28	435.41	2.29	40.42	127.64	29.89	356.30	977.50	13.96	0.09	0.10	14.13	0.10	
3010072	EMIC @ PCW	EMIC @ PCW	01/28/2003 11:45	su	16.70	9.87	1.62	17.59	0.44	135.36	100.85	11.49	38.96	125.35	0.73	2.60	3.51	3.27	172.48	250.92	1.61	0.05	0.05	2.45	0.10	
3010073	PCW @ EMIC	PCW @ EMIC	01/28/2003 12:30	su	18.60	7.83	1.98	8.33	4.72	402.83	111.91	3.64	59.25	305.44	0.88	14.13	21.44	5.16	217.06	490.47	3.74	0.06	0.39	4.13	0.43	
3010074	Drain - PCW @ Walnut	Drain - PCW @ Walnut	01/28/2003 13:50	su	19.60	8.06	2.40	8.21	0.03	614.52	89.38	1.20	90.89	367.74	1.25	26.75	29.00	14.20	184.93	495.38	14.05	0.06	0.19	12.72	0.10	
3010075	CIC @ PCW	CIC @ PCW	01/28/2003 14:20	su	17.30	9.27	1.30	10.26	0.03	125.87	87.87	15.15	31.28	168.02	0.83	5.86	7.93	4.74	164.68	293.83	30.71	0.09	0.19	31.72	0.36	
3010077	PCW @ Bryan	PCW @ Bryan	01/28/2003 15:15	su	20.40	10.38	1.66	16.06	0.37	154.22	75.18	7.55	48.17	217.54	0.65	2.37	2.11	4.20	255.34	296.13	0.24	0.04	0.01	1.62	0.09	
3010078	Tomato Springs	Tomato Springs	02/04/2003 9:35	gw	21.80	6.81	3.98	6.91	0.00	346.02	Satd	6.49	147.55	308.09	1.34	28.48	77.70	4.54	486.67	1410.98	5.34	0.12	0.04	5.86	0.04	
3010079	SADC @ Irvine	SADC @ Irvine	02/04/2003 11:10	su	16.80	8.32	2.15	Satd	1.82	252.00	218.96	4.84	87.35	239.02	1.82	7.01	8.50	1.49	206.93	864.88	2.38	0.05	0.03	3.13	0.05	
3010079D	SADC @ Irvine	SADC @ Irvine	02/04/2003 11:10	D	16.80	8.32	2.15	Satd		241.61	208.04	5.04	84.49	236.73	1.75	7.04	7.86	2.00	204.59	828.81	2.32	0.04	0.03	3.05	0.06	
3010080	SADC @ Irvine	Spring	02/04/2003 11:30	gw						428.15	178.19	4.96	51.97	262.46	1.70	12.24	7.63	4.06	282.06	392.40	4.25	0.03	0.07	4.54	0.07	
3010082	SCW @ SDC	SCW @ SDC	02/04/2003 13:05	su	12.60	7.94	2.48	5.25	0.08	388.31	127.20	6.61	107.60	367.60	0.80	18.01	3.34	3.41	641.11	388.91	1.80	0.06	0.28	2.36	0.31	
3010083	SJC @ Harvard	SJC @ Harvard	02/04/2003 13:30	su	16.20	8.54	1.43	18.20	0.21	238.78	100.81	7.01	37.15	196.14	0.68	7.69	4.20	3.99	235.61	260.60	5.03	0.06	0.16	5.88	0.20	
3010084	Drain - GWD @ SDC	Drain - GWD @ SDC	02/04/2003 14:05	gw	22.40	7.02	3.15	3.15		399.44	199.60	6.40	62.64	420.57	1.77	12.55	3.15	2.54	436.00	644.18	0.81	0.40	0.03	1.61	0.04	
3010085	BoC @ MacArthur	BoC @ MacArthur	02/04/2003 14:30	su	12.30	8.10	2.41	10.47		379.04	143.92	7.52	103.32	352.07	0.71	14.81	2.71	1.79	630.52	367.91	0.31	0.05	0.11	0.64	0.12	
3010086	Spring - PCW across from VD	Spring - PCW across from VD	02/05/2003 9:45	gw	19.80	6.96	2.63	1.13		348.40	262.76	2.36	98.98	201.96	1.99	14.20	19.73	1.74	272.34	768.18	17.09	0.04	0.04	18.23	0.05	
3010087	VD @ PCW	Spring	02/05/2003 11:00	gw	18.80	7.10	4.76	3.24		430.87	255.24	2.08	203.91	576.49	4.09	42.79	168.90	22.07	611.99	1800.81	12.80	0.09	0.09	13.23	0.08	
3010088	VD @ PCW	VD @ PCW	02/05/2003 11:10	su	18.80	8.06	3.07	8.53	0.49	387.24	210.51	2.87	117.39	375.30	1.88	35.74	26.74	10.21	399.97	866.88	21.12	0.05	0.16	22.24	0.17	
3010089	PCW @ Moffett	PCW @ Moffett	02/05/2003 10:05	su	15.60	8.08	2.08	11.74	3.20	403.04	138.73	3.50	81.51	304.34	1.25	15.81	27.48	7.85	249.14	552.13	7.23	0.09	0.04	8.06	0.22	
3010090	WD @ PCW	WD @ PCW	02/05/2003 12:20	su	17.50	7.82	2.63	7.04	0.28	375.19	226.63	3.05	88.37	339.37	1.82	37.04	19.46	9.44	386.61	664.14	14.68	0.37	0.17	16.33	0.39	
3010093	PCW @ Barranca	PCW @ Barranca	02/05/2003 13:55	su		9.04	2.21		4.37	311.77	130.38	3.98	94.40	345.06	1.31	16.96	30.75	6.06	300.24	635.29	7.71	0.05	0.12	9.62	0.19	
3010094	SDC @ Campus	SDC @ Campus	02/05/2003 16:00	su	16.20	8.47	2.68	13.76	6.74	284.69	171.94	5.51	104.71	429.02	1.57	9.41	20.05	4.41	379.46	842.16	6.87	0.04	0.01	8.40	0.13	
3010095	DP @ PCW	DP @ PCW	02/05/2003 14:55	gw	20.80	7.62	2.56		0.75	479.41	167.04	1.69	79.08	418.51	1.23	20.81	34.35	2.00	231.52	649.00	1.75	0.07	0.34	2.34	0.36	
3010096	Drain - PCW @ Barranca	Drain - PCW @ Barranca	02/05/2003 13:30	gw	12.70	8.00	3.20			274.55	Satd	2.76	142.54	372.78	2.73	13.35	71.90	2.06	297.99	1780.92	7.12	0.05	0.04	6.96	0.04	
3010097	PCW @ I5	Well #1	02/05/2003 12:48	hy	16.50			0.19		1248.05	199.37	16.02	93.72	226.43	1.49	29.66	1.12	20.28	209.53	2.58	0.07	10.96	0.03	17.67	11.50	
3010098	PCW @ I5	Well #2	02/05/2003 13:18	hy	16.30			1.98		2602.14	116.35	12.93	67.54	266.21	1.00	29.97	0.74	40.04	236.96	59.74	0.06	8.65	3.73	7.17	82.00	
3010099	PCW @ I5	PCW @ I5	02/05/2003 13:30	su	18.60			19.60		182.23	66.47	8.13	37.41	167.22	0.54	10.06	1.90	3.97	219.61	238.23	1.19	0.05	0.05	2.30	0.13	
3010100	PCW @ I5	Well #3	02/05/2003 14:17	hy	16.70			1.16		624.59	119.99	7.96	73.22	410.26	1.17	20.14	14.06	9.63	1374.89	2695.48	14.22	0.97	0.89	26.67	0.62	
3010101	Spring - PCW across from VD	Well	02/05/2003 15:00	hy	16.40			0.30		364.58	266.11	2.60	123.92	260.25	2.06	12.43	21.28	1.64	363.67	1043.16	19.20	0.07	0.06	18.21	0.07	
3010102	PCW @ I5	1#36	02/07/2003 14:00	pe							45.56	4.27	19.81	29.89	0.29	8.11					0.18		6.08			
3010103	PCW @ I5	1#32	02/07/2003 14:00	pe							44.73	4.40	20.05	31.19	0.28	7.43					0.18		4.32			
3010104	PCW @ I5	1#26_5	02/07/2003 14:00	pe							42.57	4.50	19.34	31.84	0.28	7.21					0.17		4.17			
3010105	PCW @ I5	1#22_3	02/07/2003 14:00	pe							42.21	4.31	19.09	30.40	0.26	7.00					0.18		4.49			
3010106	PCW @ I5	1#16_7	02/07/2003 14:00	pe																	0.18		4.25			
3010107	PCW @ I5	2#56_2	02/07/2003 14:00	pe							30.15	2.82	13.38	17.97	0.23	2.60					0.19		3.84			
3010108	PCW @ I5	2#46_7	02/07/2003 14:00	pe							23.15	2.04	8.25	17.39	0.14	2.27					0.18		2.69			
3010109	PCW @ I5	2#30_9	02/07/2003 14:00	pe							13.80	1.25	7.12	31.24	0.09	1.42					0.17	1.96	1.19			
3010110	PCW @ I5	2#21_8	02/07/2003 14:00	pe							13.82	1.38	7.43	30.24	0.09	1.26					0.17	1.94	0.88			
3010111	PCW @ I5	2#14	02/07/2003 14:00	pe							12.91	1.25	6.99	29.40	0.08	1.31					0.17	1.18	0.73			
3010112	PCW @ I5	2#9_3	02/07/2003 14:00	pe							14.52	1.31	7.40	31.74	0.10	1.27					0.17	0.86	1.08			
3010113	PCW @ I5	2#4_5	02/07/2003 14:00	pe							14.18	1.38	7.32	31.46	0.09	1.34					0.47	1.63	0.72			
3010114	PCW @ I5	3#33_5	02/07/2003 14:00	pe							41.21	0.85	25.47	124.70	0.32	6.03					0.19	0.78	7.90			
3010115	PCW @ I5	3#29_2	02/07/2003 14:00	pe							34.95	0.79	20.39	103.72	0.25	4.87					0.17	0.82	5.88			
3010116	PCW @ I5	3#27_6	02/07/2003 14:00	pe							40.20	1.54	21.38	98.91	0.28	5.34					0.17	2.03	7.93			
3010117	PCW @ I5	3#21_3	02/07/2003 14:00	pe							30.06	2.27	14.49	53.51	0.24	4.21					0.17	4.29	7.11			
3010118	PCW @ I5	3#19_5	02/07/2003 14:00	pe							42.86	1.99	19.84	70.70	0.29	4.57					0.18	4.72				
3010119	PCW @ I5	3#14_3	02/07/2003 14:00	pe							31.90	2.39	13.97	40.77	0.23	3.62					0.18	4.83	7.38			
3010120	PCW @ I5	3#10_3	02/07/2003 14:00	pe							57.04	3.43	27.20	69.95	0.42	5.57					0.17					

sample id	site	location	Sample Date	Type	Temp	pH	EC (ms)	D.O.	Q	alk	Ca	K	Mg	Na	Sr	Si	Se	As	Cl	SO4	NO3-N	NH4-N	PO4-P	TN	TP	volume
			mm/dd/yyyy hh:mm		deg_c		ms/cm	mg/L	CFS	mg CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml
3010121	PCW @ I5	3#8_4	02/07/2003 14:00	pe							64.55	3.83	30.36	75.15	0.43	6.25					0.18					
3010122	PCW @ I5	3#2_5	02/07/2003 14:00	pe							67.24	3.77	31.27	65.74	0.47	6.33					0.17					
3010124	PCW @ I5	Air Test	02/07/2003 14:00	pe																						
3010131	Wet Collector	Wet Collector	02/18/2003 10:00	cw						4.87							0.40	0.42	0.21	0.36	0.12	0.11	0.01	0.14	0.02	3165
3010132	Dry Collector	Dry Collector	02/18/2003 10:00	cd						5.49	0.51	0.13	0.09	0.30		0.45	0.21	0.95	0.60	0.79	0.29	0.34	0.02	0.95	0.06	2600
3010133	SDC @ Campus	SDC @ Campus	02/18/2003 11:10	su	16.70	7.98	2.42	7.67	8.66	306.49	166.62	5.65	89.01	337.79	1.45	13.45	17.93	5.85	340.38	733.12	7.31	0.38	0.21	8.46	0.32	
3010134	EMIC @ PCW	EMIC @ PCW	02/18/2003 12:10	su	19.50	9.13	1.40	12.25	0.49	170.60	113.85	8.61	52.60	144.84	0.80	9.96	4.47	2.44	181.66	260.96	1.87	0.07	0.09	2.97	0.12	
3010135	DP @ PCW	DP @ PCW	02/18/2003 12:55	gw	21.00	7.54	2.49	6.48	1.06	471.53	145.14	0.91	69.56	349.34	1.08	17.42	40.11	2.73	227.94	652.22	4.15	0.04	0.26	4.79	0.35	
3010137	EMIC @ El Camino Real	EMIC @ El Camino Real	02/18/2003 13:50	su	22.50	9.90	1.32	16.71	0.34	55.38	94.16	5.01	44.12	135.18	0.63	9.16	2.61	2.67	167.33	262.64	1.10	0.03	0.04	2.05	0.03	
3010138	EMIC @ 17th	EMIC @ 17th	02/18/2003 14:35	su	20.30	9.02	1.17	19.14	0.17	219.09	92.26	3.78	60.53	92.99	0.54	18.91	4.12	2.43	144.69	178.40	2.28	0.05	0.06	2.65	0.02	
3010140	SFC @ RR	Weephole 10N	02/19/2003 10:15	gw	22.20	6.76	2.16	2.38	0.02	352.08	252.60	2.42	74.92	141.55	1.58	14.88	17.44	1.28	201.29	540.26	16.55	0.04	0.03	17.99	0.02	
3010141	SFC @ PCW	SFC @ PCW	02/19/2003 11:00	su	18.00	7.63	1.79	10.29	0.54	311.33	226.07	3.27	72.11	139.47	1.55	12.32	16.32	1.71	176.69	501.66	12.71	0.07	0.04	13.55	0.06	
3010143	Weephole - CIC @ I5	Weephole 1	02/19/2003 12:00	gw	19.60	7.37	2.03	2.58		457.33	104.44	1.18	57.35	341.08	0.89	20.50	13.48	5.98	173.00	385.48	27.37	0.03	0.18	27.05	0.07	
3010144	Weephole - CIC @ I5	Weephole 2	02/19/2003 12:00	gw	19.90	7.32	2.05	2.59		453.72	101.66	1.27	55.89	328.41	0.85	20.00	13.87	5.93	173.91	388.77	27.36	0.03	0.09	27.32	0.08	
3010145	CIC @ Northwood Plaza on Trabuco	CIC @ Northwood Plaza on Trabuco	02/19/2003 12:30	su	20.60	8.53	1.19	12.31	0.00	138.55	91.05	11.95	39.58	123.26	0.76	4.74	9.43	7.12	131.51	249.36	9.32	0.03	0.96	10.82	1.24	
3010146	Drain - CIC @ Yale	Drain - CIC @ Yale	02/19/2003 13:00	su	16.00	8.48	1.65	8.85	0.07	220.46	97.76	5.42	71.36	218.48	0.72	2.32	64.65	3.60	241.42	395.11	16.56	0.04	0.18	17.17	0.48	
3010147	CC @ Yale	Drain	02/19/2003 13:30	su	20.00	7.17	2.50	3.26		576.20	141.88	2.01	70.98	379.43	0.81	27.35	12.66	5.49	240.42	537.44	12.96	0.03	0.22	13.90	0.48	
3010148	CC @ Yale	Spring	02/19/2003 13:30	gw	21.60	7.03	2.92	1.31		512.27	161.22	1.11	79.82	405.32	0.91	29.47	19.28	4.35	303.01	681.84	17.88	0.03	0.04	18.71	0.05	
3010150	Dry Collector	Dry Collector	02/25/2003 12:10	cd						5.12				1.33			0.09	0.82	0.38	0.30	0.13	0.07	0.00	0.16	0.02	3350
3010151	Wet Collector	Wet Collector	02/25/2003 12:10	cw						3.12				1.53			0.19	0.76	1.95	0.61	0.08	0.07	0.00	0.09	0.02	2075
3010154	SDC @ Campus	SDC @ Campus	02/26/2003 10:30	sm	13.60	7.89	0.57	9.05		100.92	46.31	4.72	19.63	73.97	0.32	4.13	2.40	4.02	76.40	131.49	2.69	0.12	0.30	3.99	0.80	
3010155	PCW below SFC	CC @ PCW	02/26/2003 12:18	sm	17.90	7.77	1.57	7.76	1.15	311.55	82.85	3.05	66.58	223.32	0.85	19.42	17.90	9.83	180.40	317.06	2.65	0.03	0.08	23.09	0.33	
3010156	SFC @ PCW	SFC @ PCW	02/26/2003 13:20	sm	15.80	7.16	0.12	8.70		24.63	11.52	1.61	1.78	10.55	0.08	0.76	0.85	2.02	13.46	17.95	1.09	0.40	0.08	2.11	0.31	
3010157	PCW @ EMIC	PCW @ EMIC	02/26/2003 13:40	sm	16.20	7.73	0.32	8.82		61.36	25.20	2.76	8.97	33.41	0.16	2.57	1.82	2.69	36.24	58.70	1.87	0.33	0.17	3.08	0.35	
3010158	PCW @ EMIC	PCW @ EMIC	02/26/2003 14:05	sm	15.80	7.84	0.61	8.08	33.36	113.01	53.09	5.67	21.99	73.23	0.32	5.46	1.66	4.75	77.30	128.29	2.04	0.10	0.22	5.95	1.13	
3010159	EMIC @ PCW	EMIC @ PCW	02/26/2003 15:00	sm	17.30	8.69	0.30	10.09	11.69	77.89	26.61	2.90	9.66	27.16	0.14	3.60	0.64	2.19	37.83	45.39	1.42	0.23	0.16	2.62	0.25	
3030001	Spring - PCW across from VD	Clay 8	02/05/2003 11:00	se																						
3030002	Spring - PCW across from VD	Clay 0	02/05/2003 10:30	se																						
3030010	BoC @ MacArthur	BoC @ MacArthur	03/04/2003 10:50	su	12.30	8.11	2.03	9.85		379.78	128.77	5.64	90.97	290.22	0.63	12.68	1.61	2.48	500.48	308.34	0.20	0.06	0.08	0.44	0.08	
3030011	LC @ McCabe/Jamboree	LC @ McCabe/Jamboree	03/04/2003 11:25	su	15.20	7.98	3.62	10.17	3.09	225.93	258.78	4.05	138.52	560.71	2.48	6.95	15.13	2.03	393.61	1692.03	10.16	0.28	0.10	11.42	0.14	
3030012	BaC @ Main	BaC @ Main	03/04/2003 12:05	su	15.30	8.32	3.82	11.00	1.08	141.03	142.36	4.07	117.69	676.02	1.76	2.29	3.54	1.98	477.70	1752.51	1.10	0.33	0.06	2.31	0.09	
3030013	SDC @ Harvard	SDC @ Harvard	03/04/2003 12:55	su	16.00	8.31	1.71	13.60	5.36	280.35	159.92	4.15	48.43	187.74	0.95	17.72	3.35	5.50	288.44	320.31	14.44	0.04	0.19	15.32	0.19	
3030014	Spring - SDC @ Harvard	Spring - SDC @ Harvard	03/04/2003 13:10	gw	20.10	7.09	3.72	0.86		331.25	224.95	2.01	88.39	425.81	2.06	25.04	34.79	5.93	387.34	1172.06	47.49	0.04	0.06	50.00	0.04	
3030015	Drain - SDC @ Harvard	Drain - SDC @ Harvard	03/04/2003 13:20	su	22.50	7.37	3.30	5.01	0.34	361.89	210.14	1.77	95.45	366.71	1.91	31.67	33.58	7.87	361.93	930.87	23.67	0.04	0.06	25.43	0.06	
3030016	Spring - SDC @ Culver	Spring - SDC @ Culver	03/04/2003 13:45	gw	18.90	6.89	2.20	1.02		390.11	197.17	2.34	52.09	199.99	1.07	27.06	4.77	4.73	320.09	411.16	19.82	0.03	0.07	20.50	0.09	
3030017	BaC @ Barranca	Drain	03/04/2003 14:10	su	20.90	7.74	9.61	6.37		309.57	Satd	4.56	218.66	1361.86	3.92	11.84	13.20	2.03	1063.44	4662.63	4.85	0.11	0.05	5.43	0.03	
3030018	Dry Collector	Dry Collector	03/04/2003 10:00	cd						2.62				2.31			0.18	1.14	0.55	0.28	0.12	0.09	0.01	0.28	0.02	3539
3030019	Wet Collector	Wet Collector	03/04/2003 10:00	cw						1.62							0.06	1.15	3.49	1.17	0.18	0.18		0.45	0.02	880
3030020	SFC @ RR	Weephole 10N	03/05/2003 9:40	gw	21.80	6.90	2.16	2.82	0.02	362.96	Satd	2.42	78.65	146.25	1.53	16.05	18.08	2.16	199.69	519.82	17.69	0.03	0.03	17.95	0.01	
3030021	PCW @ CC	Weephole 1N	03/05/2003 10:15	gw	21.30	7.51	4.13	1.14		534.62	141.92	2.37	132.12	728.51	2.21	23.47	151.00	23.82	435.42	1240.71	7.78	0.05	0.11	8.47	0.31	
3030022	PCW @ CC	Weephole 2N	03/05/2003 10:25	gw	21.10	7.43	4.27	2.08		472.96	210.30	3.20	135.51	713.16	2.52	19.98	116.80	17.12	490.66	1402.60	7.12	0.04	0.08	8.13	0.47	
3030023	PCW @ CC	Weephole 3N	03/05/2003 10:45	gw	19.90	7.35	4.25	1.97		440.76	228.95	4.08	133.63	683.97	2.53	17.18	85.40	12.84	502.72	1438.54	6.64	0.04	0.09	7.12	0.10	
3030024	PCW @ CC	Weephole 3S	03/05/2003 11:05	gw	20.80	7.65	3.82	2.03		469.99	142.26	8.66	99.85	669.35	1.60	13.20	33.85	25.77	437.06	1147.28	4.18	0.04	0.14	4.44	0.14	
3030025	VD @ PCW	VD @ PCW	03/05/2003 11:30	su	19.00	8.05	3.19	8.16	1.15	416.00	219.96	2.81	125.91	399.50	1.89	34.06	28.84	10.81	429.26	902.80	19.72	0.04	0.10	20.03	0.11	
3030026	VD @ PCW	Spring	03/05/2003 11:40	gw	18.30	7.15	4.85	2.42		464.65	256.63	2.22	184.44	587.11	4.29	44.29	185.35	23.31	632.86	1898.50	11.20	0.09	0.08	12.59	0.07	
3030027	Spring - PCW across from VD	Spring - PCW across from VD	03/05/2003 12:00	gw	22.70	7.02	2.57	0.66		352.40	274.05	2.42	100.43	197.20	1.99	14.76	21.76	2.15	263.75	750.60	16.66	0.08	0.02	16.60	0.06	
3030029	WD @ PCW	WD @ PCW	03/05/2003 12:40	su	19.00	7.72	2.73	5.31	0.58	366.40	225.82	2.03	89.20	322.00	1.83	35.03	21.53	8.53	384.16	696.29	14.30	0.05	0.12	29.28	0.13	
3030030	Drain - PCW W side S of Warner	Drain - PCW W side S of Warner	03/05/2003 12:50	su	17.10	7.83	6.47	8.04	0.01	325.46	417.72	4.60	203.33	970.27	4.09	12.65	33.05	2.76	671.59	3219.09	26.16	0.09	0.08	27.92	0.07	
3030045	DP @ PCW	DP @ PCW	03/11/2003 11:30	gw	21.20	7.59	2.57	6.96		500.97	148.69	1.47	73.05	380.45	1.13	18.02	44.08	2.62	223.75	635.43	4.85	0.18	0.27	5.34	0.17	
3030046	Weephole - CIC @ I5	Weephole 2	03/11/2003 11:55	gw	20.10	7.32	2.13	3.47		459.40	104.50	1.17	59.87	327.66	0.92	19.95	14.85	5.81	180.41	392.23	25.90	0.06	0.20	28.61	0.10	
3030047	CIC @ PCW	CIC @ PCW	03/11/2003 12:05	su	22.90	8.56	1.93	9.91	0.24	116.83	138.50	33.86	56.50	159.58	1.32	4.79	2.65	7.48	75.85	138.12	58.10	12.25	1.93	76.93	2.40	
3030048	Drain - PCW @ Walnut	Drain - PCW @ Walnut	03/11/2003 12:25	su	19.60	7.85	2.37	7.27		584.89	95.18	1.11	95.07	365.74	1.34	27.73	29.58	11.69	189.87	494.26	13.52	0.14	0.09	14.17	0.09	
3030049	CC @ Yale	Spring	03/11/2003 13:47	gw	20.40	6.98	2.99	1.69		476.96	177.06	1.14	87.25	425.32	1.06	31.24	23.26	4.28	348.01	701.62	19.98	0.04	0.15	21.14	0.08	
3030050	Drain - CIC @ Yale	Drain - CIC @ Yale	03/11/2003 14:00	su	18.00	7.73	1.77	7.93	0.56	72.80	140.79	36.04	57.14	135.30	1.40	4.14	1.26	7.18	169.35	391.50	70.49	21.68	3.94	100.90	6.40	
3030053	PCW below SFC	Duckweed	11/05/2002 0:00	se																						
3030054	SFC @ PCW	algae	11/05/2002 0:00	se																						
3030055	EMIC @ PCW	muck	11/05/2002 0:00	se																						
3030056	CC @ PCW	below station	11/05/2002 0:00	se																						
3030057	CC @ PCW	algae above station	11/05/2002 0:00	se																						
3030058	PCW @ CC	sediment	11/05/2002 0:00	se																						
3030059	PCW @ CC	Weephole 1 algae	11/05/2002 0:00	se																						
3030060	PCW @ EMIC	algae	11/05/2002 0:00	se																						
3030061	PCW below SFC	sediment	11/05/2002 0:00	se																						
3030062	SFC @ PCW	white duckweed	11/05/2002 0:00	se																						
3030130	Well 63S	Well 63S	03/19/2003 9:40	gw						552.69	107.80	0.49	131.00	434.30	1.92	33.20	51.28	11.41	382.37	750.97	23.23	0.09	0.10	24.49	0.12	
3030131	Well 85W	Well 85W	03/19/2003 10:17	gw						610.57	299.60	7.34	175.30	534.00	1.88	22.10	34.40	12.06	759.44	1148.56	13.38	0.17	0.16	14.57	0.23	
3030132	Well 86N	Well 86N	03/19/2003 11:02	gw						489.23	243.00	1.85	144.10	569.20	2.10	36.50	28.93	11.65	468.67	1522.72	17.43	0.07	0.15	18.20	0.09	
3030133	Well 103N	Well 103N	03/19/2003 11:27	gw						606.91	168.50	1.13	86.50	467.10	1.17	25.80	14.23	11.92	397.27	659.06	29.65	0.06	0.08	31.01	0.06	
3030134	Well 87N	Well 87N	03/19/2003 12:43	gw						438.37	199.40	1.75	48.20	308.90	1.07	31.60	7.62	3.46	398.20	402.79	19.88	0.06	0.05	21.19	0.04	
3030135	Well 102N	Well 102N	03/19/2003 13:13	gw						348.51	106.70	4.06	27.00	57.50	0.66	13.30	1.76	2.87	44.27	110.81	2.82	0.05	0.14	3.40	0.20	
3030136	Dry Collector	Dry Collector	03/19/2003 15:00	cd							31.08	3.69	13.77	92.60	0.24	3.28										
3030137	SDC @ Campus	SDC @ Campus	03/20/2003 9:15	su	16.90	8.16	2.37	8.89		297.77	161.50	6.07	81.90	319.10	1.37	13.60	19.70	6.04	330.86	754.77	8.38	0.10	0.18	10.01	0.14	

sample id	site	location	Sample Date	Type	Temp	pH	EC (ms)	D.O.	Q	alk	Ca	K	Mg	Na	Sr	Si	Se	As	Cl	SO4	NO3-N	NH4-N	PO4-P	TN	TP	volume
			mm/dd/yyyy hh:mm		deg_c		ms/cm	mg/L	CFS	mg CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml
3030138	PCW @ Barranca	PCW @ Barranca	03/20/2003 9:55	su	18.40	8.19	2.58	9.92	8.30	395.84	172.90	3.79	101.10	337.60	1.59	22.30	37.78	9.06	315.08	752.42	13.05	0.06	0.13	14.11	0.11	
3030139	PCW @ Moffett	PCW @ Moffett	03/20/2003 10:30	su	19.40	8.10	2.45	10.15	6.18	387.03	145.50	3.26	87.60	294.10	1.31	20.30	36.70	8.86	311.06	726.02	13.20	0.09	0.10	14.59	0.02	
3030140	SFC @ PCW	SFC @ PCW	03/20/2003 11:20	su	18.80	7.97	1.91	16.31	0.58	291.79	219.80	3.34	66.20	140.20	1.50	10.80	18.68	1.26	195.55	599.68	12.89	0.07	0.03	13.99	0.02	
3030141	ECD @ PCW	ECD @ PCW	03/20/2003 11:30	gw	20.80	7.92	3.41	7.56		506.33	141.20	1.48	175.20	421.50	2.29	39.10	139.25	29.36	371.69	1026.96	14.19	0.09	0.12	15.55	0.07	
3030142	PCW below SFC	CC @ PCW	03/20/2003 12:00	su	22.30	8.22	3.06	14.38	1.80	499.45	141.20	1.67	124.30	375.40	1.59	31.60	37.75	17.92	366.44	742.11	17.88	0.08	0.07	20.09	0.06	
3030143	EMIC @ PCW	EMIC @ PCW	03/20/2003 12:30	su	20.20	9.12	1.63	13.12		163.59	124.80	5.31	54.10	161.60	0.87	10.70	6.51	1.85	229.89	497.32	3.12	0.06	0.05	4.03	0.07	
3030144	PCW @ EMIC	PCW @ EMIC	03/20/2003 12:40	su	20.80	7.98	2.41	11.19	1.78	422.19	132.00	3.56	67.30	332.50	1.05	16.70	27.95	4.55	268.77	594.44	8.20	0.08	0.17	9.25	0.21	
3040001	Spring - SDC @ Harvard	Spring - SDC @ Harvard	04/01/2003 11:30	gw	21.20	7.08	3.78	0.73		339.08	267.30	2.04	100.60	484.00	2.27	29.10	35.27	5.36	422.77	1264.44	47.26	0.18	0.05	47.37	0.45	
3040002	SDC @ Harvard	SDC @ Harvard	04/01/2003 11:40	su	23.40	8.42	2.24	18.90	1.67	250.08	147.50	3.89	50.00	235.40	1.06	18.40	4.70	3.27	367.60	437.29	18.09	0.03	0.06	18.76		
3040003	Drain - SDC @ Harvard	Drain - SDC @ Harvard	04/01/2003 12:00	su	22.40	7.52	3.36	6.25	0.20	364.47	223.20	1.72	99.90	385.70	2.03	32.80	35.68	7.40	399.37	1015.51	23.16	0.03	0.06	23.81	0.04	
3040005	Spring - SDC @ Culver	Spring - SDC @ Culver	04/01/2003 13:00	gw	21.50	6.90	0.94	10.70		385.11	228.60	2.76	54.50	237.70	1.33	30.70	5.26	5.10	412.86	498.92	22.04	0.01	0.08	22.10	0.15	
3040006	BaC @ Main	BaC @ Main	04/01/2003 13:55	su	26.60	8.97	6.55	17.43	0.15	125.87	201.70	5.48	193.90	960.40	2.76	0.18	6.48	2.55	728.08	2704.25	0.02	0.06		0.64	0.02	
3040007	BaC @ Barranca	Drain	04/01/2003 14:45	su	20.60	7.91	9.88	7.31		302.74	434.10	5.86	403.40	1630.30	4.17	12.20	12.40	2.26	1317.42	5726.10	5.01	0.24	0.03	5.18	0.02	
3040008	Dry Collector	Dry Collector	04/01/2003 11:00	cd							1.17	0.87		2.13			-0.03	0.50	1.01	1.26	0.11	0.19	0.15	1.08	0.25	1725
3040036	SDC @ Campus	SDC @ Campus	04/07/2003 9:40	mu																						
3040037	BaC @ Alton	BaC @ Alton	04/07/2003 10:05	mu																						
3040038	PCW @ Barranca	PCW @ Barranca	04/07/2003 10:20	mu																						
3040039	SDC @ Harvard	SDC @ Harvard	04/07/2003 10:30	mu																						
3040042	EMIC @ 17th	EMIC @ 17th	04/07/2003 11:20	mu																						
3040043	PCW below SFC	CC @ PCW	04/07/2003 11:50	mu																						
3040044	PCW @ CIC	PCW @ CIC	04/07/2003 12:05	mu																						
3040045	CIC @ PCW	CIC @ PCW	04/07/2003 12:10	mu																						
3040046	Dry Collector	Dry Collector	04/08/2003 10:15	cd						3.00	0.13	0.18					-0.01	1.09	0.48	0.48	0.02	0.05	0.01	0.25	0.03	2930
3040047	Wet Collector	Wet Collector	04/08/2003 10:15	cw							0.61	0.23	0.11	4.09			0.29	0.85	5.92	4.03	1.36	0.71				65
3040048	SDC @ Campus	SDC @ Campus	04/08/2003 10:30	su	19.00	8.39	2.88	10.99	7.82	280.90	164.50	5.80	105.90	434.70	1.54	8.44	20.37	4.41	423.41	1244.91	3.19	0.15	0.12	4.37	0.18	
3040049	DP @ PCW	DP @ PCW	04/09/2003 11:30	gw	19.80	7.81	2.66	6.78	0.02	428.05	148.10	4.17	65.10	389.90	1.24	18.90	42.44	4.01	256.11	737.45	30.85	0.19	0.32	33.86	0.23	
3040050	Drain - PCW @ Walnut	Drain - PCW @ Walnut	04/08/2003 12:10	su	20.30	7.91	2.23	7.64		593.45	100.75	1.19	97.62	368.22	1.30	27.00	30.66	13.44	251.36	724.11	12.59	0.01	0.11	13.95	0.10	
3040051	CIC @ PCW	CIC @ PCW	04/08/2003 12:55	su	22.10	8.76	1.64	8.84	0.06	203.49	100.15	11.76	35.00	234.03	0.81	9.19	16.82	3.60	201.56	533.63	13.56	0.19	0.17	15.56	0.48	
3040053	Weephole - CIC @ I5	Weephole 2	04/08/2003 13:25	gw	20.80	7.38	2.18	3.63	0.00	457.85	112.06	1.27	62.59	334.91	0.91	20.10	15.20	5.56	0.28	0.34	19.49		0.08	28.93	0.08	
3040054	Drain - CIC @ Yale	Drain - CIC @ Yale	04/08/2003 12:15	su	18.00	8.25	1.75	8.11	0.16	212.79	113.03	8.04	71.38	224.23	0.84	12.40	62.70	3.62	262.82	418.36	22.57	0.01	0.06	29.13	0.05	
3040056	BoC @ MacArthur	BoC @ MacArthur	04/08/2003 16:15	su	18.60	8.23	2.76	10.84		413.58	128.50	7.98	97.50	353.20	0.69	14.00	2.73	3.45	654.92	408.18	0.22	0.02	0.14	0.74	0.16	
3040057	Wet Collector	Wet Collector	04/14/2003 9:30	cw								0.07		0.41			0.16	1.13	0.81	0.05	0.02	0.13		0.22	0.03	550
3040058	Dry Collector	Dry Collector	04/14/2003 9:30	cd								0.12					0.12	1.55	0.20	0.29		0.04		0.10	0.02	3140
3040061	PCW @ CIC	PCW @ CIC	04/14/2003 11:15	sm	18.10	8.16	0.49	9.10		81.89	43.02	6.46	15.72	50.81	0.24	3.98	0.48	4.14	58.32	99.13	4.34	0.01	0.55	6.38	1.33	
3040062	CIC @ PCW	CIC @ PCW	04/14/2003 11:15	sm	17.40	7.45	0.96	9.00		71.10	107.69	21.88	33.23	73.66	0.68	3.70	0.75	8.08	85.93	252.63	26.39	1.62	2.96	12.40	2.95	
3040063	SDC above PCW	SDC above PCW	04/14/2003 11:40	sm	17.40	7.84	0.50	9.16		78.98	50.26	8.76	14.69	41.88	0.28	2.51	0.69	8.01	68.68	89.36	8.57	0.10	0.57	12.45	2.48	
3040064	PCW above SDC	PCW above SDC	04/14/2003 11:50	sm	17.60	7.96	0.35	8.35		61.97	36.17	6.53	10.66	29.43	0.21	2.22	1.02	5.13	29.68	82.14	5.61	0.30	0.70	7.61	3.80	
3040067	SDC @ Campus	SDC @ Campus	04/14/2003 13:40	sm	19.40	8.20	0.51	6.62		71.71	44.66	6.15	16.52	52.23	0.29	2.22	1.43	4.66	56.35	127.62	5.71	0.31	0.48	8.42	2.68	
3040118	Circular Drain - LC Before bridge	Circular Drain - LC Before bridge	04/21/2003 11:40	su	15.90	8.36	3.31	8.79		271.87	157.30	11.23	100.20	490.10	2.05	10.40	3.63	3.56	427.00	1230.06	2.56	0.11	0.33	3.40	0.39	
3040119	LC @ SCM	Saline Drain	04/21/2003 12:30	gw	20.70	8.17	15.50	6.29		339.63	245.90	15.15	495.00	2998.20	3.69	8.97	8.21	3.34	2619.98	6134.66	1.52	0.28	0.08	1.94	0.07	
3040120	LC @ SCM	LC @ SCM	04/21/2003 12:40	su	20.30	8.01	3.70	12.15		235.94	276.60	3.94	147.80	414.20	2.69	5.82	21.31	2.72	284.61	1711.99	10.37	0.10		10.22	0.02	
3040121	LC below 55	Drain - LC below I5	04/21/2003 13:20	gw	19.30	7.93	3.40	6.72		358.88	307.60	3.40	161.00	457.80	2.61	10.90	23.23	2.01	229.87	1956.40	9.88	0.07	0.05	10.03	0.11	
3040122	LC below 55	LC below I5	04/21/2003 13:30	su	21.30	8.75	2.26	14.05		203.03	214.50	3.63	93.60	190.00	2.18	8.87	23.21	4.02	126.64	990.09	9.82	0.05	0.06	10.49	0.11	
3040123	LC below 55	Crack - LC below I5	04/21/2003 13:50	gw	20.20	7.14	4.79	1.66			533.90	4.78	167.50	432.50	4.00	12.10	54.02	1.88	443.06	2253.08	24.05	0.06	0.03	26.06	0.01	
3040124	AC @ LC	AC @ LC	04/21/2003 14:45	su	21.80	8.29	4.91	12.96		197.62	302.90	12.47	136.50	644.60	3.51	6.52	3.50	2.18	413.41	2401.42	0.19	0.04		0.89	0.04	
3040125	LC above AC	LC above AC	04/21/2003 14:50	su	22.00	8.44	3.11	19.04		202.23	244.20	3.37	121.30	299.10	2.19	7.27	19.85	2.06	198.72	1359.61	10.94	0.05		11.56	0.01	
3040126	Dry Collector	Dry Collector	04/22/2003 10:45	cd													-0.09	-0.12	0.54	0.41	0.07	0.04	0.01	0.39	0.05	3100
3040127	Wet Collector	Wet Collector	04/22/2003 10:45	cw										0.94			0.05	0.52	0.69	0.59	0.09	0.08		0.30	0.04	1790
3040128	SDC @ Campus	SDC @ Campus	04/22/2003 11:00	su	17.70	8.24	2.81	9.68	9.12	269.97	143.30	5.51	91.20	387.20	1.46	8.87	20.46	4.23	398.74	890.61	4.68	0.04		6.41	0.16	
3040129	SFC @ RR	Weephole 10N	04/22/2003 12:15	gw	22.00	6.84	2.17	2.46		375.72	231.70	2.26	61.90	137.30	1.45	13.90	18.69	2.01	201.96	527.47	16.53	0.01	0.02	19.18	0.03	
3040130	PCW @ CC	Weephole 3S	04/22/2003 12:30	gw	21.00	7.76	4.12	2.56		485.63	125.80	9.27	86.80	679.70	1.69	13.00	31.46	28.02	469.09	1272.70	2.11	0.02	0.16	2.66	0.19	
3040131	PCW @ CC	Weephole 1N	04/22/2003 13:00	gw	21.40	7.42	4.34	0.41		531.13	131.20	2.80	125.80	692.70	2.21	20.30	148.20	23.99	475.87	1390.72	7.90	0.04	0.11	8.43	0.12	
3040132	PCW @ CC	Weephole 2N	04/22/2003 13:10	gw	21.30	7.26	4.84	0.62		414.84	264.60	4.11	142.00	667.60	2.91	15.10	73.22	9.17	613.59	1780.81	3.34	0.05	0.06	6.62	0.07	
3040133	PCW @ CC	Weephole 3N	04/22/2003 13:20	gw	21.50	7.34	4.77	1.91		443.47	229.20	5.27	130.60	704.30	2.60	14.20	68.02	10.10	596.24	1709.67	4.68	0.02	0.07	5.31	0.10	
3040134	VD @ PCW	VD @ PCW	04/22/2003 13:45	su	19.20	8.09	3.19	8.09	1.75	432.96	218.66	2.18	121.22	390.90	1.88	33.20	27.98	12.65	446.64	925.57	19.36	0.03	0.10	20.92	0.12	
3040135	VD @ PCW	Spring	04/22/2003 13:55	gw	19.30	7.13	5.12	7.13		476.75	236.96	2.22	94.35	332.05	1.87	34.60	232.90	24.13	694.80	2163.96	10.51	0.09	0.06	11.56	0.06	
3040136	Spring - PCW across from VD	Spring - PCW across from VD	04/22/2003 14:25	gw	21.10	6.95	2.51	1.05		390.01	272.75	2.26	99.88	195.61	1.96	13.50	22.56	3.78	280.65	811.73	15.73	0.02	0.03	18.07	0.09	
3040138	WD @ PCW	WD @ PCW	04/22/2003 15:20	su	20.80	7.72	2.97	6.06		392.13	217.10	2.22	84.70	342.80	1.92	35.10	22.83	8.03	443.32	841.34	13.75	0.02	0.17	14.09	0.17	
3040140	Well 2 - LC @ Red Hill	Well - LC/RH 2	04/28/2003 10:50	gw	22.30	6.91	5.65	0.13		303.29	613.10	5.22	148.70	550.60	4.69	12.80	27.87	2.08	522.00	2952.29	30.76	0.08	0.04	35.00	0.03	
3040141	Well 5/6 - LC @ Red Hill	Well - LC/RH 5	04/28/2003 12:15	gw	23.20	7.19	3.77	0.13		182.00	500.50	4.30	120.70	290.00	3.98	12.40	37.45	2.36	383.31	1996.45	16.38	0.03	0.03	18.08	0.12	
3040142	Well 5/6 - LC @ Red Hill	Well - LC/RH 6	04/28/2003 13:00	gw	23.10	7.10	4.11	0.10		247.49	492.80	4.35	155.40	330.40	4.03	13.40	50.08	2.61	344.79	2094.42	16.40	0.04	0.13	17.22	0.03	
3040143	LC below 55	Weephole - LC @ 55 ramp	04/28/2003 14:15	gw	24.10	7.58	5.58	3.46		289.46	462.00	6.47	229.70	584.30	3.23	10.60	79.85	3.37	415.61	2741.74	32.13	0.07	0.07	35.05	0.08	
3040144	LC below 55	Spring - LC @ 55	04/28/2003 14:40	gw	21.30	7.33	3.39	3.14		263.13	397.20	4.58	126.00	245.70	3.19	11.10	28.25	4.64	252.62	1647.06	8.69	0.04	0.11	9.46	0.11	
3040145	PCW @ Barranca	PCW @ Barranca	04/29/2003 10:00	su	20.70	8.37	2.49	13.51	5.66	324.15	139.10	4.40	87.20	286.70	1.48	18.40	30.61	7.95	338.97	700.49	13.71	0.07	0.01	15.58	0.06	
3040146	PCW @ Moffett	PCW @ Moffett	04/29/2003 11:00	su	20.30	8.25	2.18	13.52	5.49	301.19	124.00	4.68	77.50	240.70	1.24	15.10	26.81	8.03	278.39	552.30	12.97	0.33	0.04	13.85	0.07	
3040147	SFC @ PCW	SFC @ PCW	04/29/2003 12:00	su	18.80	8.18	1.93	17.76	0.54	314.29	213.30	2.82	65.90	138.80	1.56	6.35	19.29	1.38	198.65	636.63	12.71	0.05		13.67	0.02	
3040148	ECD @ PCW	ECD @ PCW	04/29/2003 12:40	gw	21.10	7.90	3.57	7.62	0.20	521.82	144.90	1.59	177.40	428.00	2.52	41.70	132.80	28.79	400.12	1110.09	14.66	0.06	0.11	15.27	0.10	
3040149	PCW below SFC	CC @ PCW	04/29/2003 13:20	su	26.20	8.43	3.24	Satd	0.79	457.13	115.00	1.54	115.60	371.20	1.46	28.20	31.05	17.48	372.11	738.32	17.68	0.06	0.02	18.61	0.03	
3040151	EMIC @ PCW	EMIC @ PCW	04/29/2003 14:00	su	23.90	9.43	1.37	13.74	0.44	106.79	91.44	4.13	39.05	146.31	0.80	11.60	5.24	5.14	211.69	305.31	6.00	0.05	0.02	6.75	0.05	
3040152	PCW @ EMIC	PCW @ EMIC	04/29/2003 14:20	su	22.00	8.63	1.85	15.90		266.16	92.34	9.38	60.20	240.72	0.86	8.26	10.45	7.20	238.57	372.39	15.55	1.10	0.33	18.69	0.44	
3050001	Well 4_5 A/B - LC @ Red Hill	Well 4_5A - LC @ RH	05/05/2003 12:00	gw	24.20	7.31	3.86	5.64		211.07	465.30	5.24	110.70	254.10	3.94	11.30	17.16	1.85	302.00	1650.49	14.05	0.10	0.13	13.81	1.79	
3050002	Well 4_5 A/B - LC @ Red Hill	Well 4_5B - LC @ RH	05/05/2003 12:30	gw	22.90	7.03	4.29	0.12		230.49	510.70	5.08	154.40	314.80	4.84	15.60	34.47	2.34	299.30	1895.21	33.63	0.06	0.02	31.09	0.02	

sample id	site	location	Sample Date	Type	Temp	pH	EC (ms)	D.O.	Q	alk	Ca	K	Mg	Na	Sr	Si	Se	As	Cl	SO4	NO3-N	NH4-N	PO4-P	TN	TP	volume
			mm/dd/yyyy hh:mm		deg_c		ms/cm	mg/L	CFS	mg CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml
3050003	Well 3 - LC @ Red Hill	Well 3 - LC @ RH	05/05/2003 13:00	gw	22.60	6.83	5.71	0.14		299.87	599.50	8.05	257.00	564.20	7.22	17.10	28.02	2.03	388.71	2936.47	25.21	0.05	0.03	24.86		
3050004	Weephole - LC @ Red Hill	Weephole - LC @ Red Hill	05/05/2003 13:30	gw	22.00	6.91	4.13	0.86		271.31	465.40	4.27	184.80	348.10	4.76	14.50	30.19	2.48	208.26	2036.75	40.53	0.04	0.03	42.08		
3050005	Dry Collector	Dry Collector	05/06/2003 11:05	cd										1.26			0.44	1.90	1.12	0.75	0.23	0.09	0.01	0.31	0.03	2100
3050006	Wet Collector	Wet Collector	05/06/2003 11:05	cw										0.78			0.02	1.61	0.83	0.73	0.13	0.11		0.20	-0.01	1028
3050007	SDC @ Campus	SDC @ Campus	05/06/2003 11:50	su	20.00	8.00	2.59	8.80	9.34	265.94	183.28	6.50	101.30	378.69	1.53	12.30	16.07	7.07	296.43	723.77	5.15	0.13	0.06	5.96	0.18	
3050008	BoC @ MacArthur	BoC @ MacArthur	05/06/2003 12:45	su	18.30	8.03	2.28	11.61		349.16	147.70	5.88	101.08	321.35	0.65	16.60	2.02	5.12	440.41	289.06	0.24	0.05	0.09	0.59	0.11	
3050009	LC @ McCabe/Jamboree	LC @ McCabe/Jamboree	05/06/2003 13:35	su	22.60	8.25	6.31	Satd	1.43	275.11	254.20	6.57	198.00	902.90	3.13	8.22	16.70	1.63	652.78	2380.30	7.53	0.10	0.02	7.98	0.06	
3050010	BaC @ Main	BaC @ Main	05/06/2003 14:20	su	22.30	8.81	3.63	15.98	0.48	147.99	130.90	5.42	99.00	531.60	2.11	3.62	3.13	2.44	321.12	1370.75	0.07	0.06		0.60	0.01	
3050011	BaC @ Barranca	Drain	05/06/2003 14:55	su	21.80	7.77	9.94	6.82		277.23	410.20	9.10	383.00	1551.20	5.16	12.80	12.09	2.72	964.63	4847.69	4.84	0.11	0.04	4.89	0.01	
3050092	SDC @ Sand Canyon	SDC @ Sand Canyon	05/19/2003 10:20	su	25.20	8.67	1.91	14.93		208.20	105.80	4.72	40.20	184.90	0.88	9.55	1.05	5.13	366.10	211.27	0.17	0.07	0.04	0.87	0.08	
3050093	SDC @ Valley Oak	Weephole 27 N	05/19/2003 10:50	gw	20.90	7.47	1.96	3.54		302.52	127.80	1.39	34.10	237.30	0.81	32.90	3.05	7.92	281.06	329.54	11.75	0.03	0.10	13.32	0.09	
3050094	SDC @ Valley Oak	Weephole 40 N	05/19/2003 11:15	gw	22.00	7.09	1.93	1.15		320.98	155.70	3.59	42.20	211.70	1.01	25.70	3.24	12.75	275.85	348.83	15.67	0.02	0.46	16.63	0.56	
3050095	SDC @ Valley Oak	Weephole 47 N	05/19/2003 11:30	gw	25.80	7.17	2.16	1.43		313.86	154.60	4.04	42.20	208.50	1.00	24.60	2.93	13.73	284.05	355.16	14.32	0.02	0.52	15.40	0.54	
3050096	Spring - Upper SDC 1&2	Upper SDC - 1USDC1	05/19/2003 12:30	gw	26.70	8.17	2.49	14.68		304.39	161.60	3.56	47.40	253.60	1.01	26.80	4.48	10.37	321.18	416.03	21.42	0.05	0.20	23.41	0.26	
3050097	Spring - Upper SDC 1&2	Upper SDC - 2USDC2	05/19/2003 12:40	gw	21.70	7.21	2.18	0.23		323.28	163.30	4.30	47.20	242.10	1.04	28.00	5.52	9.92	263.11	380.88	23.95	0.01	0.40	23.93	0.40	
3050098	Spring - Upper SDC 3	Upper SDC - 3USDC3	05/19/2003 13:30	gw	23.80	6.99	3.16	3.32		431.29	279.60	3.86	64.80	342.80	1.49	26.00	12.78	5.29	381.12	617.02	42.44	0.03	0.09	44.31	0.09	
3050099	Spring - SDC @ Culver	Spring - SDC @ Culver	05/19/2003 14:20	gw	23.70	6.87	2.56	1.07		361.14	233.90	2.75	56.50	242.90	1.32	32.40	5.10	5.17	317.12	474.01	21.23	0.03	0.15	22.15	0.05	
3050101	SDC above PCW	SDC above PCW	05/19/2003 15:15	su	28.40	8.45	2.65	Satd		187.33	138.74	2.65	63.45	278.36	1.13	18.60	13.83	3.39	322.79	582.29	19.85	0.01		20.32	-0.03	
3050102	Dry Collector	Dry Collector	05/20/2003 10:15	cd								0.12		1.11			0.74	1.24	1.66	1.50	0.22	0.13	0.01	0.45	0.01	1140
3050103	Wet Collector	Wet Collector	05/20/2003 10:15	cw							0.46	0.52		2.93					4.29	2.29	0.20	0.07				20
3050104	SDC @ Campus	SDC @ Campus	05/20/2003 10:25	su	23.10	8.23	2.92	9.35		247.83	144.64	4.52	92.55	377.74	1.31	9.81	19.28	5.53	332.28	819.66	5.33	0.04	0.03	6.30	0.10	
3050105	Drain - PCW @ Walnut	Drain - PCW @ Walnut	05/20/2003 11:35	su	21.30	7.96	2.49	7.60		592.48	96.04	0.97	93.98	398.72	1.35	27.70	30.71	12.27	166.91	525.73	13.41	0.15	0.09	13.69	0.08	
3050106	CIC @ PCW	CIC @ PCW	05/20/2003 12:00	su	20.50	9.02	1.35	5.70		152.46	87.34	14.72	26.97	181.29	0.74	10.80	4.91	3.06	131.53	279.66	21.36	0.20	0.31	23.62	0.56	
3050107	Weephole - CIC @ I5	Weephole 2	05/20/2003 12:15	gw	21.20	7.28	2.17	2.72		432.43	101.52	1.23	55.99	340.18	0.84	20.10	14.58	5.43	163.39	407.89	26.64	0.03	0.17	29.26	0.06	
3050108	Drain - CIC @ Yale	Drain - CIC @ Yale	05/20/2003 13:10	su	20.50	7.53	2.27	6.83		83.58	175.40	42.55	62.20	164.60	1.63	7.77	4.84	6.00	179.17	515.63	92.47	2.65	1.70	118.68	2.64	
3050109	CC @ Yale	Spring	05/20/2003 13:38	gw	21.30	6.93	3.17	2.51		418.83	201.60	1.33	95.60	391.40	1.11	33.10	27.20	4.49	352.27	784.62	21.93	0.02	0.04	22.19	0.03	
3050110	Sump - CC @ Culver	Sump - CC @ Culver	05/20/2003 14:00	gw	22.40	7.49	3.16	6.62		491.23	157.30	2.39	134.80	355.70	1.87	35.70	21.42	23.89	326.62	777.76	18.99	0.06	0.08	18.95	0.04	
3050112	SDC @ Campus	SDC @ Campus	05/27/2003 11:00	su	22.20	7.98	2.89	8.71	11.27	251.21	145.60	5.96	90.70	364.30	1.33	11.50	18.68	6.57	339.63	845.24	8.66	0.25	0.05	10.68	0.14	
3050113	SFC @ RR	Weephole 10N	05/27/2003 12:05	gw	22.10	6.74	2.13	2.21	0.02	372.73	245.00	2.24	66.50	136.40	1.47	13.90	19.52	1.95	178.61	563.32	15.87		0.02	17.86		
3050115	WD @ PCW	WD @ PCW	05/27/2003 12:55	su	22.50	7.66	2.79	6.69		387.99	209.80	2.62	78.30	308.30	1.60	32.70	20.21	9.14	331.25	672.50	13.08		0.14	13.98	0.15	
3050117	VD @ PCW	VD @ PCW	05/27/2003 14:05	su	22.00	7.97	2.73	8.23	2.06	331.25	135.90	3.16	76.70	325.80	1.23	22.40	17.41	9.23	381.21	608.17	11.98		0.07	13.86	0.08	
3050118	VD @ PCW	Spring	05/27/2003 14:20	gw	20.50	7.09	5.06	2.12		481.25	278.20	2.66	312.40	603.40	4.28	42.70	270.40	24.05	580.04	2017.54	9.72	0.07	0.09	11.33	0.06	
3050119	Spring - PCW across from VD	Spring - PCW across from VD	05/27/2003 14:45	gw	21.40	6.93	2.47	0.47		370.16	255.50	2.49	94.10	190.70	1.91	13.70	21.63	4.03	233.74	766.29	15.47		0.02	17.84		
3050121	PCW @ CC	Weephole 1N	05/27/2003 15:15	gw	22.90	7.39	4.34	0.39		539.70	130.30	2.71	124.50	684.50	2.11	21.20	139.90	23.19	401.28	1323.13	7.91		0.11	9.20	0.10	
3050122	PCW @ CC	Weephole 2N	05/27/2003 15:20	gw	23.20	7.25	4.32	1.20		463.93	248.40	5.14	134.40	725.60	2.63	14.70	78.24	7.96	512.80	1692.38	5.53		0.07	6.92	0.14	
3050123	PCW @ CC	Weephole 3N	05/27/2003 15:30	gw	24.20	7.36	4.97	1.61		731.33	218.50	5.83	125.10	723.60	2.37	14.30	84.00	8.92	490.06	1615.14	5.34		0.08	6.54	0.12	
3050124	PCW @ CC	Weephole 3S	05/27/2003 15:40	gw	24.70	7.61	4.59	1.28		883.67	124.59	9.37	89.52	779.73	1.46	13.90	88.65	29.71	407.63	1362.55	0.04		0.18	2.93	0.19	
3060001	SDC above Jeffrey	SDC above Jeffrey	06/02/2003 10:05	su	20.70	7.56	2.13	10.66		326.34	199.63	4.77	47.10	252.40	1.14	24.90	5.66	6.80	293.06	379.15	35.14	0.06	0.21	19.38	0.22	
3060002	SDC above Jeffrey	1B-A1	06/02/2003 0:00	pe															71.19	0.67	20.11	0.70	0.03			
3060003	SDC above Jeffrey	1B-A2	06/02/2003 0:00	pe													0.97		647.52	862.84	8.71	0.23				
3060004	SDC above Jeffrey	1A-A1	06/02/2003 0:00	pe													-1.25		890.03	906.45	2.35	0.13	0.17			
3060005	SDC above Jeffrey	1A-A2	06/02/2003 0:00	pe													-0.14		126.91	155.17	0.20	1.01	0.49			
3060006	SDC above Jeffrey	1A-A3	06/02/2003 0:00	pe													-1.26		241.50	324.94	25.47	0.45	0.10			
3060007	SDC above Jeffrey	1A-A4	06/02/2003 0:00	pe													-1.25		235.15	394.50	29.62	0.57	0.14			
3060008	SDC above Jeffrey	1A-A5	06/02/2003 0:00	pe													-0.72		236.64	394.84	30.39	0.51	0.13			
3060009	SDC above Jeffrey	1A-B1	06/02/2003 0:00	pe							45.29	3.02	10.61	38.80	0.23	2.50			237.03	389.39						
3060010	SDC above Jeffrey	1A-B2	06/02/2003 0:00	pe							121.64	3.07	24.52	142.45	0.67	9.01										
3060011	SDC above Jeffrey	1A-B3	06/02/2003 0:00	pe							114.28	3.55	26.42	139.10	0.67	14.50										
3060012	SDC above Jeffrey	1A-B4	06/02/2003 0:00	pe							114.14	4.18	26.75	138.88	0.70	14.70										
3060013	SDC above Jeffrey	1A-B5	06/02/2003 0:00	pe							97.27	3.60	23.29	114.93	0.58	10.90										
3060014	SDC above Jeffrey	2B-A1	06/02/2003 0:00	pe													-2.18				5.65	0.11	0.15			
3060015	SDC above Jeffrey	2B-A2	06/02/2003 0:00	pe													-2.24		13.19	19.91	0.51	0.06	0.10			
3060016	SDC above Jeffrey	2B-A3	06/02/2003 0:00	pe													-1.30		271.19	383.17	13.67	0.49	0.19			
3060017	SDC above Jeffrey	2B-A4	06/02/2003 0:00	pe													1.56		254.25	343.05	25.26	0.52	0.07			
3060018	SDC above Jeffrey	2B-B1	06/02/2003 0:00	pe							36.00	1.49	7.50	40.75	0.19	2.45			251.55	356.80						
3060019	SDC above Jeffrey	2B-B2	06/02/2003 0:00	pe							102.68	0.91	24.12	105.35	0.54	9.03										
3060020	SDC above Jeffrey	2B-B3	06/02/2003 0:00	pe							97.67	1.83	23.75	102.05	0.51	12.20										
3060021	SDC above Jeffrey	2B-B4	06/02/2003 0:00	pe							98.68	1.65	24.04	104.06	0.52	12.80										
3060022	SDC above Jeffrey	UCR5-A1	06/02/2003 0:00	pe													4.98				21.31	0.64	0.12			
3060023	SDC above Jeffrey	UCR5-A2	06/02/2003 0:00	pe													4.92		294.80	344.37	21.64	0.89	0.14			
3060024	SDC above Jeffrey	UCR5-B1	06/02/2003 0:00	pe							88.17	2.03	28.01	120.61	0.52	11.70			296.15	346.32						
3060025	SDC above Jeffrey	UCR5-B2	06/02/2003 0:00	pe							96.29	2.34	28.61	122.43	0.54	12.00										
3060026	SDC above Jeffrey	UCR5-B3	06/02/2003 0:00	pe							97.79	1.97	28.94	120.71	0.54	12.10										
3060027	SDC above Jeffrey	UCR5-B4	06/02/2003 0:00	pe							95.43	1.98	28.24	121.03	0.54	11.70										
3060028	SDC above Jeffrey	2A-A1	06/02/2003 0:00	pe													4.55				17.84	1.10	0.18			
3060029	SDC above Jeffrey	2A-A2	06/02/2003 0:00	pe													4.01		300.50	340.84	15.64	0.72	0.19			
3060030	SDC above Jeffrey	2A-A3	06/02/2003 0:00	pe													4.16		314.26	344.84	17.55	0.71	0.13			
3060031	SDC above Jeffrey	2A-B1	06/02/2003 0:00	pe							90.12	2.04	27.83	120.18	0.52	11.40			278.85	306.33						
3060032	SDC above Jeffrey	2A-B2	06/02/2003 0:00	pe							85.71	2.15	26.42	113.60	0.50	10.80										
3060033	Dry Collector	Dry Collector	06/02/2003 11:00	cd								0.12		0.45			0.28	1.46	0.51	1.07	0.25	0.21	0.04	0.70	0.10	2230
3060039	SDC @ Campus	Basin2-Upstream-B	06/13/2003 0:00	se																						
3060040	SDC @ Campus	Basin2-Upstream-T	06/13/2003 0:00	se																						

sample id	site	location	Sample Date	Type	Temp	pH	EC (ms)	D.O.	Q	alk	Ca	K	Mg	Na	Sr	Si	Se	As	Cl	SO4	NO3-N	NH4-N	PO4-P	TN	TP	volume
			mm/dd/yyyy hh:mm		deg_c		ms/cm	mg/L	CFS	mg CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml
3060041	SDC @ Campus	Basin2-Middle-B	06/13/2003 0:00	se																						
3060042	SDC @ Campus	Basin2-Middle-T	06/13/2003 0:00	se																						
3060043	SDC @ Campus	Basin2-Downstream-T	06/13/2003 0:00	se																						
3060044	SDC @ Campus	Basin2-Downstream-B	06/13/2003 0:00	se																						
3060045	PCW @ Walnut	PCW @ Walnut	06/18/2003 8:50	su	20.60	7.78	1.50	3.52		275.00							8.02	7.00	188.58	299.16	4.57	0.10	0.25	6.44	0.35	
3060046	PCW @ CIC	PCW @ CIC	06/18/2003 9:06	su	20.77	8.67	1.60	14.63		283.13							1.57	4.25	214.75	283.94	0.06		0.02	1.40	0.11	
3060047	CIC @ PCW	CIC @ PCW	06/18/2003 9:19	su	19.50	8.57	1.53	10.43	0.07	207.52							27.72	4.80	219.49	320.13	6.30	0.11	0.50	8.48	0.70	
3060048	PCW @ Bryan	PCW @ Bryan	06/18/2003 10:00	su	21.20	8.77	1.05	13.16		258.08							1.39	5.29	210.56	273.04	0.10		0.09	1.42	0.21	
3060049	PCW @ Irvine	PCW @ Irvine	06/18/2003 10:24	su	21.80	8.80	1.59	14.37		242.85							1.35	6.18	215.68	292.51	0.62	0.01	0.19	1.86	0.29	
3060050	HCW @ PCW	HCW @ PCW	06/18/2003 10:44	su	19.40	8.18	0.99	10.98		229.92							0.48	6.58	97.83	135.40	2.52	0.20	0.79	5.76	1.20	
3060052	VD @ PCW	VD @ PCW	06/18/2003 13:50	su	22.20	7.87	2.64	8.00		347.86							16.50	8.17	217.88	414.35	15.65	0.05	0.09	13.90	0.35	
3060053	WD @ PCW	WD @ PCW	06/18/2003 14:15	su	21.80	7.64	2.78	7.57		384.79							19.27	7.73	328.47	666.35	14.46		0.30	13.81	0.23	
3060055	WD @ PCW	PCW @ Warner	06/18/2003 14:33	su	25.60	8.13	2.17	10.89		312.87							21.79	7.35	247.58	533.06	8.97	0.14	0.11	9.71	0.20	
3060056	PCW @ Barranca	PCW @ Barranca	06/18/2003 15:03	su	25.50	8.44	2.09	15.11		274.33							23.33	6.60	205.43	548.91	5.77	0.07	0.05	6.61	0.12	
3060058	SDC above PCW	SDC @ PCW	06/18/2003 15:17	su	25.20	8.23	2.43	19.57		258.19							12.84	4.04	303.16	541.22	17.49			20.14	0.02	
3060060	SDC @ Campus	SDC @ Campus	06/18/2003 11:00	su	21.70		3.10	8.44		265.26							19.20	5.07	389.18	872.61	5.30	0.06		6.15	0.20	
3060061	SJC @ Harvard	SJC @ Michelson	06/18/2003 11:30	su	21.20		1.50	5.04		256.95							3.06	5.21	182.38	243.47	3.38	0.03	0.13	4.23	0.21	
3060062	SCW @ SDC	SCW @ SDC	06/18/2003 14:11	su	21.80		9.13	6.25		186.52							2.80	2.79	2804.65	251.28	4.59		0.31	5.01	0.42	
3060063	BaC @ Jamboree	BaC @ SDC	06/18/2003 14:30	su	22.00		6.08	10.90		212.33							2.62	4.01	632.11	2530.85	0.11	0.04	0.09	0.84	0.21	
3060064	LC @ McCabe/Jamboree	LC @ McCabe/Jamboree	06/18/2003 14:50	su	24.50		6.00	20.00		243.42							13.27	2.73	698.47	2384.69	4.97	0.06	0.01	6.06	0.10	
3060065	SDC @ Alton	SDC @ Alton	06/18/2003 15:15	su	25.00		2.05	13.64		259.65							17.57	7.55	217.72	496.68	7.76	0.03		8.86	0.08	
3060066	SFC @ PCW	SFC @ PCW	06/18/2003 9:50	su	20.70	7.42	1.86		0.44	304.50							16.87	3.71	162.82	540.77	11.76	0.03		12.41	0.06	
3060067	SDC @ Campus	PCW below SFC	06/18/2003 10:10	su	21.70	8.09	2.16		3.66	342.77							27.22	11.21	239.70	480.87	8.20	0.09	0.07	9.34	0.18	
3060068	ECD @ PCW	ECD @ PCW	06/18/2003 10:50	gw	3.20	7.60	3.30		0.17	497.32							136.65	29.48	317.13	972.78	13.33	0.03	0.14	13.71	0.17	
3060069	SFC @ PCW	SFC @ PCW	06/18/2003 11:05	su	21.20	7.56	1.88		0.44	287.91							26.13	9.93	162.41	527.10	12.32	0.02		12.34	0.05	
3060070	SDC @ Campus	PCW below SFC	06/18/2003 11:35	su	22.20	8.22	2.12		3.93	328.63							26.29	11.92	250.75	488.41	7.52	0.09	0.06	9.00	0.16	
3060071	ECD @ PCW	ECD @ PCW	06/18/2003 12:06	gw	23.10	7.63	3.29		0.18	497.93							129.30	27.43	106.04	333.13	14.67	0.06	0.20	13.76	0.30	
3060073	SFC @ PCW	SFC @ PCW	06/18/2003 13:00	su	21.80	7.74	1.88		0.42	289.57							17.34	2.38	166.33	541.23	11.96	0.02		11.99	0.04	
3060074	SDC @ Campus	PCW below SFC	06/18/2003 13:20	su	23.00	8.29	2.05		4.14	302.85							24.14	10.67	246.56	469.51	6.88	0.07	0.06	8.21	0.16	
3060075	ECD @ PCW	ECD @ PCW	06/18/2003 14:40	gw	22.90	7.65	3.33		0.18	492.96							130.50	29.27	327.33	1000.47	13.67		0.18	13.70	0.19	
3060076	SFC @ PCW	SFC @ PCW	06/18/2003 15:00	su	22.30	7.93	1.87		0.41	290.35							16.94	3.38	167.10	546.62	12.12	0.01		12.78	0.06	
3060077	SDC @ Campus	PCW below SFC	06/18/2003 15:20	su	23.60	8.40	2.11		3.80	319.12							25.11	10.49	251.48	507.66	8.40	0.03	0.04	9.19	0.13	
3060078	EMIC @ PCW	EMIC @ PCW	06/18/2003 10:10	su	20.00	8.80	1.78	14.89	0.71	191.50							2.38	3.01	296.04	328.00	2.69	0.13		4.73	0.12	
3060080	PCW @ EMIC	PCW @ EMIC	06/18/2003 10:40	su	22.20	8.13	1.63	7.81	1.20	253.35							8.55	6.66	181.47	305.64	4.36	0.01	0.22	5.77	0.30	
3060081	PCW below SFC	CC @ PCW	06/18/2003 11:05	su	21.60	8.17	2.67	12.07	0.68	432.33							24.78	14.96	284.19	606.84	14.65			15.03	0.02	
3060082	EMIC @ PCW	EMIC @ PCW	06/18/2003 11:30	su	21.00	9.18	1.67	16.12	0.66	172.93							2.57	3.14	266.02	333.35	1.98	0.03		3.77	0.08	
3060083	PCW @ EMIC	PCW @ EMIC	06/18/2003 11:40	su	22.30	8.12	1.63	7.95	1.27	265.49							8.84	8.02	186.25	312.00	4.66	0.03	0.21	5.92	0.30	
3060084	PCW below SFC	CC @ PCW	06/18/2003 12:05	su	22.30	8.22	2.76	13.49	0.64	450.72							24.42	15.38	301.00	644.15	15.03			15.91	0.02	
3060085	EMIC @ PCW	EMIC @ PCW	06/18/2003 13:45	su	23.50	9.82	1.53	16.48	0.48	154.22							3.19	2.23	255.77	337.56	1.13			2.68	0.09	
3060086	PCW @ EMIC	PCW @ EMIC	06/18/2003 14:00	su	23.20	8.36	1.65	11.07	1.00	261.11							9.13	6.79	202.56	314.38	4.51	0.01	0.22	6.04	0.32	
3060087	PCW below SFC	CC @ PCW	06/18/2003 14:25	su	25.30	8.29	2.97	18.75	0.50	408.11							26.05	15.39	312.22	668.43	15.81	0.01		15.52	0.02	
3060088	EMIC @ PCW	EMIC @ PCW	06/18/2003 14:45	su	23.20	10.11	1.48	14.50	0.41	135.36							2.29	1.82	234.00	319.71	0.63			2.40	0.10	
3060089	PCW @ EMIC	PCW @ EMIC	06/18/2003 15:00	su	23.80	8.41	1.65	12.42	1.11	275.55							8.59	7.06	0.15	302.39	4.55			5.97	0.29	
3060090	PCW below SFC	CC @ PCW	06/18/2003 15:25	su	25.50	8.31	2.97	17.87	0.62	394.78							26.37	14.77	322.17	698.94	17.27	0.02		16.35	0.02	
3060098	PCW @ CC	Weephole 1N	06/24/2003 9:15	gw	22.50	7.43	4.41	1.48		514.49							133.15	22.65	392.14	1288.29	7.91	0.07	0.11	8.36	0.10	
3060099	VD @ PCW	VD @ PCW	06/24/2003 9:45	su	21.60	7.91	2.45	7.77	1.53	317.48							15.85	7.93	284.85	501.33	12.47	0.10	0.16	12.61	0.20	
3060100	VD @ PCW	Spring	06/24/2003 10:05	gw	20.50	7.14	5.08	2.01		469.07							222.20	24.27	592.29	2073.33	10.35	0.12	0.09	10.78	0.08	
3060103	WD @ PCW	WD @ PCW	06/24/2003 10:50	su	22.00	7.64	2.70	3.55	0.54	379.14							18.30	8.50	296.60	591.21	15.52	0.07	0.23	15.22	0.23	
3060107	CIC @ PCW	CIC @ PCW	06/24/2003 13:00	su	20.20	9.00	1.30	8.45		159.14							2.84	5.31	124.01	266.07	20.41	0.29	0.48	21.31	0.87	
3060115	Dry Collector	Dry Collector	06/24/2003 16:40	cd													-0.22	0.31	2.18	1.40	0.60	0.20	0.05	1.32	0.12	2200
3060116	SDC @ Campus	SDC @ Campus	06/24/2003 17:00	su	28.00	8.62	3.14	17.14	7.30	225.82							18.10	5.59	315.97	743.26	7.50	0.04	0.01	9.11	0.10	
3060117	BoC @ MacArthur	BoC @ MacArthur	06/24/2003 17:30	su	20.30	7.91	2.66	7.12		416.84							2.17	2.97	510.61	337.44	0.31	0.05	0.11	1.02	0.14	
3060118	BaC @ Barranca	Drain	06/24/2003 18:00	su	22.40	7.89	2.53	5.93		287.13							11.35	1.54	909.03	4690.55	4.88	0.10	0.05	5.28	0.05	
3070002	Dry Collector	Dry Collector	07/08/2003 9:30	cd													0.35	-0.98	0.65	0.68	0.20	0.09	0.01	1.03	0.18	1830
3070248	Dry Collector	Dry Collector	07/21/2003 0:00	cd													0.49	-1.28			0.21	0.61	0.06	1.70	0.26	2255
3080010	SDC @ Campus	SDC @ Campus	08/06/2003 9:45	su	25.10	8.27	3.14	10.94									13.35	4.97	333.39	794.25	2.01	0.06		4.09	0.18	
3080011	Tomato Springs	Tomato Springs	08/06/2003 10:50	gw	23.60	7.40	4.26	6.94									77.40	4.28	417.45	1405.33	4.42	0.05	0.02	4.64		
3080013	Wet Collector	Wet Collector	08/06/2003 0:00	cw															2.56	2.71	1.67	1.40	0.02	4.84	0.06	111
3080014	Dry Collector	Dry Collector	08/06/2003 0:00	cd													0.39	0.59	0.66	0.80	0.29	0.55	0.08	1.58	0.19	2050
3080018	Dry Collector	Dry Collector	08/19/2003 0:00	cd													0.28	0.64	0.81	0.96	0.43	0.37	0.07	0.86	0.15	1725
3080022	Dry Collector	Dry Collector	08/28/2003 0:00	cd													0.39	0.62	0.43	0.57	0.11	0.25	0.02	0.66	0.12	1280
3090053	Dry Collector	Dry Collector	09/25/2003 0:00	cd													0.49	0.86	2.17	5.31	0.18	0.08	0.02	3.93	0.23	1980
3090057	PCW @ CC	Weephole 32N	09/30/2003 10:25	gw	22.30	7.30	1.60	2.23		311.55							8.46	6.04	68.23	395.73	1.27	0.03	0.30	1.56	0.33	
3090059	VD @ PCW	Spring	09/30/2003 11:20	gw	22.50	7.15	5.08	2.21		451.55							123.70	23.19	463.19	1648.65	12.34	0.09	0.10	11.17	0.05	
3090060	VD @ PCW	VD @ PCW	09/30/2003 11:30	su	23.50	7.96	2.64	7.53		327.43							14.59	7.66	314.26	497.22	12.65	0.04	0.17	12.45	0.14	0
3090062	WD @ PCW	WD @ PCW	09/30/2003 11:58	su	23.20	7.72	2.79	6.78		344.18							17.72	8.11	307.01	607.44	13.43	0.04	0.20	13.17	0.23	
3090065	CIC @ PCW	CIC @ PCW	09/30/2003 13:25	su	26.10	9.18	0.24	9.65		161.25							3.61	5.00	106.18	239.34	1.07	0.19	0.37	2.42	0.37	
3100002	SDC @ Campus	SDC @ Campus	10/07/2003 0:00	su	21.00	8.18	2.93	9.84		365.94							12.72	3.87	330.07	782.87	2.10	0.07		3.42	0.10	
3100004	BoC @ MacArthur	BoC @ MacArthur	10/07/2003 0:00	su	18.80	7.91	2.62	7.91		437.33							3.69	2.47	507.96	330.35	0.39	0.02	0.15	0.84	0.15	
3100006	BaC @ Main	BaC @ Main	10/07/2003 0:00	su	26.20	8.05	3.89	8.05		246.36							1.82	2.99	338.75	1292.92	0.34	0.33	0.07	1.64	0.17	
3100008	SDC @ Harvard	SDC @ Harvard	10/07/2003 0:00	su	24.90	8.40	2.30	8.40		289.91							3.44	4.39	291.68	415.36	14.03	0.02	0.17	13.73	0.17	
3100010	Dry Collector	Dry Collector	10/07/2003 0:00	cd													0.14	1.51	1.64	5.94	0.05	0.07		1.77	0.09	3190

sample id	site	location	Sample Date	Type	Temp	pH	EC (ms)	D.O.	Q	alk	Ca	K	Mg	Na	Sr	Si	Se	As	Cl	SO4	NO3-N	NH4-N	PO4-P	TN	TP	volume
			mm/dd/yyyy hh:mm		deg_c		ms/cm	mg/L	CFS	mg CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml
3100016	PCW @ Barranca	PCW @ Barranca	10/21/2003 10:30	su	23.10	8.47	2.29	19.85		256.05							20.52	9.00	214.07	587.26	6.23	0.05	0.20	7.54	0.31	
3100017	PCW @ Moffett	PCW @ Moffett	10/21/2003 11:00	su	22.60	9.94	2.04	11.97		274.10							16.12	8.51	189.85	476.02	6.90	0.09	0.38	9.43	0.54	
3100018	SFC @ PCW	SFC @ PCW	10/21/2003 11:45	su	22.50	7.57	1.83	15.56		300.97							13.25	2.08	147.36	456.93	10.78	0.05	0.13	11.79	0.16	
3100019	ECD @ PCW	ECD @ PCW	10/21/2003 12:20	su	24.40	7.49	2.68	5.28		478.08							121.40	30.85	301.07	938.75	13.24	0.08	0.14	13.29	0.12	
3100020	PCW below SFC	CC @ PCW	10/21/2003 13:00	su	29.40	8.50	2.34			323.06							25.83	13.35	313.26	658.35	18.02	0.06	0.02	18.40	0.09	
3100021	EMIC @ PCW	EMIC @ PCW	10/21/2003 13:45	su	27.50	9.57	1.37	13.51		87.56							2.49	1.18	147.25	268.80	1.17	0.09	0.10	4.30	0.23	
3100022	PCW @ EMIC	PCW @ EMIC	10/21/2003 14:15	gw	21.50	7.84	1.72	9.92		260.33							5.08	4.96	153.42	412.76	6.53	0.06	0.80	7.56	1.06	
3100023	Dry Collector	Dry Collector	10/21/2003 0:00	cd													0.24	-0.27	2.07	6.02	0.10	0.15	0.02	4.40	0.20	2300
3110001	SDC @ Campus	SDC @ Campus	11/04/2003 9:30	su	16.20	7.74	1.60	7.21		189.07							8.29	2.89	195.15	472.67	4.74	0.34	0.27	0.00	0.45	
3110002	Spring - SDC @ Harvard	Spring - SDC @ Harvard	11/04/2003 10:00	gw	22.00	7.03	3.89	0.71		340.17							34.56	3.88	329.15	1120.65	50.33	0.03	0.07		0.06	
3110003	VD @ PCW	Spring	11/04/2003 10:20	gw	20.40	7.15	4.72	2.37		460.84							139.70	21.19	472.79	1659.99	11.37	0.08	0.09		0.07	
3110004	Spring - PCW across from VD	Spring - PCW across from VD	11/04/2003 10:30	gw	21.10	6.96	2.56	0.44		355.43							20.47	-0.72	223.00	695.94	17.27	0.06	0.05		0.02	
3110005	PCW @ CC	Weephole 1N	11/04/2003 11:00	gw	19.30	7.77	4.12	3.26		561.67							135.75	20.99	371.82	1221.77	7.69	0.02	0.13		0.52	
3110006	SFC @ RR	Weephole 10N	11/04/2003 11:15	gw	22.70	6.92	2.25	2.33		359.20							20.03	-0.59	170.28	552.38	17.72	0.04	0.04		0.05	
3110007	Tomato Springs	Tomato Springs	11/04/2003 11:45	gw	21.80	7.19	4.10	5.63		345.27							177.15	3.89	436.17	1461.49	4.89	0.04	0.03		0.02	
3110008	Wet Collector	Wet Collector	11/04/2003 9:00	cw													0.13	-0.26	3.89	2.41	0.51	0.56	0.07		0.16	370
3110009	Dry Collector	Dry Collector	11/04/2003 9:00	cd													0.08	0.50	1.42	2.67	0.23	0.20	0.31		0.58	3800
3110024	EMIC @ PCW	EMIC @ PCW	11/18/2003 10:15	su	14.70	8.72	1.33			192.89							2.27	1.61	168.76	237.95	1.49	0.04	0.11		0.21	
3110025	PCW @ EMIC	PCW @ EMIC	11/18/2003 10:40	gw	14.70	8.01	1.84			292.79							9.72	4.70	194.65	326.05	5.54	0.04	0.22		0.27	
3110026	PCW below SFC	CC @ PCW	11/18/2003 11:10	su	22.10	8.40	2.99			455.79							26.35	14.91	329.85	704.81	20.23	0.04	0.36		0.45	
3110027	EMIC @ PCW	EMIC @ PCW	11/18/2003 12:25	su	19.60	9.71	1.15			106.79							2.79	1.84	150.37	229.60	0.96	0.05	0.11		0.21	
3110028	PCW @ EMIC	PCW @ EMIC	11/18/2003 12:30	gw	16.90	8.20	1.82			292.12							10.26	5.88	189.64	321.92	5.69	0.03	0.20		0.27	
3110029	PCW below SFC	CC @ PCW	11/18/2003 13:00	su	24.70	8.58	2.93			402.62							27.06	15.18	304.53	654.95	21.72	0.04	0.05		0.25	
3110030	EMIC @ PCW	EMIC @ PCW	11/18/2003 14:30	su	19.60		1.15			172.93							3.06	2.32	161.03	276.75	0.66	0.05	0.05		0.13	
3110031	PCW @ EMIC	PCW @ EMIC	11/18/2003 14:45	gw	16.50	8.90	1.84			283.91							10.90	5.50	195.42	343.67	6.27	0.03	0.20		0.26	
3110032	PCW below SFC	CC @ PCW	11/18/2003 15:00	su	22.10	8.56	3.00			403.57							27.60	13.79	316.49	676.04	21.33	0.03	0.04		0.18	
3110033	SFC @ PCW	SFC @ PCW	11/18/2003 10:05	su	15.70	7.76	1.55	12.56		313.42							13.39	0.66	138.60	450.29	11.93	0.03	0.08		0.12	
3110034	SDC @ Campus	PCW below SFC	11/18/2003 10:40	su	16.80	8.01	2.07	9.82		334.95							28.69	9.56	222.18	505.57	10.18	0.08	0.14		0.19	
3110035	ECD @ PCW	ECD @ PCW	11/18/2003 11:20	su	22.80	7.69	3.51	5.38		498.74							122.40	30.31	294.97	926.42	14.13	0.06	0.16		0.32	
3110037	SFC @ PCW	SFC @ PCW	11/18/2003 13:45	su	20.10	8.32	1.72	Satd		281.13							13.43	1.58	139.45	451.48	11.36	0.03	0.04		0.06	
3110038	SDC @ Campus	PCW below SFC	11/18/2003 14:12	su	19.00	8.24	2.19	12.87		401.88							28.52	10.28	224.29	505.19	10.56	0.06	0.14		0.19	
3110039	ECD @ PCW	ECD @ PCW	11/18/2003 14:33	su	23.30	7.69	3.51	5.44		517.30							122.30	31.00	297.88	933.35	13.74	0.07	0.17		0.19	
3110040	SDC @ Campus	PCW below SFC	11/18/2003 0:00	su	19.00	8.34	2.25	12.66		390.96							29.77	13.59	231.13	531.64	10.87	0.07	0.14		0.19	
3110041	ECD @ PCW	ECD @ PCW	11/18/2003 0:00	su	22.90	7.75	3.54	5.53		500.06							122.50	29.89	299.41	938.39	14.41	0.06	0.24		0.31	
3110041D	ECD @ PCW	ECD @ PCW	11/18/2003 0:00	su						499.04							121.70	29.67	300.49	933.97	14.96	0.06	0.21		0.32	
3110042	SFC @ PCW	SFC @ PCW	11/18/2003 0:00	su		8.14		15.99		301.53							14.32	0.71	142.75	456.40	11.70	0.03	0.02		0.05	
3110043	Wet Collector	Wet Collector	11/18/2003 0:00	cw													0.20	-0.31	2.36	1.81	0.87	0.51	0.02		0.04	250
3110044	Dry Collector	Dry Collector	11/18/2003 0:00	cd													0.02	0.52	1.48	1.38	0.24	0.29	0.08		0.19	2550
3120009	Dry Collector	Dry Collector	12/06/2003 15:00	cd															2.07	1.67	0.25	0.89	0.22		0.38	2530
3120011	EMIC @ PCW	EMIC @ PCW	12/16/2003 9:50	su	0.00	8.65	0.92	16.47		228.66									128.69	235.10	1.70	0.03	0.12		0.11	
3120012	PCW @ EMIC	PCW @ EMIC	12/16/2003 10:10	gw	11.20	8.22	1.47	10.61		286.91									192.35	386.80	9.61	0.04	0.53		0.66	
3120013	PCW below SFC	CC @ PCW	12/16/2003 10:40	su	16.20	8.41	2.73	18.48		501.78									332.08	707.28	18.16	0.14	0.07		0.12	
3120014	Drain - PCW @ Walnut	Drain - PCW @ Walnut	12/16/2003 11:00	su	17.70	8.51	2.34	7.62		589.76									160.99	480.60	12.99	0.03	0.12		0.15	
3120015	CIC @ PCW	CIC @ PCW	12/16/2003 11:12	su	9.90	9.93	1.08	15.51		106.79									174.24	337.79	10.32	0.04	0.38		0.56	
3120016	Weephole - CIC @ I5	Weephole 1	12/16/2003 11:25	gw	19.60	7.62	2.16	1.71		432.43									160.88	378.45	26.38	0.02	0.10		0.08	
3120017	CC @ Yale	Spring	12/16/2003 11:55	gw	19.30	7.25	2.66	2.77		570.03									221.22	595.18	13.10	0.03	0.06		0.14	
3120018	Sump - CC @ Culver	Sump - CC @ Culver	12/16/2003 12:22	gw	21.10	7.74	3.20	4.53		516.80									328.53	771.56	17.60	0.05	0.06		0.09	
3120019	SFC @ PCW	SFC @ PCW	12/16/2003 13:00	su	16.10	7.75	1.60	15.15		340.93									140.50	478.42	11.67	0.04	0.14		0.11	
3120020	ECD @ PCW	ECD @ PCW	12/16/2003 13:19	su	21.30	7.84	3.34	6.55		478.69									323.48	1011.20	11.69	0.03	0.25		0.58	
3120021	Spring - PCW across from VD	Spring - PCW across from VD	12/16/2003 13:45	gw	21.00	7.37	2.55	0.44		401.67									215.01	685.30	16.21	0.02	0.06		0.07	
3120022	VD @ PCW	Spring	12/16/2003 13:50	gw	18.70	7.35	4.61	2.98		476.14									504.07	1760.77	11.03	0.08	0.12		0.08	
3120023	VD @ PCW	VD @ PCW	12/16/2003 13:55	su	19.00	8.18	3.18	9.17		408.53									347.89	884.79	19.01	0.03	0.06		0.09	
3120024	Drain - PCW E Side N of Warner	Drain - PCW E Side N of Warner	12/16/2003 14:30	su	20.60	8.02	3.61	5.35		427.94									357.60	1083.43	12.48	0.04	0.07		0.04	
3120025	WD @ PCW	WD @ PCW	12/16/2003 14:50	su	18.00	7.93	2.42	4.68		351.76									305.40	602.63	11.85	0.04	0.27		0.27	
3120026	Drain - PCW W side S of Warner	Drain - PCW W side S of Warner	12/16/2003 15:00	su	16.80	8.01	6.10	8.54		386.82									598.61	2984.33	20.76	0.08	0.07		0.07	
3120027	PCW @ Barranca	PCW @ Barranca	12/16/2003 15:20	su	16.90	8.54	2.07	14.96		346.24									243.66	603.56	11.01	0.04	0.33		0.27	
3120028	Spring - SDC @ Harvard	Spring - SDC @ Harvard	12/16/2003 15:35	gw	21.20	7.40	3.80	0.85		362.21									339.34	1143.96	47.01	0.03	0.08		0.05	
3120029	SDC @ Harvard	SDC @ Harvard	12/16/2003 15:40	su	14.50	8.23	1.90	13.69		310.01									262.33	366.82	17.43	0.01	0.20		0.14	
3120030	Drain - SDC @ Harvard	Drain - SDC @ Harvard	12/16/2003 16:00	su	22.70	7.66	3.53	6.49		375.19									318.65	942.11	22.96	0.02	0.06		0.04	
3120031	SDC @ Culver	Weephole	12/16/2003 16:15	gw	17.40	7.29	2.22	1.32		412.11									301.42	414.81	20.47	0.03	0.15		0.07	
3120032	Spring - SDC @ Culver	Spring - SDC @ Culver	12/16/2003 16:25	gw	18.00	7.18	2.38	2.23		394.25									290.55	422.10	21.92	0.03	0.11		0.05	
3120037	SFC @ RR	Weephole 10N	12/19/2003 8:47	gw	21.30	6.88	2.21	1.77		356.07									163.35	533.76	17.56	0.03	0.03		0.00	
3120038	BaC @ Main	BaC @ Main	12/19/2003 9:37	su	9.70	8.07	2.42	8.33		179.33									298.18	1049.34	0.03	0.40	0.04		0.18	
3120039	SDC @ Campus	SDC @ Campus	12/19/2003 10:25	su	11.50	8.38	2.52	13.64		313.75									349.57	811.15	11.64	0.11	0.07		0.15	
3120040	BoC @ MacArthur	BoC @ MacArthur	12/19/2003 10:44	su	9.50	8.12	2.08	12.29		372.41									478.77	336.31	0.50	0.04	0.07		0.08	
3120041	SADC @ Irvine	Spring	12/19/2003 11:21	gw	15.90	7.21	1.89	1.35		429.62									223.60	352.59	2.38	0.02	0.06		0.52	
3120042	LC @ McCabe/Jamboree	LC @ McCabe/Jamboree	12/19/2003 11:53	su	15.00	8.31	5.58	19.03		269.18									741.70	2364.02	7.44	0.14	0.08		0.16	
3120043	BaC @ Barranca	Drain	12/19/2003 12:19	su	18.50	8.22	7.67	7.69		285.47									720.06	3661.71	5.20	0.07	0.04		0.07	
3120045	Wet Collector	Wet Collector	12/19/2003 10:00	cw															1.11	1.66	0.30	0.43			0.03	390
3120046	Dry Collector	Dry Collector	12/19/2003 10:00	cd															1.46	0.79	0.11	0.17	0.14		0.25	4050
4010011	Wet Collector	Wet Collector	01/08/2004 0:00	cw																	0.21	0.24	0.05		0.11	450
4010012	Dry Collector	Dry Collector	01/08/2004 0:00	cd																	0.13	0.12	0.12		0.26	4200

sample id	site	location	Sample Date	Type	Temp	pH	EC (ms)	D.O.	Q	alk	Ca	K	Mg	Na	Sr	Si	Se	As	Cl	SO4	NO3-N	NH4-N	PO4-P	TN	TP	volume
			mm/dd/yyyy hh:mm		deg_c		ms/cm	mg/L	CFS	mg CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml
4010184	SDC @ Campus	SDC @ Campus	01/19/2004 11:00	su	15.80	8.40	2.58	13.95		249.41											11.72	0.07	0.03			
4010184D	SDC @ Campus	SDC @ Campus	01/19/2004 11:00	su						255.15											12.12	0.07	0.03			
4010268	Wet Collector	Wet Collector	01/29/2004 0:00	cw		7.40	0.04														1.40	0.37	0.00			90
4010269	Dry Collector	Dry Collector	01/29/2004 0:00	cd		7.47	0.01														0.31	0.24	0.02			2290
4020083	Wet Collector	Wet Collector	02/13/2004 0:00	cw																	0.04	0.23	0.08			
4020084	Dry Collector	Dry Collector	02/13/2004 0:00	cd																	0.06	0.11	0.02			
4030119	Wet Collector	Wet Collector	03/06/2004 0:00	cw						3.12											0.11	0.10	0.00			
4030120	Dry Collector	Dry Collector	03/06/2004 0:00	cd																	0.25	0.23	0.00			
4030147	SFC @ RR	Weephole 10N	03/22/2004 0:00	gw	21.20	6.76	2.16	4.27													17.73	0.00	0.03			
4030148	Weephole - LC @ Red Hill	Weephole - LC @ Red Hill	03/22/2004 0:00	gw	21.50	7.01	4.22	1.58													46.61	0.00	0.02			
4030149	SADC @ Irvine	Spring	03/22/2004 0:00	gw	21.00	7.04	1.62	1.46													1.22	0.02	0.07			
4030150	SDC @ Campus	SDC @ Campus	03/22/2004 0:00	su	21.70	8.35	3.01	11.63													9.82	0.04	0.00			
4030151	SDC @ Campus	SDC @ Campus	03/22/2004 0:00	su	21.70	8.35	3.01	11.63													9.44	0.01	0.00			
4030152	Wet Collector	Wet Collector	03/22/2004 0:00	cw			0.01														0.10	0.08	0.00			15
4030153	Dry Collector	Dry Collector	03/22/2004 0:00	cd			0.03														0.60	1.01	0.01			810
4030154	Spring - SDC @ Harvard	Spring - SDC @ Harvard	03/22/2004 0:00	gw	21.01	7.09	3.45	0.89													50.92	0.00	0.05			
4030155	SDC @ Culver	Weephole	03/22/2004 0:00	gw	22.90	6.92	2.43	2.09													19.07	0.00	0.09			
4030156	Spring - SDC @ Culver	Spring - SDC @ Culver	03/22/2004 0:00	gw	21.40	6.83	2.46	0.85													22.96	0.00	0.08			
4030169	SDC @ Harvard	SDC @ Harvard	03/31/2004 9:54	su	19.90	8.83	2.16	17.07													19.23	0.05	0.00			
4030170	PCW @ Barranca	PCW @ Barranca	03/31/2004 10:25	su	24.30	8.46	2.50	15.77													8.95	0.07	0.03			
4030171	SFC @ PCW	SFC @ PCW	03/31/2004 11:08	su	19.70	8.16	1.59	16.80													7.49	0.02	0.00			
4030172	ECD @ PCW	ECD @ PCW	03/31/2004 11:48	su	20.60	7.89	3.46	5.43													14.23	0.07	0.13			
4030172D	ECD @ PCW	ECD @ PCW	03/31/2004 11:48	su																	14.05	0.05	0.13			
4030174	Spring - PCW across from VD	Spring - PCW across from VD	03/31/2004 12:19	gw	20.80	7.50	2.46	1.21													16.88	0.03	0.01			
4030175	VD @ PCW	Spring	03/31/2004 12:30	gw	19.70	7.55	4.70	2.80													10.49	0.08	0.07			
4030176	PCW below SFC	CC @ PCW	03/31/2004 12:56	su	25.90	8.51	3.15	Satd		397.43											19.85	0.04	0.00			
4030177	PCW @ CC	Weephole 1N	03/31/2004 13:25	gw	23.00	7.76	4.30	2.45		527.03											6.98	0.06	0.11			
4030178	EMIC @ PCW	EMIC @ PCW	03/31/2004 13:46	su	26.00	9.03	1.26	14.30		185.02											1.82	0.04	0.01			
4030180	PCW @ EMIC	PCW @ EMIC	03/31/2004 13:56	gw	21.10	8.53	1.74	12.04		277.12											11.17	0.06	0.18			
4030181	CIC @ PCW	CIC @ PCW	03/31/2004 14:50	su	25.60	8.45	3.02	10.98		77.29											129.71	35.50	1.54			
4030182	Weephole - CIC @ I5	Weephole 99	03/31/2004 14:55	gw	21.30	7.60	2.19	1.47		433.37											32.26	0.04	0.06			
4030183	Sump - CC @ Culver	Sump - CC @ Culver	03/31/2004 15:24	gw	20.90	7.77	3.08	6.53		464.24											18.18	0.10	0.02			
4030184	Dry Collector	Dry Collector	03/31/2004 9:30	cd																	0.35	0.41	0.07			
4030185	Well 63S	Well 63S	03/31/2004 9:04	gw	20.70	7.15	3.31	0.10		565.51											24.07	0.04	0.08			
4030186	Well 85W	Well 85W	03/31/2004 9:52	gw	20.70	6.95	3.54	1.27		553.38											26.28	0.03	0.10			
4030187	Well 86N	Well 86N	03/31/2004 10:48	gw	21.90	6.97	4.01	0.37		480.02											17.10	0.03	0.08			
4030188	Well 103N	Well 103N	03/31/2004 11:32	gw	20.90	6.98	3.32	1.50		524.13											31.60	0.03	0.04			
4030189	Well 87N	Well 87N	03/31/2004 12:25	gw	21.50	6.82	2.63	0.51		421.35											21.65	0.03	0.03			
4030190	Well 102N	Well 102N	03/31/2004 14:15	gw	22.20	7.10	0.65	2.15		278.90											1.52	0.02	0.16			
4030191	Well - PCW N of RR	Well - PCW N of RR	03/31/2004 14:58	gw	22.10	7.05	6.41	0.12		534.22											3.69	0.02	0.03			

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
2060013	SDC @ Campus	SDC @ Campus	06/06/2002 11:00	su					0.01					
2060014	SDC @ Culver	SDC @ Culver	06/06/2002 11:42	su					0.01					
2060015	PCW below SFC	CC @ PCW	06/06/2002 13:30	su										
2060016	PCW @ CC	PCW @ CC	06/06/2002 13:00	su					0.00					
2060017	PCW @ CC	Weephole 1	06/06/2002 13:00	gw					0.07	0.00	478.00	89.30		
2060018	PCW @ CC	Weephole 2	06/06/2002 13:00	gw					0.03	34.33	366.00	42.70		
2060019	SFC @ RR	Weephole - first under road	06/06/2002 14:10	gw						0.00	3.00	4.90		
2060021	SDC @ Valley Oak	SDC @ Valley Oak	06/13/2002 11:00	su					0.42					
2060023	Spring - SDC @ Culver	Spring - SDC @ Culver	06/13/2002 11:55	gw						0.00	23.00	24.80		
2060024	SDC 300 m below Culver	SDC 300 m below Culver	06/13/2002 12:20	su										
2060025	Spring - SDC @ Harvard	Spring - SDC @ Harvard	06/13/2002 12:40	gw						0.00	58.00	28.40		
2060026	SDC @ Harvard	SDC @ Harvard	06/13/2002 13:00	su					0.00					
2060027	ECD @ PCW	ECD @ PCW	06/20/2002 10:20	gw	0.01					0.00	130.00	141.90		
2060028	VD @ PCW	VD @ PCW	06/20/2002 11:00	su										
2060029	VD @ PCW	Spring	06/20/2002 11:10	gw						0.00	144.00	154.70		
2060030	Spring - PCW across from VD	Spring - PCW across from VD	06/20/2002 11:40	gw					0.08	79.08	78.00			
2060031	PCW @ Moffett	PCW @ Moffett	06/20/2002 12:00	su	0.02				0.02					
2060032	WD @ PCW	WD @ PCW	06/20/2002 12:50	su										
2060034	Drain - PCW W side S of Warner	Drain - PCW W side S of Warner	06/20/2002 13:30	su	0.02				0.09					
2060035	PCW 350 m below Warner	PCW 350 m below Warner	06/20/2002 14:00	su										
2060036	SDC @ Campus	SDC @ Campus	06/27/2002 11:25	su	0.01				0.02					
2060038	SDC @ Michelson	SDC @ Michelson	06/27/2002 12:50	su					0.02					
2060039	SDC @ Coronado	SDC @ Coronado	06/27/2002 14:15	su										
2060040	Dry Collector	Dry Collector	06/27/2002 0:00	cd										
2060041	Dry Collector	Dry Collector	07/02/2002 9:30	cd										
2060042	SDC @ Alton	SDC @ Alton	07/02/2002 10:30	su					0.01					
2060043	PCW @ Barranca	PCW @ Barranca	07/02/2002 11:15	su										
2060044	SDC @ Harvard	SDC @ Harvard	07/02/2002 12:00	su	0.01									
2060045	PCW @ Moffett	PCW @ Moffett	07/02/2002 12:45	su					0.01					
2060046	PCW @ CC	PCW @ CC	07/02/2002 13:15	su										
2060047	PCW @ Bryan	PCW @ Bryan	07/02/2002 14:30	su										
2060048	SFC @ Red Hill	SFC @ Red Hill	07/10/2002 9:30	su										
2060049	SFC @ RR	SFC @ RR	07/10/2002 10:20	su										
2060050	SFC @ RR	Weephole 10N	07/10/2002 10:30	gw						0.00	0.00			
2060051	EMIC @ El Camino Real	EMIC N of El Camino Real	07/10/2002 11:10	su										
2060052	CIC @ Northwood Plaza on Trabuco	CIC @ Northwood Plaza on Trabuco	07/10/2002 12:00	su										
2060053	PCW @ Irvine	PCW @ Irvine	07/10/2002 12:40	su										
2060061	BoC @ MacArthur	BoC @ MacArthur	07/18/2002 10:20	su			-6.00	-45.43						
2060062	SCW @ Harvard	SCW @ Harvard	07/18/2002 11:45	su			-6.40	-47.77						
2060063	SCW @ Harvard	Drain	07/18/2002 12:00	su			-7.50	-51.72						
2060064	SJC @ Harvard	SJC @ Harvard	07/18/2002 12:45	su			-5.00	-43.09						
2060065	LC @ McCabe/Jamboree	LC @ McCabe/Jamboree	07/18/2002 13:50	su			-6.70	-52.81						
2060066	BaC @ Alton	BaC @ Alton	07/18/2002 15:00	su			-5.80	-49.56						
2060162	EMIC @ Newport	EMIC @ Newport	07/25/2002 9:40	su			-6.00	-50.30						
2060163	EMIC @ Newport	Drain B - EMIC @ Newport	07/25/2002 9:40	su			-7.00	-48.66						
2060164	HCW @ Culver	HCW @ Culver	07/25/2002 11:30	su			-6.70	-53.91						
2060165	CC @ Yale	CC @ Yale	07/25/2002 13:15	su			-5.50	-52.75						
2060166	CC @ Yale	Spring	07/25/2002 13:15	gw			-6.70	-50.61		0.00	38.00			
2060167	CC @ Yale	Drain	07/25/2002 13:15	su			-7.10	-52.64						
2060254	Dry Collector	Dry Collector	08/01/2002 9:15	cd										
2060255	PCW below SFC	CC @ PCW	08/01/2002 10:25	su			-6.80	-51.32						
2060256	Weephole - PCW @ Harvard	Weephole - PCW @ Harvard	08/01/2002 11:00	gw			-6.90	-49.56		0.00	188.00	10.00		

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
2060257	EMIC @ PCW	EMIC @ PCW	08/01/2002 11:00	su			-6.79	-55.20						
2060259	PCW @ EMIC	PCW @ EMIC	08/01/2002 11:30	su			-6.58	-51.58						
2060260	DP @ PCW	DP @ PCW	08/01/2002 12:15	gw			-6.72	-50.13		5.49	72.00	9.30		
2060261	Drain - GWD @ SDC	Drain - GWD @ SDC	08/01/2002 12:30	su			-6.54	-49.26						
2060262	SFC @ RR	SFC @ RR	08/01/2002 13:15	su			-6.03	-49.45						
2060263	Drain - PCW @ CC	Drain - PCW @ CC	08/01/2002 13:30	su			-7.42	-61.63						
2060264	SFC @ PCW	SFC @ PCW	08/01/2002 14:15	su			-6.00	-47.16						
2060265	ECD @ PCW	ECD @ PCW	08/01/2002 14:30	gw			-7.09	-52.29		0.00	145.00	129.30		
2060266	SDC @ Campus	PCW below SFC	08/01/2002 14:50	su			-6.43	-51.37						
2060267	Well 63S	Well 63S	08/08/2002 10:00	gw			-6.57	-48.25		11.00	82.00	51.70		
2060268	Well 85W	Well 85W	08/08/2002 10:50	gw			-6.35	-48.54		108.90	53.00	84.80		
2060269	Well 86N	Well 86N	08/08/2002 12:45	gw			-6.68	-47.90		0.00	91.00	60.80		
2060270	Well 103N	Well 103N	08/08/2002 14:15	gw			-6.86	-52.60		0.00	25.00	62.70		
2060271	VD @ PCW	Spring	08/08/2002 10:00	gw			-6.56	-46.56		0.00	136.00	159.10		
2060272	VD @ PCW	VD @ PCW	08/08/2002 10:00	su			-6.71	-49.56						
2060273	SFC @ RR	Weephole 7S	08/08/2002 11:00	gw			-6.78	-49.13		0.00	0.00	2.30		
2060274	SFC @ RR	Spring 7-8R	08/08/2002 11:00	gw			-6.96	-49.15		0.00	0.00	1.30		
2060275	SFC @ RR	Weephole 19S	08/08/2002 11:30	gw			-6.88	-48.09		0.00	0.00	1.60		
2060276	SFC @ RR	Weephole 23S	08/08/2002 11:45	gw			-6.87	-48.49		0.00	0.00	1.10		
2060277	SFC @ RR	Weephole 4N	08/08/2002 12:00	gw			-6.89	-49.35		0.00	0.00	0.40		
2060278	SFC @ RR	Weephole 9N	08/08/2002 12:00	gw			-6.95	-49.31		0.00	0.00			
2060279	SFC @ RR	Drain	08/08/2002 12:00	su			-7.28	-51.03						
2060280	SFC @ RR	Weephole 23N	08/08/2002 12:20	gw			-6.84	-48.45		0.00	1.00	0.50		
2060281	SFC @ RR	Weephole 33N	08/08/2002 12:30	gw			-6.80	-48.61		0.00	2.00	0.40		
2060282	PCW @ CC	Weephole 1N	08/08/2002 14:00	gw			-6.57	-46.88		79.86	510.00	82.10		
2060283	PCW @ CC	Weephole 2N	08/08/2002 14:00	gw			-6.55	-47.23		48.13	385.00	29.90		
2060284	PCW @ CC	Weephole 3N	08/08/2002 14:15	gw			-6.61	-46.54		72.26	604.00	15.90		
2060285	EMIC above PCW (S)	EMIC above PCW (S)	08/08/2002 15:15	su			-5.45	-41.01						
2060293	Well 87N	Well 87N	08/15/2002 12:20	gw			-5.55	-43.80		0.00	19.00	21.20	8.16	3.65
2060294	Well 102N	Well 102N	08/15/2002 14:15	gw			-5.09	-35.81		728.42	7.00	16.30	1.27	1.83
2060295	Dry Collector	Dry Collector	08/15/2002 9:15	cd									0.29	-0.02
2060296	SDC @ Campus	SDC @ Campus	08/15/2002 10:50	su			-4.93	-42.94					13.77	6.58
2060297	SADC @ Irvine	SADC @ Irvine	08/15/2002 12:20	su			-6.90	-52.77					6.52	1.98
2060298	SADC @ Irvine	Spring	08/15/2002 13:00	gw			-7.49	-54.47		108.66	62.00	5.40	6.83	3.56
2060299	LC @ Main	LC @ Main	08/15/2002 14:30	su			-7.33	-56.10					13.87	2.78
2060301	LC @ McCabe/Jamboree	Spring	08/22/2002 10:15	gw			-8.90	-67.11		119.42	376.00	0.40	10.87	2.17
2060302	BaC @ Jamboree	BaC @ Jamboree	08/22/2002 11:30	su			-6.83	-54.24					1.81	3.94
2060303	BaC @ Barranca	Drain	08/22/2002 12:10	su			-6.43	-43.19					14.51	0.80
2060304	BaC @ Barranca	BaC @ Barranca	08/22/2002 12:15	su			-7.50	-64.83					3.88	4.03
2060305	BaC @ Red Hill	IRWD Pipe	08/22/2002 13:00	su			-8.51	-57.48					0.88	2.16
2060306	BaC @ Red Hill	BaC @ Red Hill	08/22/2002 13:30	su			-5.44	-51.66					1.32	0.94
2060307	SFC @ PCW	SFC @ PCW	08/22/2002 14:20	su			-6.50	-48.92					6.50	1.77
2060308	SDC @ Campus	PCW below SFC	08/22/2002 14:30	su			-6.53	-50.27					24.58	6.96
2060309	EMIC @ PCW	EMIC @ PCW	08/22/2002 15:40	su			-6.05	-53.04					2.38	2.24
2060310	PCW @ EMIC	PCW @ EMIC	08/22/2002 16:00	su			-6.68	-50.31					20.09	4.97
2060311	PCW below SFC	CC @ PCW	08/22/2002 16:15	su			-6.17	-48.10					26.69	16.91
2060312	SDC @ Campus	PCW below SFC	08/26/2002 10:00	su			-6.64	-51.19					28.47	6.54
2060313	SFC @ PCW	SFC @ PCW	08/26/2002 10:30	su			-6.69	-50.74					11.63	1.80
2060314	PCW below SFC	CC @ PCW	08/26/2002 11:00	su			-6.41	-49.65					25.86	15.21
2060315	PCW @ EMIC	PCW @ EMIC	08/26/2002 11:30	su			-6.53	-51.02					26.82	3.84
2060316	EMIC @ PCW	EMIC @ PCW	08/26/2002 12:00	su			-6.99	-56.59					2.52	3.11
2060317	SFC @ PCW	Auto	08/22/2002 15:45	ai										

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
2060318	SFC @ PCW	Auto	08/22/2002 18:45	ai										
2060319	SFC @ PCW	Auto	08/22/2002 21:45	ai										
2060320	SFC @ PCW	Auto	08/23/2002 0:45	ai										
2060321	SFC @ PCW	Auto	08/23/2002 3:45	ai										
2060322	SFC @ PCW	Auto	08/23/2002 6:45	ai										
2060323	SFC @ PCW	Auto	08/23/2002 9:45	ai										
2060324	SFC @ PCW	Auto	08/23/2002 12:45	ai										
2060325	SFC @ PCW	Auto	08/23/2002 15:45	ai										
2060326	SFC @ PCW	Auto	08/23/2002 18:45	ai										
2060327	SFC @ PCW	Auto	08/23/2002 21:45	ai										
2060328	SFC @ PCW	Auto	08/24/2002 0:45	ai										
2060329	SFC @ PCW	Auto	08/24/2002 3:45	ai										
2060330	SFC @ PCW	Auto	08/24/2002 6:45	ai										
2060331	SFC @ PCW	Auto	08/24/2002 9:45	ai										
2060332	SFC @ PCW	Auto	08/24/2002 12:45	ai										
2060333	SFC @ PCW	Auto	08/24/2002 15:45	ai										
2060334	SFC @ PCW	Auto	08/24/2002 18:45	ai										
2060335	SFC @ PCW	Auto	08/24/2002 21:45	ai										
2060336	SFC @ PCW	Auto	08/25/2002 0:45	ai										
2060337	SFC @ PCW	Auto	08/25/2002 3:45	ai										
2060338	SFC @ PCW	Auto	08/25/2002 6:45	ai										
2060339	SFC @ PCW	Auto	08/25/2002 9:45	ai										
2060340	SFC @ PCW	Auto	08/25/2002 12:45	ai										
2060341	CC @ PCW	Auto	08/22/2002 16:30	ai										
2060342	CC @ PCW	Auto	08/22/2002 19:30	ai										
2060343	CC @ PCW	Auto	08/22/2002 22:30	ai										
2060344	CC @ PCW	Auto	08/23/2002 1:30	ai										
2060345	CC @ PCW	Auto	08/23/2002 4:30	ai										
2060346	CC @ PCW	Auto	08/23/2002 7:30	ai										
2060347	CC @ PCW	Auto	08/23/2002 10:30	ai										
2060348	CC @ PCW	Auto	08/23/2002 13:30	ai										
2060349	CC @ PCW	Auto	08/23/2002 16:30	ai										
2060350	CC @ PCW	Auto	08/23/2002 19:30	ai										
2060351	CC @ PCW	Auto	08/23/2002 22:30	ai										
2060352	CC @ PCW	Auto	08/24/2002 1:30	ai										
2060353	CC @ PCW	Auto	08/24/2002 4:30	ai										
2060354	CC @ PCW	Auto	08/24/2002 7:30	ai										
2060355	CC @ PCW	Auto	08/24/2002 10:30	ai										
2060356	CC @ PCW	Auto	08/24/2002 13:30	ai										
2060357	CC @ PCW	Auto	08/24/2002 16:30	ai										
2060358	CC @ PCW	Auto	08/24/2002 19:30	ai										
2060359	CC @ PCW	Auto	08/24/2002 22:30	ai										
2060360	CC @ PCW	Auto	08/25/2002 1:30	ai										
2060361	CC @ PCW	Auto	08/25/2002 4:30	ai										
2060362	CC @ PCW	Auto	08/25/2002 7:30	ai										
2060363	CC @ PCW	Auto	08/25/2002 10:30	ai										
2060364	CC @ PCW	Auto	08/25/2002 13:30	ai										
2060365	PCW @ EMIC	Auto	08/22/2002 14:02	ai										
2060366	PCW @ EMIC	Auto	08/22/2002 17:02	ai										
2060367	PCW @ EMIC	Auto	08/22/2002 20:02	ai										
2060368	PCW @ EMIC	Auto	08/22/2002 23:02	ai										
2060369	PCW @ EMIC	Auto	08/23/2002 2:02	ai										

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
2060370	PCW @ EMIC	Auto	08/23/2002 5:02	ai										
2060371	PCW @ EMIC	Auto	08/23/2002 8:02	ai										
2060372	PCW @ EMIC	Auto	08/23/2002 11:02	ai										
2060373	PCW @ EMIC	Auto	08/23/2002 14:02	ai										
2060374	PCW @ EMIC	Auto	08/23/2002 17:02	ai										
2060375	PCW @ EMIC	Auto	08/23/2002 20:02	ai										
2060376	EMIC @ PCW	Auto	08/22/2002 14:00	ai										
2060377	EMIC @ PCW	Auto	08/22/2002 17:00	ai										
2060378	EMIC @ PCW	Auto	08/22/2002 20:00	ai										
2060379	EMIC @ PCW	Auto	08/22/2002 23:00	ai										
2060380	EMIC @ PCW	Auto	08/23/2002 2:00	ai										
2060381	EMIC @ PCW	Auto	08/23/2002 5:00	ai										
2060382	EMIC @ PCW	Auto	08/23/2002 8:00	ai										
2060383	EMIC @ PCW	Auto	08/23/2002 11:00	ai										
2060384	EMIC @ PCW	Auto	08/23/2002 14:00	ai										
2060385	EMIC @ PCW	Auto	08/23/2002 17:00	ai										
2060386	EMIC @ PCW	Auto	08/23/2002 20:00	ai										
2060387	EMIC @ PCW	Auto	08/23/2002 23:00	ai										
2060388	EMIC @ PCW	Auto	08/24/2002 2:00	ai										
2060389	EMIC @ PCW	Auto	08/24/2002 5:00	ai										
2060390	EMIC @ PCW	Auto	08/24/2002 8:00	ai										
2060391	EMIC @ PCW	Auto	08/24/2002 11:00	ai										
2060392	EMIC @ PCW	Auto	08/24/2002 14:00	ai										
2060393	EMIC @ PCW	Auto	08/24/2002 17:00	ai										
2060394	EMIC @ PCW	Auto	08/24/2002 20:00	ai										
2060395	EMIC @ PCW	Auto	08/24/2002 23:00	ai										
2060396	EMIC @ PCW	Auto	08/25/2002 2:00	ai										
2060397	EMIC @ PCW	Auto	08/25/2002 5:00	ai										
2060398	EMIC @ PCW	Auto	08/25/2002 8:00	ai										
2060399	EMIC @ PCW	Auto	08/25/2002 11:00	ai										
2060405	Sump - CC @ Culver	Sump - CC @ Culver	08/29/2002 12:00	gw						0.00	69.00	41.00	22.73	23.34
2060406	Dry Collector	Dry Collector	08/29/2002 15:00	cd									0.24	2.13
2090001	SDC @ Campus	SDC @ Campus	09/12/2002 10:40	su			-4.73	-42.19					13.68	7.07
2090002	SCW @ SDC	SCW @ SDC	09/12/2002 12:10	su			-6.27	-47.74					3.72	4.00
2090003	SJC @ Harvard	SJC @ Harvard	09/12/2002 12:50	su			-5.29	-42.90					2.57	4.38
2090004	LC @ McCabe/Jamboree	LC @ McCabe/Jamboree	09/12/2002 14:00	su			-6.60	-51.48					13.22	2.91
2090005	BaC @ Main	BaC @ Main	09/12/2002 14:40	su			-5.75	-48.78					2.00	4.76
2090006	Dry Collector	Dry Collector	09/12/2002 10:00	cd									0.42	1.92
2090007	SDC @ Michelson	SDC @ Michelson	09/19/2002 10:10	su			-6.35	-49.30						
2090008	SDC @ Coronado	SDC @ Coronado	09/19/2002 11:00	su			-6.29	-48.31						
2090009	SDC @ Alton	SDC @ Alton	09/19/2002 11:50	su			-6.23	-48.82						
2090010	SDC above PCW	SDC above PCW	09/19/2002 12:40	su			-6.26	-48.22						
2090011	PCW @ Barranca	PCW @ Barranca	09/19/2002 13:50	su			-6.34	-49.10						
2090012	Dry Collector	Dry Collector	09/19/2002 9:30	cd										
2100001	PCW @ Moffett	PCW @ Moffett	10/01/2002 10:30	su			-6.52	-51.13						
2100003	SFC @ PCW	SFC @ PCW	10/01/2002 11:30	su			-6.67	-50.19						
2100005	EMIC @ PCW	EMIC @ PCW	10/01/2002 12:10	su			-6.77	-54.33						
2100006	PCW @ EMIC	PCW @ EMIC	10/01/2002 12:30	su			-6.72	-51.22						
2100007	PCW below SFC	CC @ PCW	10/01/2002 13:10	su			-6.59	-51.39						
2100008	Dry Collector	Dry Collector	10/01/2002 9:30	cd										
2100009	PCW @ CC	Weephole 3S	10/08/2002 9:45	gw			-6.55	-47.33		19.97	611.00	11.20		
2100010	PCW @ CC	Weephole 1N	10/08/2002 10:00	gw			-6.51	-47.00		79.66	496.00	75.90		

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
2100011	PCW @ CC	Weephole 2N	10/08/2002 10:10	gw			-6.68	-47.00		56.58	471.00	30.00		
2100012	CIC @ Northwood Plaza on Trabuco	CIC @ Northwood Plaza on Trabuco	10/08/2002 11:00	su			-8.21	-70.00						
2100013	Drain - CIC @ Yale	Drain - CIC @ Yale	10/08/2002 11:45	su			-8.70	-78.00					0.09	
2100014	PCW @ Bryan	PCW @ Bryan	10/08/2002 12:40	su			-7.43	-65.00					0.05	
2100015	HCW @ PCW	HCW @ PCW	10/08/2002 13:15	su			-8.14	-67.00						
2100016	PCW @ RCW	PCW @ RCW	10/08/2002 14:00	su			-7.96	-66.00						
2100023	SDC @ Campus	SDC @ Campus	10/15/2002 10:15	su			-5.95	-49.00						
2100024	Spring - SDC @ Harvard	Spring - SDC @ Harvard	10/15/2002 11:30	gw			-6.50	-46.00		0.00	67.00	25.00		
2100025	SDC @ Harvard	SDC @ Harvard	10/15/2002 11:30	su			-6.40	-50.00						
2100026	Drain - SDC @ Harvard	Drain - SDC @ Harvard	10/15/2002 11:45	su			-6.58	-48.00						
2100027	Spring - Seams - SDC @ Harvard	Seam 7	10/15/2002 12:00	gw			-6.57	-47.00		0.00	43.00	21.70		
2100028	SDC @ Culver	Drain	10/15/2002 12:15	su			-9.94	-79.00						
2100029	CC @ Yale	CC @ Yale	10/15/2002 14:00	su			-6.32	-54.00						
2100030	CC @ Yale	Spring	10/15/2002 14:00	gw			-6.82	-51.00		0.00	18.00	30.00		
2100031	CC @ Yale	Drain	10/15/2002 14:00	su			-7.30	-56.00						
2100032	Dry Collector	Dry Collector	10/22/2002 9:30	cd										
2100033	SFC @ Red Hill	SFC @ Red Hill	10/22/2002 10:27	su			-8.37	-69.00						
2100033H	SFC @ Red Hill	Hyporheic	10/22/2002 0:00	hy										
2100034	SFC @ RR	Weephole 7S	10/22/2002 11:30	gw			-6.92	-50.00		0.00	0.00			
2100035	SFC @ RR	Spring 7-8S	10/22/2002 11:40	gw			-6.89	-50.00		0.00	0.00	5.30		
2100036	SFC @ RR	Weephole 19S	10/22/2002 12:00	gw			-6.64	-48.00		0.00	0.00	4.40		
2100037	SFC @ RR	Weephole 23S	10/22/2002 12:10	gw			-6.87	-49.00		0.00	3.00	3.10		
2100038	SFC @ RR	Weephole 4N	10/22/2002 12:30	gw			-6.94	-49.76		0.00	3.00	2.30		
2100039	SFC @ RR	Weephole 9N	10/22/2002 13:00	gw			-6.91	-49.77		0.00	2.00	1.80		
2100041	SFC @ RR	Weephole 23N	10/22/2002 13:25	gw			-6.72	-48.57		0.00	2.00	2.40		
2100042	SFC @ RR	Weephole 33N	10/22/2002 13:40	gw			-6.69	-48.56		0.00	2.00	2.20		
2100043	SFC @ RR	SFC @ RR	10/22/2002 12:50	su			-7.37	-59.54						
2100044	SFC @ PCW	SFC @ PCW	10/22/2002 14:41	su			-6.95	-51.50						
2100050	SDC @ Campus	SDC @ Campus	10/29/2002 10:30	su			-5.85	-48.81						
2100051	BaC @ Main	BaC @ Main	10/29/2002 11:15	su			-5.37	-44.17						
2100052	BaC @ Jamboree	BaC @ Jamboree	10/29/2002 11:45	su			-5.54	-45.34						
2100053	BaC @ Alton	BaC @ Alton	10/29/2002 13:00	su			-6.61	-52.30						
2100054	BaC @ Barranca	BaC @ Barranca	10/29/2002 14:30	su			-7.96	-68.25						
2100055	BaC @ Barranca	Drain	10/29/2002 14:30	su			-6.31	-44.30						
2100056	BaC @ Red Hill	BaC @ Red Hill	10/29/2002 15:00	su			-9.37	-78.17						
2100057	Wet Collector	Wet Collector	10/29/2002 9:30	cw										
2100058	Dry Collector	Dry Collector	10/29/2002 9:30	cd										
2110001	SFC @ PCW	SFC @ PCW	11/05/2002 10:55	su			-3.74	-44.74						
2110002	ECD @ PCW	ECD @ PCW	11/05/2002 11:10	gw			-7.01	-53.06		2.19	125.00	106.70		
2110003	SDC @ Campus	PCW below SFC	11/05/2002 11:30	su			-6.94	-54.74						
2110004	PCW below SFC	CC @ PCW	11/05/2002 12:00	su			-6.50	-50.23						
2110005	PCW @ Walnut	PCW @ Walnut	11/05/2002 12:25	su			-6.60	-56.19						
2110007	DP @ PCW	DP @ PCW	11/05/2002 13:00	gw			-6.53	-50.52		4.21	67.00	12.10		
2110008	EMIC @ PCW	EMIC @ PCW	11/05/2002 13:30	su			-7.50	-61.57						
2110009	SFC @ PCW	SFC @ PCW	11/05/2002 14:20	su			-6.84	-51.25						
2110010	SDC @ Campus	PCW below SFC	11/05/2002 14:30	su			-6.89	-53.36						
2110011	ECD @ PCW	ECD @ PCW	11/05/2002 14:45	gw			-7.19	-53.24		2.52	138.00			
2110012	PCW below SFC	CC @ PCW	11/05/2002 15:00	su			-6.36	-49.56						
2110013	EMIC @ PCW	EMIC @ PCW	11/05/2002 15:30	su			-7.06	-58.63						
2110014	PCW @ EMIC	PCW @ EMIC	11/05/2002 16:00	su			-6.85	-51.82						
2110015	DP @ PCW	DP @ PCW	11/05/2002 16:20	gw			-6.73	-48.93		5.96	63.00			
2110016	PCW @ Walnut	PCW @ Walnut	11/05/2002 16:40	su			-7.07	-57.70						

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
2110017	Drain - PCW @ Walnut	Drain - PCW @ Walnut	11/05/2002 16:50	su			-6.96	-50.91						
2110019	SDC @ Campus	SDC @ Campus	11/12/2002 10:30	su		5.00	-3.74	-29.15						
2110020	SDC @ Michelson	SDC @ Michelson	11/12/2002 11:30	su			-5.52	-42.27						
2110021	SDC @ Alton	SDC @ Alton	11/12/2002 12:30	su			-5.57	-42.36						
2110022	PCW @ Barranca	PCW @ Barranca	11/12/2002 13:30	su		2.70	-6.08	-46.09						
2110023	SDC @ Harvard	SDC @ Harvard	11/12/2002 14:15	su		3.30	-4.47	-36.83						
2110024	Spring - SDC @ Harvard	Spring - SDC @ Harvard	11/12/2002 15:00	gw			-6.32	-46.06		0.00	72.00			
2110025	Wet Collector	Wet Collector	11/12/2002 9:30	cw			-1.04	-5.01						
2110026	Dry Collector	Dry Collector	11/12/2002 9:30	cd										
2110039	SFC @ RR	Weephole 10N	11/19/2002 10:16	gw		1.80	-6.87	-48.83		0.00	1.00	1.60		
2110040	EMIC @ PCW	EMIC @ PCW	11/19/2002 10:55	su		2.90	-7.43	-60.22						
2110041	PCW @ EMIC	PCW @ EMIC	11/19/2002 11:32	su		6.80	-6.75	-52.16						
2110042	PCW below SFC	CC @ PCW	11/19/2002 12:20	su		5.10	-6.38	-49.74						
2110044	PCW @ Moffett	PCW @ Moffett	11/19/2002 14:32	su			-6.84	-52.55						
2110045	SDC @ Campus	SDC @ Campus	11/26/2002 10:30	su			-6.37	-52.67						
2110045B	SDC @ Campus	sediment	11/26/2002 10:30	se										
2110045H	SDC @ Campus	Hyporheic	11/26/2002 10:30	hy										
2110046	SDC @ Marsh Inlet	SDC @ Marsh Inlet	11/26/2002 13:00	su			-6.36	-52.24						
2110046B	SDC @ Marsh Inlet	sediment1	11/26/2002 13:00	se										
2110046H	SDC @ Marsh Inlet	Hyporheic	11/26/2002 13:00	hy										
2110047	PCW @ CC	PCW below CC	11/26/2002 15:20	su			-6.58	-53.86						
2110047B	PCW below CC	sediment	11/26/2002 15:20	se										
2110049	Dry Collector	Dry Collector	11/26/2002 9:30	cd										
2120001	PCW @ CC	PCW below CC	12/03/2002 13:00	su			-6.93	-56.62						
2120003	Dry Collector	Dry Collector	12/03/2002 10:00	cd										
2120004	Wet Collector	Wet Collector	12/03/2002 10:00	cw										
2120005	PCW below CC	Well 2(B)	12/03/2002 14:00	hy										
2120009	PCW below CC	1A1	12/17/2002 11:30	pe										
2120010	PCW below CC	1A2	12/17/2002 11:30	pe										
2120011	PCW below CC	1A3	12/17/2002 11:30	pe										
2120012	PCW below CC	1A4	12/17/2002 11:30	pe										
2120013	PCW below CC	1B1	12/17/2002 11:30	pe										
2120014	PCW below CC	1B2	12/17/2002 11:30	pe										
2120015	PCW below CC	1B3	12/17/2002 11:30	pe										
2120016	PCW below CC	1B4	12/17/2002 11:30	pe										
2120017	PCW below CC	1B5	12/17/2002 11:30	pe										
2120018	PCW below CC	2A1	12/17/2002 11:30	pe										
2120019	PCW below CC	2A2	12/17/2002 11:30	pe										
2120020	PCW below CC	2A3	12/17/2002 11:30	pe										
2120021	PCW below CC	2A4	12/17/2002 11:30	pe										
2120022	PCW below CC	2A5	12/17/2002 11:30	pe										
2120023	PCW below CC	2B1	12/17/2002 11:30	pe										
2120024	PCW below CC	2B2	12/17/2002 11:30	pe										
2120025	PCW below CC	2B3	12/17/2002 11:30	pe										
2120026	PCW below CC	2B4	12/17/2002 11:30	pe										
2120027	PCW below CC	2B5	12/17/2002 11:30	pe										
2120028	PCW below CC	2B6	12/17/2002 11:30	pe										
2120029	PCW below CC	2B7	12/17/2002 11:30	pe										
2120030	PCW below CC	3A1	12/17/2002 11:30	pe										
2120031	PCW below CC	3A2	12/17/2002 11:30	pe										
2120032	PCW below CC	3A3	12/17/2002 11:30	pe										
2120033	PCW below CC	3A4	12/17/2002 11:30	pe										

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
2120034	PCW below CC	3A5	12/17/2002 11:30	pe										
2120035	PCW below CC	3B1	12/17/2002 11:30	pe										
2120036	PCW below CC	3B2	12/17/2002 11:30	pe										
2120037	PCW below CC	3B3	12/17/2002 11:30	pe										
2120038	PCW below CC	4A1	12/17/2002 11:30	pe										
2120039	PCW below CC	4A2	12/17/2002 11:30	pe										
2120040	PCW below CC	4A3	12/17/2002 11:30	pe										
2120041	PCW below CC	4A4	12/17/2002 11:30	pe										
2120042	PCW below CC	4A5	12/17/2002 11:30	pe										
2120043	PCW below CC	4B1	12/17/2002 11:30	pe										
2120044	PCW below CC	4B2	12/17/2002 11:30	pe										
2120045	PCW below CC	4B3	12/17/2002 11:30	pe										
2120046	PCW below CC	4B4	12/17/2002 11:30	pe										
2120047	PCW below CC	4B5	12/17/2002 11:30	pe										
2120049	SDC @ Campus	SDC @ Campus	12/17/2002 10:30	sm										
2120050	EMIC @ El Camino Real	EMIC @ El Camino Real	12/17/2002 13:35	sm										
2120051	PCW @ El Camino Real	PCW @ El Camino Real	12/17/2002 14:00	sm										
2120052	Dry Collector	Dry Collector	12/17/2002 9:45	cd										
2120053	Wet Collector	Wet Collector	12/17/2002 9:45	cw										
3010001	SDC @ Campus	SDC @ Campus	01/02/2003 10:00	su										
3010002	CIC @ Northwood Plaza on Trabuco	CIC @ Northwood Plaza on Trabuco	01/02/2003 11:10	su		3.10								
3010003	BaC @ Alton	BaC @ Alton	01/02/2003 12:00	su		4.40								
3010004	EMIC @ 17th	EMIC @ 17th	01/02/2003 13:00	su		1.60								
3010005	Dry Collector	Dry Collector	01/02/2003 9:45	cd										
3010006	Wet Collector	Wet Collector	01/02/2003 9:45	cw										
3010007	SFC @ Red Hill	SFC @ Red Hill	01/07/2003 9:40	su										
3010008	SFC @ RR	SFC @ RR	01/07/2003 10:15	su										
3010010	SFC @ RR	Weephole 10N	01/07/2003 10:52	gw						0.00		1.70		
3010011	SFC @ RR	Weephole 33N	01/07/2003 11:12	gw						0.00	1.00	4.10		
3010012	SFC @ RR	Weephole 7S	01/07/2003 11:45	gw						0.00	3.00	2.80		
3010013	SFC @ RR	Spring 7-8S	01/07/2003 11:50	gw						0.00	2.00	2.10		
3010014	SFC @ RR	Weephole 21S	01/07/2003 12:15	gw						0.00	3.00	2.30		
3010015	SFC @ RR	Drain	01/07/2003 12:20	su										
3010016	SFC @ PCW	SFC @ PCW	01/07/2003 14:00	su										
3010018	SDC @ Campus	SDC @ Campus	01/08/2003 10:00	su										
3010019	SDC @ Coronado	SDC @ Coronado	01/08/2003 11:15	su										
3010020	SDC @ Michelson	SDC @ Michelson	01/08/2003 10:45	su										
3010021	SDC @ Alton	SDC @ Alton	01/08/2003 12:00	su										
3010022	SFC @ PCW	SFC @ PCW	01/08/2003 14:00	sm										
3010023	PCW @ Moffett	PCW @ Moffett	01/08/2003 14:30	sm										
3010024	PCW below SFC	CC @ PCW	01/08/2003 14:45	sm										
3010025	PCW @ EMIC	PCW @ EMIC	01/08/2003 15:00	sm										
3010026	DP @ PCW	DP @ PCW	01/08/2003 15:15	gw						4.26	58.00	10.70		
3010027	EMIC @ PCW	EMIC @ PCW	01/08/2003 15:40	sm										
3010028	PCW @ Barranca	PCW @ Barranca	01/14/2003 10:20	su										
3010030	Drain - PCW W side S of Warner	Drain - PCW W side S of Warner	01/14/2003 11:15	su										
3010031	WD @ PCW	WD @ PCW	01/14/2003 11:30	su										
3010032	PCW @ Moffett	PCW @ Moffett	01/14/2003 12:05	su										
3010034	VD @ PCW	VD @ PCW	01/14/2003 12:40	su										
3010035	VD @ PCW	Spring	01/14/2003 12:55	gw						0.00	146.00	175.10		
3010036	Spring - PCW across from VD	Spring - PCW across from VD	01/14/2003 13:10	gw						70.38	79.00	6.40		
3010037	Dry Collector	Dry Collector	01/14/2003 9:30	cd										

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
3010038	Wet Collector	Wet Collector	01/14/2003 9:30	cw										
3010039	PCW below CC	Well A	01/15/2003 10:20	hy										
3010040	PCW below CC	Well B	01/15/2003 10:30	hy										
3010041	PCW below CC	Well C	01/15/2003 10:45	hy										
3010042	PCW below CC	Well D	01/15/2003 11:15	hy										
3010043	PCW @ CC	Weephole 1N	01/15/2003 12:05	gw						61.15	482.00	82.60		
3010044	Drain - PCW @ CC	Drain - PCW @ CC	01/15/2003 12:20	su										
3010045	PCW below SFC	CC @ PCW	01/15/2003 13:10	su										
3010046	SDC @ Harvard	SDC @ Harvard	01/15/2003 14:15	su										
3010047	Spring - Seams - SDC @ Harvard	Seam 8N	01/15/2003 14:40	gw						0.00	42.00	24.80		
3010048	Drain - SDC @ Harvard	Drain - SDC @ Harvard	01/15/2003 15:00	su										
3010050	Spring - SDC @ Culver	Spring - SDC @ Culver	01/15/2003 15:45	gw						0.00	19.00	23.70		
3010051	SDC @ Culver	SDC @ Culver	01/15/2003 15:40	su										
3010062	SDC @ Campus	SDC @ Campus	01/21/2003 9:45	su										
3010064	LC @ Main	LC @ Main	01/21/2003 11:50	su										
3010066	BaC @ Main	BaC @ Main	01/21/2003 12:35	su										
3010067	BaC @ Alton	BaC @ Alton	01/21/2003 13:45	su										
3010068	BaC @ Jamboree	BaC @ Jamboree	01/21/2003 14:20	su										
3010069	BaC @ Barranca	BaC @ Barranca	01/21/2003 15:00	su										
3010070	Dry Collector	Dry Collector	01/28/2003 9:40	cd										
3010071	ECD @ PCW	ECD @ PCW	01/28/2003 10:10	gw							140.74	162.50		
3010071D	ECD @ PCW	ECD @ PCW	01/28/2003 10:10	D										
3010072	EMIC @ PCW	EMIC @ PCW	01/28/2003 11:45	su										
3010073	PCW @ EMIC	PCW @ EMIC	01/28/2003 12:30	su										
3010074	Drain - PCW @ Walnut	Drain - PCW @ Walnut	01/28/2003 13:50	su										
3010075	CIC @ PCW	CIC @ PCW	01/28/2003 14:20	su										
3010077	PCW @ Bryan	PCW @ Bryan	01/28/2003 15:15	su										
3010078	Tomato Springs	Tomato Springs	02/04/2003 9:35	gw							459.41	15.10		
3010079	SADC @ Irvine	SADC @ Irvine	02/04/2003 11:10	su										
3010079D	SADC @ Irvine	SADC @ Irvine	02/04/2003 11:10	D										
3010080	SADC @ Irvine	Spring	02/04/2003 11:30	gw							45.76	9.50		
3010082	SCW @ SDC	SCW @ SDC	02/04/2003 13:05	su										
3010083	SJC @ Harvard	SJC @ Harvard	02/04/2003 13:30	su										
3010084	Drain - GWD @ SDC	Drain - GWD @ SDC	02/04/2003 14:05	gw							41.72	4.80		
3010085	BoC @ MacArthur	BoC @ MacArthur	02/04/2003 14:30	su										
3010086	Spring - PCW across from VD	Spring - PCW across from VD	02/05/2003 9:45	gw							65.65	3.10		
3010087	VD @ PCW	Spring	02/05/2003 11:00	gw								194.00		
3010088	VD @ PCW	VD @ PCW	02/05/2003 11:10	su										
3010089	PCW @ Moffett	PCW @ Moffett	02/05/2003 10:05	su										
3010090	WD @ PCW	WD @ PCW	02/05/2003 12:20	su										
3010093	PCW @ Barranca	PCW @ Barranca	02/05/2003 13:55	su										
3010094	SDC @ Campus	SDC @ Campus	02/05/2003 16:00	su										
3010095	DP @ PCW	DP @ PCW	02/05/2003 14:55	gw							56.89	8.00		
3010096	Drain - PCW @ Barranca	Drain - PCW @ Barranca	02/05/2003 13:30	gw							12.24	4.50		
3010097	PCW @ I5	Well #1	02/05/2003 12:48	hy										
3010098	PCW @ I5	Well #2	02/05/2003 13:18	hy										
3010099	PCW @ I5	PCW @ I5	02/05/2003 13:30	su										
3010100	PCW @ I5	Well #3	02/05/2003 14:17	hy										
3010101	Spring - PCW across from VD	Well	02/05/2003 15:00	hy										
3010102	PCW @ I5	1#36	02/07/2003 14:00	pe										
3010103	PCW @ I5	1#32	02/07/2003 14:00	pe										
3010104	PCW @ I5	1#26_5	02/07/2003 14:00	pe										

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
3010105	PCW @ I5	1#22_3	02/07/2003 14:00	pe										
3010106	PCW @ I5	1#16_7	02/07/2003 14:00	pe										
3010107	PCW @ I5	2#56_2	02/07/2003 14:00	pe										
3010108	PCW @ I5	2#46_7	02/07/2003 14:00	pe										
3010109	PCW @ I5	2#30_9	02/07/2003 14:00	pe										
3010110	PCW @ I5	2#21_8	02/07/2003 14:00	pe										
3010111	PCW @ I5	2#14	02/07/2003 14:00	pe										
3010112	PCW @ I5	2#9_3	02/07/2003 14:00	pe										
3010113	PCW @ I5	2#4_5	02/07/2003 14:00	pe										
3010114	PCW @ I5	3#33_5	02/07/2003 14:00	pe										
3010115	PCW @ I5	3#29_2	02/07/2003 14:00	pe										
3010116	PCW @ I5	3#27_6	02/07/2003 14:00	pe										
3010117	PCW @ I5	3#21_3	02/07/2003 14:00	pe										
3010118	PCW @ I5	3#19_5	02/07/2003 14:00	pe										
3010119	PCW @ I5	3#14_3	02/07/2003 14:00	pe										
3010120	PCW @ I5	3#10_3	02/07/2003 14:00	pe										
3010121	PCW @ I5	3#8_4	02/07/2003 14:00	pe										
3010122	PCW @ I5	3#2_5	02/07/2003 14:00	pe										
3010124	PCW @ I5	Air Test	02/07/2003 14:00	pe										
3010131	Wet Collector	Wet Collector	02/18/2003 10:00	cw										
3010132	Dry Collector	Dry Collector	02/18/2003 10:00	cd										
3010133	SDC @ Campus	SDC @ Campus	02/18/2003 11:10	su										
3010134	EMIC @ PCW	EMIC @ PCW	02/18/2003 12:10	su										
3010135	DP @ PCW	DP @ PCW	02/18/2003 12:55	gw							62.70	5.50		
3010137	EMIC @ El Camino Real	EMIC @ El Camino Real	02/18/2003 13:50	su										
3010138	EMIC @ 17th	EMIC @ 17th	02/18/2003 14:35	su										
3010140	SFC @ RR	Weephole 10N	02/19/2003 10:15	gw							1.34	1.30		
3010141	SFC @ PCW	SFC @ PCW	02/19/2003 11:00	su										
3010143	Weephole - CIC @ I5	Weephole 1	02/19/2003 12:00	gw							39.18	17.20		
3010144	Weephole - CIC @ I5	Weephole 2	02/19/2003 12:00	gw							39.66	16.90		
3010145	CIC @ Northwood Plaza on Trabuco	CIC @ Northwood Plaza on Trabuco	02/19/2003 12:30	su										
3010146	Drain - CIC @ Yale	Drain - CIC @ Yale	02/19/2003 13:00	su										
3010147	CC @ Yale	Drain	02/19/2003 13:30	su										
3010148	CC @ Yale	Spring	02/19/2003 13:30	gw							21.05	31.10		
3010150	Dry Collector	Dry Collector	02/25/2003 12:10	cd										
3010151	Wet Collector	Wet Collector	02/25/2003 12:10	cw										
3010154	SDC @ Campus	SDC @ Campus	02/26/2003 10:30	sm										
3010155	PCW below SFC	CC @ PCW	02/26/2003 12:18	sm										
3010156	SFC @ PCW	SFC @ PCW	02/26/2003 13:20	sm										
3010157	PCW @ EMIC	PCW @ EMIC	02/26/2003 13:40	sm										
3010158	PCW @ EMIC	PCW @ EMIC	02/26/2003 14:05	sm										
3010159	EMIC @ PCW	EMIC @ PCW	02/26/2003 15:00	sm										
3030001	Spring - PCW across from VD	Clay 8	02/05/2003 11:00	se										
3030002	Spring - PCW across from VD	Clay 0	02/05/2003 10:30	se										
3030010	BoC @ MacArthur	BoC @ MacArthur	03/04/2003 10:50	su										
3030011	LC @ McCabe/Jamboree	LC @ McCabe/Jamboree	03/04/2003 11:25	su										
3030012	BaC @ Main	BaC @ Main	03/04/2003 12:05	su										
3030013	SDC @ Harvard	SDC @ Harvard	03/04/2003 12:55	su										
3030014	Spring - SDC @ Harvard	Spring - SDC @ Harvard	03/04/2003 13:10	gw							58.24	27.10		
3030015	Drain - SDC @ Harvard	Drain - SDC @ Harvard	03/04/2003 13:20	su										
3030016	Spring - SDC @ Culver	Spring - SDC @ Culver	03/04/2003 13:45	gw							16.04	19.80		
3030017	BaC @ Barranca	Drain	03/04/2003 14:10	su										

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
3030018	Dry Collector	Dry Collector	03/04/2003 10:00	cd										
3030019	Wet Collector	Wet Collector	03/04/2003 10:00	cw										
3030020	SFC @ RR	Weephole 10N	03/05/2003 9:40	gw							1.77	2.10		
3030021	PCW @ CC	Weephole 1N	03/05/2003 10:15	gw							515.44	82.90		
3030022	PCW @ CC	Weephole 2N	03/05/2003 10:25	gw							529.84	52.80		
3030023	PCW @ CC	Weephole 3N	03/05/2003 10:45	gw							595.48	34.70		
3030024	PCW @ CC	Weephole 3S	03/05/2003 11:05	gw							619.45	12.60		
3030025	VD @ PCW	VD @ PCW	03/05/2003 11:30	su										
3030026	VD @ PCW	Spring	03/05/2003 11:40	gw							188.26	166.50		
3030027	Spring - PCW across from VD	Spring - PCW across from VD	03/05/2003 12:00	gw							72.23	2.10		
3030029	WD @ PCW	WD @ PCW	03/05/2003 12:40	su										
3030030	Drain - PCW W side S of Warner	Drain - PCW W side S of Warner	03/05/2003 12:50	su										
3030045	DP @ PCW	DP @ PCW	03/11/2003 11:30	gw							68.68	3.00		
3030046	Weephole - CIC @ I5	Weephole 2	03/11/2003 11:55	gw							41.15	15.10		
3030047	CIC @ PCW	CIC @ PCW	03/11/2003 12:05	su										
3030048	Drain - PCW @ Walnut	Drain - PCW @ Walnut	03/11/2003 12:25	su										
3030049	CC @ Yale	Spring	03/11/2003 13:47	gw							21.94	24.50		
3030050	Drain - CIC @ Yale	Drain - CIC @ Yale	03/11/2003 14:00	su										
3030053	PCW below SFC	Duckweed	11/05/2002 0:00	se										
3030054	SFC @ PCW	algae	11/05/2002 0:00	se										
3030055	EMIC @ PCW	muck	11/05/2002 0:00	se										
3030056	CC @ PCW	below station	11/05/2002 0:00	se										
3030057	CC @ PCW	algae above station	11/05/2002 0:00	se										
3030058	PCW @ CC	sediment	11/05/2002 0:00	se										
3030059	PCW @ CC	Weephole 1 algae	11/05/2002 0:00	se										
3030060	PCW @ EMIC	algae	11/05/2002 0:00	se										
3030061	PCW below SFC	sediment	11/05/2002 0:00	se										
3030062	SFC @ PCW	white duckweed	11/05/2002 0:00	se										
3030130	Well 63S	Well 63S	03/19/2003 9:40	gw							74.60	42.30		
3030131	Well 85W	Well 85W	03/19/2003 10:17	gw							36.88	49.50		
3030132	Well 86N	Well 86N	03/19/2003 11:02	gw							80.65	54.10		
3030133	Well 103N	Well 103N	03/19/2003 11:27	gw							22.59	64.40		
3030134	Well 87N	Well 87N	03/19/2003 12:43	gw							18.68	24.00		
3030135	Well 102N	Well 102N	03/19/2003 13:13	gw							15.40	14.50		
3030136	Dry Collector	Dry Collector	03/19/2003 15:00	cd										
3030137	SDC @ Campus	SDC @ Campus	03/20/2003 9:15	su										
3030138	PCW @ Barranca	PCW @ Barranca	03/20/2003 9:55	su										
3030139	PCW @ Moffett	PCW @ Moffett	03/20/2003 10:30	su										
3030140	SFC @ PCW	SFC @ PCW	03/20/2003 11:20	su										
3030141	ECD @ PCW	ECD @ PCW	03/20/2003 11:30	gw							132.02	147.10		
3030142	PCW below SFC	CC @ PCW	03/20/2003 12:00	su										
3030143	EMIC @ PCW	EMIC @ PCW	03/20/2003 12:30	su										
3030144	PCW @ EMIC	PCW @ EMIC	03/20/2003 12:40	su										
3040001	Spring - SDC @ Harvard	Spring - SDC @ Harvard	04/01/2003 11:30	gw							64.69	33.10		
3040002	SDC @ Harvard	SDC @ Harvard	04/01/2003 11:40	su										
3040003	Drain - SDC @ Harvard	Drain - SDC @ Harvard	04/01/2003 12:00	su										
3040005	Spring - SDC @ Culver	Spring - SDC @ Culver	04/01/2003 13:00	gw							19.85	22.90		
3040006	BaC @ Main	BaC @ Main	04/01/2003 13:55	su										
3040007	BaC @ Barranca	Drain	04/01/2003 14:45	su										
3040008	Dry Collector	Dry Collector	04/01/2003 11:00	cd										
3040036	SDC @ Campus	SDC @ Campus	04/07/2003 9:40	mu		3.40								
3040037	BaC @ Alton	BaC @ Alton	04/07/2003 10:05	mu		2.80								

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
3040038	PCW @ Barranca	PCW @ Barranca	04/07/2003 10:20	mu		3.40								
3040039	SDC @ Harvard	SDC @ Harvard	04/07/2003 10:30	mu		2.20								
3040042	EMIC @ 17th	EMIC @ 17th	04/07/2003 11:20	mu		1.70								
3040043	PCW below SFC	CC @ PCW	04/07/2003 11:50	mu		1.50								
3040044	PCW @ CIC	PCW @ CIC	04/07/2003 12:05	mu		3.20								
3040045	CIC @ PCW	CIC @ PCW	04/07/2003 12:10	mu		4.50								
3040046	Dry Collector	Dry Collector	04/08/2003 10:15	cd										
3040047	Wet Collector	Wet Collector	04/08/2003 10:15	cw										
3040048	SDC @ Campus	SDC @ Campus	04/08/2003 10:30	su										
3040049	DP @ PCW	DP @ PCW	04/09/2003 11:30	gw							62.55	11.60		
3040050	Drain - PCW @ Walnut	Drain - PCW @ Walnut	04/08/2003 12:10	su										
3040051	CIC @ PCW	CIC @ PCW	04/08/2003 12:55	su										
3040053	Weephole - CIC @ I5	Weephole 2	04/08/2003 13:25	gw							44.32	21.80		
3040054	Drain - CIC @ Yale	Drain - CIC @ Yale	04/08/2003 12:15	su										
3040056	BoC @ MacArthur	BoC @ MacArthur	04/08/2003 16:15	su										
3040057	Wet Collector	Wet Collector	04/14/2003 9:30	cw										
3040058	Dry Collector	Dry Collector	04/14/2003 9:30	cd										
3040061	PCW @ CIC	PCW @ CIC	04/14/2003 11:15	sm										
3040062	CIC @ PCW	CIC @ PCW	04/14/2003 11:15	sm										
3040063	SDC above PCW	SDC above PCW	04/14/2003 11:40	sm										
3040064	PCW above SDC	PCW above SDC	04/14/2003 11:50	sm										
3040067	SDC @ Campus	SDC @ Campus	04/14/2003 13:40	sm										
3040118	Circular Drain - LC Before bridge	Circular Drain - LC Before bridge	04/21/2003 11:40	su										
3040119	LC @ SCM	Saline Drain	04/21/2003 12:30	gw							171.59	3.00		
3040120	LC @ SCM	LC @ SCM	04/21/2003 12:40	su										
3040121	LC below 55	Drain - LC below I5	04/21/2003 13:20	gw							7.86	3.90		
3040122	LC below 55	LC below I5	04/21/2003 13:30	su										
3040123	LC below 55	Crack - LC below I5	04/21/2003 13:50	gw							4.36	3.40		
3040124	AC @ LC	AC @ LC	04/21/2003 14:45	su										
3040125	LC above AC	LC above AC	04/21/2003 14:50	su										
3040126	Dry Collector	Dry Collector	04/22/2003 10:45	cd										
3040127	Wet Collector	Wet Collector	04/22/2003 10:45	cw										
3040128	SDC @ Campus	SDC @ Campus	04/22/2003 11:00	su										
3040129	SFC @ RR	Weephole 10N	04/22/2003 12:15	gw								0.60		
3040130	PCW @ CC	Weephole 3S	04/22/2003 12:30	gw							730.18	18.10		
3040131	PCW @ CC	Weephole 1N	04/22/2003 13:00	gw							609.85	82.90		
3040132	PCW @ CC	Weephole 2N	04/22/2003 13:10	gw							611.99	27.80		
3040133	PCW @ CC	Weephole 3N	04/22/2003 13:20	gw							764.01	26.10		
3040134	VD @ PCW	VD @ PCW	04/22/2003 13:45	su										
3040135	VD @ PCW	Spring	04/22/2003 13:55	gw							164.99	189.60		
3040136	Spring - PCW across from VD	Spring - PCW across from VD	04/22/2003 14:25	gw							64.60	9.00		
3040138	WD @ PCW	WD @ PCW	04/22/2003 15:20	su										
3040140	Well 2 - LC @ Red Hill	Well - LC/RH 2	04/28/2003 10:50	gw							3.09	8.50		
3040141	Well 5/6 - LC @ Red Hill	Well - LC/RH 5	04/28/2003 12:15	gw							4.11	10.10		
3040142	Well 5/6 - LC @ Red Hill	Well - LC/RH 6	04/28/2003 13:00	gw								11.00		
3040143	LC below 55	Weephole - LC @ 55 ramp	04/28/2003 14:15	gw							8.76	1.70		
3040144	LC below 55	Spring - LC @ 55	04/28/2003 14:40	gw								6.40		
3040145	PCW @ Barranca	PCW @ Barranca	04/29/2003 10:00	su										
3040146	PCW @ Moffett	PCW @ Moffett	04/29/2003 11:00	su										
3040147	SFC @ PCW	SFC @ PCW	04/29/2003 12:00	su										
3040148	ECD @ PCW	ECD @ PCW	04/29/2003 12:40	gw							108.10	162.20		
3040149	PCW below SFC	CC @ PCW	04/29/2003 13:20	su										

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
3040151	EMIC @ PCW	EMIC @ PCW	04/29/2003 14:00	su										
3040152	PCW @ EMIC	PCW @ EMIC	04/29/2003 14:20	su										
3050001	Well 4_5 A/B - LC @ Red Hill	Well 4_5A - LC @ RH	05/05/2003 12:00	gw							7.88	8.60		
3050002	Well 4_5 A/B - LC @ Red Hill	Well 4_5B - LC @ RH	05/05/2003 12:30	gw							4.99	6.20		
3050003	Well 3 - LC @ Red Hill	Well 3 - LC @ RH	05/05/2003 13:00	gw							4.32	3.10		
3050004	Weephole - LC @ Red Hill	Weephole - LC @ Red Hill	05/05/2003 13:30	gw							4.55	5.80		
3050005	Dry Collector	Dry Collector	05/06/2003 11:05	cd										
3050006	Wet Collector	Wet Collector	05/06/2003 11:05	cw										
3050007	SDC @ Campus	SDC @ Campus	05/06/2003 11:50	su										
3050008	BoC @ MacArthur	BoC @ MacArthur	05/06/2003 12:45	su										
3050009	LC @ McCabe/Jamboree	LC @ McCabe/Jamboree	05/06/2003 13:35	su										
3050010	BaC @ Main	BaC @ Main	05/06/2003 14:20	su										
3050011	BaC @ Barranca	Drain	05/06/2003 14:55	su										
3050092	SDC @ Sand Canyon	SDC @ Sand Canyon	05/19/2003 10:20	su										
3050093	SDC @ Valley Oak	Weephole 27 N	05/19/2003 10:50	gw							58.87	29.90		
3050094	SDC @ Valley Oak	Weephole 40 N	05/19/2003 11:15	gw							47.76	28.60		
3050095	SDC @ Valley Oak	Weephole 47 N	05/19/2003 11:30	gw							45.72	32.60		
3050096	Spring - Upper SDC 1&2	Upper SDC - 1USDC1	05/19/2003 12:30	gw							48.19	33.50		
3050097	Spring - Upper SDC 1&2	Upper SDC - 2USDC2	05/19/2003 12:40	gw							60.82	31.60		
3050098	Spring - Upper SDC 3	Upper SDC - 3USDC3	05/19/2003 13:30	gw							27.28	23.60		
3050099	Spring - SDC @ Culver	Spring - SDC @ Culver	05/19/2003 14:20	gw							17.18	26.00		
3050101	SDC above PCW	SDC above PCW	05/19/2003 15:15	su										
3050102	Dry Collector	Dry Collector	05/20/2003 10:15	cd										
3050103	Wet Collector	Wet Collector	05/20/2003 10:15	cw										
3050104	SDC @ Campus	SDC @ Campus	05/20/2003 10:25	su										
3050105	Drain - PCW @ Walnut	Drain - PCW @ Walnut	05/20/2003 11:35	su										
3050106	CIC @ PCW	CIC @ PCW	05/20/2003 12:00	su										
3050107	Weephole - CIC @ I5	Weephole 2	05/20/2003 12:15	gw							37.82	21.60		
3050108	Drain - CIC @ Yale	Drain - CIC @ Yale	05/20/2003 13:10	su										
3050109	CC @ Yale	Spring	05/20/2003 13:38	gw							19.13	26.90		
3050110	Sump - CC @ Culver	Sump - CC @ Culver	05/20/2003 14:00	gw							48.67	45.50		
3050112	SDC @ Campus	SDC @ Campus	05/27/2003 11:00	su										
3050113	SFC @ RR	Weephole 10N	05/27/2003 12:05	gw							2.13	2.10		
3050115	WD @ PCW	WD @ PCW	05/27/2003 12:55	su										
3050117	VD @ PCW	VD @ PCW	05/27/2003 14:05	su										
3050118	VD @ PCW	Spring	05/27/2003 14:20	gw							161.56	185.20		
3050119	Spring - PCW across from VD	Spring - PCW across from VD	05/27/2003 14:45	gw							60.57	2.60		
3050121	PCW @ CC	Weephole 1N	05/27/2003 15:15	gw							612.56	80.40		
3050122	PCW @ CC	Weephole 2N	05/27/2003 15:20	gw							764.82	20.70		
3050123	PCW @ CC	Weephole 3N	05/27/2003 15:30	gw							851.26	19.20		
3050124	PCW @ CC	Weephole 3S	05/27/2003 15:40	gw							718.52	12.70		
3060001	SDC above Jeffrey	SDC above Jeffrey	06/02/2003 10:05	su										
3060002	SDC above Jeffrey	1B-A1	06/02/2003 0:00	pe										
3060003	SDC above Jeffrey	1B-A2	06/02/2003 0:00	pe										
3060004	SDC above Jeffrey	1A-A1	06/02/2003 0:00	pe										
3060005	SDC above Jeffrey	1A-A2	06/02/2003 0:00	pe										
3060006	SDC above Jeffrey	1A-A3	06/02/2003 0:00	pe										
3060007	SDC above Jeffrey	1A-A4	06/02/2003 0:00	pe										
3060008	SDC above Jeffrey	1A-A5	06/02/2003 0:00	pe										
3060009	SDC above Jeffrey	1A-B1	06/02/2003 0:00	pe										
3060010	SDC above Jeffrey	1A-B2	06/02/2003 0:00	pe										
3060011	SDC above Jeffrey	1A-B3	06/02/2003 0:00	pe										

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
3060012	SDC above Jeffrey	1A-B4	06/02/2003 0:00	pe										
3060013	SDC above Jeffrey	1A-B5	06/02/2003 0:00	pe										
3060014	SDC above Jeffrey	2B-A1	06/02/2003 0:00	pe										
3060015	SDC above Jeffrey	2B-A2	06/02/2003 0:00	pe										
3060016	SDC above Jeffrey	2B-A3	06/02/2003 0:00	pe										
3060017	SDC above Jeffrey	2B-A4	06/02/2003 0:00	pe										
3060018	SDC above Jeffrey	2B-B1	06/02/2003 0:00	pe										
3060019	SDC above Jeffrey	2B-B2	06/02/2003 0:00	pe										
3060020	SDC above Jeffrey	2B-B3	06/02/2003 0:00	pe										
3060021	SDC above Jeffrey	2B-B4	06/02/2003 0:00	pe										
3060022	SDC above Jeffrey	UCR5-A1	06/02/2003 0:00	pe										
3060023	SDC above Jeffrey	UCR5-A2	06/02/2003 0:00	pe										
3060024	SDC above Jeffrey	UCR5-B1	06/02/2003 0:00	pe										
3060025	SDC above Jeffrey	UCR5-B2	06/02/2003 0:00	pe										
3060026	SDC above Jeffrey	UCR5-B3	06/02/2003 0:00	pe										
3060027	SDC above Jeffrey	UCR5-B4	06/02/2003 0:00	pe										
3060028	SDC above Jeffrey	2A-A1	06/02/2003 0:00	pe										
3060029	SDC above Jeffrey	2A-A2	06/02/2003 0:00	pe										
3060030	SDC above Jeffrey	2A-A3	06/02/2003 0:00	pe										
3060031	SDC above Jeffrey	2A-B1	06/02/2003 0:00	pe										
3060032	SDC above Jeffrey	2A-B2	06/02/2003 0:00	pe										
3060033	Dry Collector	Dry Collector	06/02/2003 11:00	cd										
3060039	SDC @ Campus	Basin2-Upstream-B	06/13/2003 0:00	se										
3060040	SDC @ Campus	Basin2-Upstream-T	06/13/2003 0:00	se										
3060041	SDC @ Campus	Basin2-Middle-B	06/13/2003 0:00	se										
3060042	SDC @ Campus	Basin2-Middle-T	06/13/2003 0:00	se										
3060043	SDC @ Campus	Basin2-Downstream-T	06/13/2003 0:00	se										
3060044	SDC @ Campus	Basin2-Downstream-B	06/13/2003 0:00	se										
3060045	PCW @ Walnut	PCW @ Walnut	06/18/2003 8:50	su										
3060046	PCW @ CIC	PCW @ CIC	06/18/2003 9:06	su										
3060047	CIC @ PCW	CIC @ PCW	06/18/2003 9:19	su										
3060048	PCW @ Bryan	PCW @ Bryan	06/18/2003 10:00	su										
3060049	PCW @ Irvine	PCW @ Irvine	06/18/2003 10:24	su										
3060050	HCW @ PCW	HCW @ PCW	06/18/2003 10:44	su										
3060052	VD @ PCW	VD @ PCW	06/18/2003 13:50	su										
3060053	WD @ PCW	WD @ PCW	06/18/2003 14:15	su										
3060055	WD @ PCW	PCW @ Warner	06/18/2003 14:33	su										
3060056	PCW @ Barranca	PCW @ Barranca	06/18/2003 15:03	su								25.00		
3060058	SDC above PCW	SDC @ PCW	06/18/2003 15:17	su										
3060060	SDC @ Campus	SDC @ Campus	06/18/2003 11:00	su										
3060061	SJC @ Harvard	SJC @ Michelson	06/18/2003 11:30	su										
3060062	SCW @ SDC	SCW @ SDC	06/18/2003 14:11	su										
3060063	BaC @ Jamboree	BaC @ SDC	06/18/2003 14:30	su										
3060064	LC @ McCabe/Jamboree	LC @ McCabe/Jamboree	06/18/2003 14:50	su										
3060065	SDC @ Alton	SDC @ Alton	06/18/2003 15:15	su										
3060066	SFC @ PCW	SFC @ PCW	06/18/2003 9:50	su										
3060067	SDC @ Campus	PCW below SFC	06/18/2003 10:10	su										
3060068	ECD @ PCW	ECD @ PCW	06/18/2003 10:50	gw							135.86			
3060069	SFC @ PCW	SFC @ PCW	06/18/2003 11:05	su										
3060070	SDC @ Campus	PCW below SFC	06/18/2003 11:35	su										
3060071	ECD @ PCW	ECD @ PCW	06/18/2003 12:06	gw							139.52	149.80		
3060073	SFC @ PCW	SFC @ PCW	06/18/2003 13:00	su										

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
3060074	SDC @ Campus	PCW below SFC	06/18/2003 13:20	su										
3060075	ECD @ PCW	ECD @ PCW	06/18/2003 14:40	gw							140.65			
3060076	SFC @ PCW	SFC @ PCW	06/18/2003 15:00	su										
3060077	SDC @ Campus	PCW below SFC	06/18/2003 15:20	su										
3060078	EMIC @ PCW	EMIC @ PCW	06/18/2003 10:10	su										
3060080	PCW @ EMIC	PCW @ EMIC	06/18/2003 10:40	su										
3060081	PCW below SFC	CC @ PCW	06/18/2003 11:05	su										
3060082	EMIC @ PCW	EMIC @ PCW	06/18/2003 11:30	su										
3060083	PCW @ EMIC	PCW @ EMIC	06/18/2003 11:40	su										
3060084	PCW below SFC	CC @ PCW	06/18/2003 12:05	su										
3060085	EMIC @ PCW	EMIC @ PCW	06/18/2003 13:45	su										
3060086	PCW @ EMIC	PCW @ EMIC	06/18/2003 14:00	su										
3060087	PCW below SFC	CC @ PCW	06/18/2003 14:25	su										
3060088	EMIC @ PCW	EMIC @ PCW	06/18/2003 14:45	su										
3060089	PCW @ EMIC	PCW @ EMIC	06/18/2003 15:00	su										
3060090	PCW below SFC	CC @ PCW	06/18/2003 15:25	su										
3060098	PCW @ CC	Weephole 1N	06/24/2003 9:15	gw							573.56	72.10		
3060099	VD @ PCW	VD @ PCW	06/24/2003 9:45	su										
3060100	VD @ PCW	Spring	06/24/2003 10:05	gw							181.79	188.20		
3060103	WD @ PCW	WD @ PCW	06/24/2003 10:50	su										
3060107	CIC @ PCW	CIC @ PCW	06/24/2003 13:00	su										
3060115	Dry Collector	Dry Collector	06/24/2003 16:40	cd										
3060116	SDC @ Campus	SDC @ Campus	06/24/2003 17:00	su										
3060117	BoC @ MacArthur	BoC @ MacArthur	06/24/2003 17:30	su										
3060118	BaC @ Barranca	Drain	06/24/2003 18:00	su										
3070002	Dry Collector	Dry Collector	07/08/2003 9:30	cd										
3070248	Dry Collector	Dry Collector	07/21/2003 0:00	cd										
3080010	SDC @ Campus	SDC @ Campus	08/06/2003 9:45	su										
3080011	Tomato Springs	Tomato Springs	08/06/2003 10:50	gw							438.57			
3080013	Wet Collector	Wet Collector	08/06/2003 0:00	cw										
3080014	Dry Collector	Dry Collector	08/06/2003 0:00	cd										
3080018	Dry Collector	Dry Collector	08/19/2003 0:00	cd										
3080022	Dry Collector	Dry Collector	08/28/2003 0:00	cd										
3090053	Dry Collector	Dry Collector	09/25/2003 0:00	cd										
3090057	PCW @ CC	Weephole 32N	09/30/2003 10:25	gw								11.30		
3090059	VD @ PCW	Spring	09/30/2003 11:20	gw							153.39	161.30		
3090060	VD @ PCW	VD @ PCW	09/30/2003 11:30	su							34.99	33.50		
3090062	WD @ PCW	WD @ PCW	09/30/2003 11:58	su										
3090065	CIC @ PCW	CIC @ PCW	09/30/2003 13:25	su										
3100002	SDC @ Campus	SDC @ Campus	10/07/2003 0:00	su										
3100004	BoC @ MacArthur	BoC @ MacArthur	10/07/2003 0:00	su										
3100006	BaC @ Main	BaC @ Main	10/07/2003 0:00	su										
3100008	SDC @ Harvard	SDC @ Harvard	10/07/2003 0:00	su										
3100010	Dry Collector	Dry Collector	10/07/2003 0:00	cd										
3100016	PCW @ Barranca	PCW @ Barranca	10/21/2003 10:30	su										
3100017	PCW @ Moffett	PCW @ Moffett	10/21/2003 11:00	su										
3100018	SFC @ PCW	SFC @ PCW	10/21/2003 11:45	su										
3100019	ECD @ PCW	ECD @ PCW	10/21/2003 12:20	su										
3100020	PCW below SFC	CC @ PCW	10/21/2003 13:00	su										
3100021	EMIC @ PCW	EMIC @ PCW	10/21/2003 13:45	su										
3100022	PCW @ EMIC	PCW @ EMIC	10/21/2003 14:15	gw										
3100023	Dry Collector	Dry Collector	10/21/2003 0:00	cd										

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
3110001	SDC @ Campus	SDC @ Campus	11/04/2003 9:30	su										
3110002	Spring - SDC @ Harvard	Spring - SDC @ Harvard	11/04/2003 10:00	gw										
3110003	VD @ PCW	Spring	11/04/2003 10:20	gw										
3110004	Spring - PCW across from VD	Spring - PCW across from VD	11/04/2003 10:30	gw										
3110005	PCW @ CC	Weephole 1N	11/04/2003 11:00	gw										
3110006	SFC @ RR	Weephole 10N	11/04/2003 11:15	gw										
3110007	Tomato Springs	Tomato Springs	11/04/2003 11:45	gw										
3110008	Wet Collector	Wet Collector	11/04/2003 9:00	cw										
3110009	Dry Collector	Dry Collector	11/04/2003 9:00	cd										
3110024	EMIC @ PCW	EMIC @ PCW	11/18/2003 10:15	su										
3110025	PCW @ EMIC	PCW @ EMIC	11/18/2003 10:40	gw										
3110026	PCW below SFC	CC @ PCW	11/18/2003 11:10	su										
3110027	EMIC @ PCW	EMIC @ PCW	11/18/2003 12:25	su										
3110028	PCW @ EMIC	PCW @ EMIC	11/18/2003 12:30	gw										
3110029	PCW below SFC	CC @ PCW	11/18/2003 13:00	su										
3110030	EMIC @ PCW	EMIC @ PCW	11/18/2003 14:30	su										
3110031	PCW @ EMIC	PCW @ EMIC	11/18/2003 14:45	gw										
3110032	PCW below SFC	CC @ PCW	11/18/2003 15:00	su										
3110033	SFC @ PCW	SFC @ PCW	11/18/2003 10:05	su										
3110034	SDC @ Campus	PCW below SFC	11/18/2003 10:40	su										
3110035	ECD @ PCW	ECD @ PCW	11/18/2003 11:20	su										
3110037	SFC @ PCW	SFC @ PCW	11/18/2003 13:45	su										
3110038	SDC @ Campus	PCW below SFC	11/18/2003 14:12	su										
3110039	ECD @ PCW	ECD @ PCW	11/18/2003 14:33	su										
3110040	SDC @ Campus	PCW below SFC	11/18/2003 0:00	su										
3110041	ECD @ PCW	ECD @ PCW	11/18/2003 0:00	su										
3110041D	ECD @ PCW	ECD @ PCW	11/18/2003 0:00	su										
3110042	SFC @ PCW	SFC @ PCW	11/18/2003 0:00	su										
3110043	Wet Collector	Wet Collector	11/18/2003 0:00	cw										
3110044	Dry Collector	Dry Collector	11/18/2003 0:00	cd										
3120009	Dry Collector	Dry Collector	12/06/2003 15:00	cd										
3120011	EMIC @ PCW	EMIC @ PCW	12/16/2003 9:50	su										
3120012	PCW @ EMIC	PCW @ EMIC	12/16/2003 10:10	gw										
3120013	PCW below SFC	CC @ PCW	12/16/2003 10:40	su										
3120014	Drain - PCW @ Walnut	Drain - PCW @ Walnut	12/16/2003 11:00	su										
3120015	CIC @ PCW	CIC @ PCW	12/16/2003 11:12	su										
3120016	Weephole - CIC @ I5	Weephole 1	12/16/2003 11:25	gw										
3120017	CC @ Yale	Spring	12/16/2003 11:55	gw										
3120018	Sump - CC @ Culver	Sump - CC @ Culver	12/16/2003 12:22	gw										
3120019	SFC @ PCW	SFC @ PCW	12/16/2003 13:00	su										
3120020	ECD @ PCW	ECD @ PCW	12/16/2003 13:19	su										
3120021	Spring - PCW across from VD	Spring - PCW across from VD	12/16/2003 13:45	gw										
3120022	VD @ PCW	Spring	12/16/2003 13:50	gw										
3120023	VD @ PCW	VD @ PCW	12/16/2003 13:55	su										
3120024	Drain - PCW E Side N of Warner	Drain - PCW E Side N of Warner	12/16/2003 14:30	su										
3120025	WD @ PCW	WD @ PCW	12/16/2003 14:50	su										
3120026	Drain - PCW W side S of Warner	Drain - PCW W side S of Warner	12/16/2003 15:00	su										
3120027	PCW @ Barranca	PCW @ Barranca	12/16/2003 15:20	su										
3120028	Spring - SDC @ Harvard	Spring - SDC @ Harvard	12/16/2003 15:35	gw										
3120029	SDC @ Harvard	SDC @ Harvard	12/16/2003 15:40	su										
3120030	Drain - SDC @ Harvard	Drain - SDC @ Harvard	12/16/2003 16:00	su										
3120031	SDC @ Culver	Weephole	12/16/2003 16:15	gw										

sample	site	location	Sample Date	Type	Fe	Hg, total	O-18	Deuterium	Mn-ICP	Mn-GF-AA	Mo	V	Se Total	As Total
			mm/dd/yyyy hh:mm		mg/L	ng/L	del	del	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
3120032	Spring - SDC @ Culver	Spring - SDC @ Culver	12/16/2003 16:25	gw										
3120037	SFC @ RR	Weephole 10N	12/19/2003 8:47	gw										
3120038	BaC @ Main	BaC @ Main	12/19/2003 9:37	su										
3120039	SDC @ Campus	SDC @ Campus	12/19/2003 10:25	su										
3120040	BoC @ MacArthur	BoC @ MacArthur	12/19/2003 10:44	su										
3120041	SADC @ Irvine	Spring	12/19/2003 11:21	gw										
3120042	LC @ McCabe/Jamboree	LC @ McCabe/Jamboree	12/19/2003 11:53	su										
3120043	BaC @ Barranca	Drain	12/19/2003 12:19	su										
3120045	Wet Collector	Wet Collector	12/19/2003 10:00	cw										
3120046	Dry Collector	Dry Collector	12/19/2003 10:00	cd										
4010011	Wet Collector	Wet Collector	01/08/2004 0:00	cw										
4010012	Dry Collector	Dry Collector	01/08/2004 0:00	cd										
4010184	SDC @ Campus	SDC @ Campus	01/19/2004 11:00	su										
4010184D	SDC @ Campus	SDC @ Campus	01/19/2004 11:00	su										
4010268	Wet Collector	Wet Collector	01/29/2004 0:00	cw										
4010269	Dry Collector	Dry Collector	01/29/2004 0:00	cd										
4020083	Wet Collector	Wet Collector	02/13/2004 0:00	cw										
4020084	Dry Collector	Dry Collector	02/13/2004 0:00	cd										
4030119	Wet Collector	Wet Collector	03/06/2004 0:00	cw										
4030120	Dry Collector	Dry Collector	03/06/2004 0:00	cd										
4030147	SFC @ RR	Weephole 10N	03/22/2004 0:00	gw										
4030148	Weephole - LC @ Red Hill	Weephole - LC @ Red Hill	03/22/2004 0:00	gw										
4030149	SADC @ Irvine	Spring	03/22/2004 0:00	gw										
4030150	SDC @ Campus	SDC @ Campus	03/22/2004 0:00	su										
4030151	SDC @ Campus	SDC @ Campus	03/22/2004 0:00	su										
4030152	Wet Collector	Wet Collector	03/22/2004 0:00	cw										
4030153	Dry Collector	Dry Collector	03/22/2004 0:00	cd										
4030154	Spring - SDC @ Harvard	Spring - SDC @ Harvard	03/22/2004 0:00	gw										
4030155	SDC @ Culver	Weephole	03/22/2004 0:00	gw										
4030156	Spring - SDC @ Culver	Spring - SDC @ Culver	03/22/2004 0:00	gw										
4030169	SDC @ Harvard	SDC @ Harvard	03/31/2004 9:54	su										
4030170	PCW @ Barranca	PCW @ Barranca	03/31/2004 10:25	su										
4030171	SFC @ PCW	SFC @ PCW	03/31/2004 11:08	su										
4030172	ECD @ PCW	ECD @ PCW	03/31/2004 11:48	su										
4030172D	ECD @ PCW	ECD @ PCW	03/31/2004 11:48	su										
4030174	Spring - PCW across from VD	Spring - PCW across from VD	03/31/2004 12:19	gw										
4030175	VD @ PCW	Spring	03/31/2004 12:30	gw										
4030176	PCW below SFC	CC @ PCW	03/31/2004 12:56	su										
4030177	PCW @ CC	Weephole 1N	03/31/2004 13:25	gw										
4030178	EMIC @ PCW	EMIC @ PCW	03/31/2004 13:46	su										
4030180	PCW @ EMIC	PCW @ EMIC	03/31/2004 13:56	gw										
4030181	CIC @ PCW	CIC @ PCW	03/31/2004 14:50	su										
4030182	Weephole - CIC @ I5	Weephole 99	03/31/2004 14:55	gw										
4030183	Sump - CC @ Culver	Sump - CC @ Culver	03/31/2004 15:24	gw										
4030184	Dry Collector	Dry Collector	03/31/2004 9:30	cd										
4030185	Well 63S	Well 63S	03/31/2004 9:04	gw										
4030186	Well 85W	Well 85W	03/31/2004 9:52	gw										
4030187	Well 86N	Well 86N	03/31/2004 10:48	gw										
4030188	Well 103N	Well 103N	03/31/2004 11:32	gw										
4030189	Well 87N	Well 87N	03/31/2004 12:25	gw										
4030190	Well 102N	Well 102N	03/31/2004 14:15	gw										
4030191	Well - PCW N of RR	Well - PCW N of RR	03/31/2004 14:58	gw										