THE CITY OF SAN DIEGO

February 5, 2009

Hand Delivery

Wayne Chiu, P.E.
California Regional Water Quality Control Board
San Diego Region
9174 Sky Park Court
San Diego, CA 92123

Dear Mr. Chiu:

Subject: Submission of the Final Report for TMDL Monitoring of Sedimentation/Siltation in Los Peñasquitos Lagoon

On behalf of the Los Peñasquitos Lagoon responsible dischargers, the City of San Diego is pleased to provide the San Diego Regional Water Quality Control Board with the Final Report of the TMDL Monitoring for Sedimentation/Siltation in Los Peñasquitos Lagoon (Order No. R9-2006-0076).

If you have any questions, please contact Storm Water Specialist Ruth Kolb at (858) 541-4328.

Sincerely,

Kris McFadden
Deputy Director

KM/bm

Enclosures: TMDL Monitoring for Sedimentation/Siltation in Los Peñasquitos Lagoon (1 hardcopy, 2 CDs)

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TMDL Monitoring for Sedimentation/Siltation in Los Peñasquitos Lagoon

In Response to Investigation Order R9-2006-076

FINAL REPORT
January 21, 2009

Prepared for:

City of Poway
City of Del Mar
City of San Diego
County of San Diego, and
California Department of Transportation

WESTON SOLUTIONS

TMDL MONITORING FOR SEDIMENTATION/SILTATION IN LOS PEÑASQUITOS LAGOON
In Response to Investigation Order R9-2006-076

Final Report

Prepared for:

City of Poway,
City of Del Mar,
City of San Diego,
County of San Diego, and
California Department of Transportation

Prepared by:

Weston Solutions, Inc.
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Carlsbad, California 92010

January 21, 2009

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Caltrans	California Department of Transportation
cfs	cubic feet per second
CRG	CRG Marine Laboratories, Inc.
cy	cubic yards
DO	dissolved oxygen
EMC	event mean concentration
FWC	flow-weighted composite
HA	hydrologic area
LPLF	Los Peñasquitos Lagoon Foundation
MES	mass emission station
Order	San Diego Regional Water Quality Control Board Investigation Order R9-2006-0076
QA/QC	quality assurance / quality check
RWQCB	Regional Water Quality Control Board
sondes	water quality data loggers
TMDL	total maximum daily load
TSS	total suspended solids
TWAS	Temporary Watershed Assessment Site
Weston	Weston Solutions, Inc.

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The purpose of this report is to provide an assessment of the Los Peñasquitos Watershed and Lagoon monitoring conducted during the 2007–2008 wet weather monitoring season in response to San Diego Regional Water Quality Control Board (RWQCB) Investigation Order R9-2006-0076 dated July 19, 2006 (Order). The Order requires the responsible dischargers to the Los Peñasquitos Watershed Management Area to conduct specific water quality and water quantity monitoring at the base of the watershed and within Los Peñasquitos Lagoon. Water quality monitoring data reports were required for submittal to the RWQCB for the purposes of parameterizing, calibrating, and validating the watershed and lagoon models being developed. The models will be used to estimate existing loading, develop total maximum daily loads (TMDLs), and identify sources of pollutants. The responsible dischargers to the Los Peñasquitos Watershed listed in the Order are presented below:

- City of San Diego.
- City of Poway (watershed lead).
- City of Del Mar.
- County of San Diego.
- California Department of Transportation (Caltrans).

Weston Solutions, Inc. (WESTON), under contract with the City of San Diego, conducted the required monitoring. The focus of the monitoring program was to address data needs with regard to current watershed loading and water quality models. Monitoring occurred at five locations as follows:

- Base of Carmel Creek.
- Base of Los Peñasquitos Creek.
- Base of Carroll Canyon Creek.
- Lagoon segment.
- Ocean inlet.

This report is organized in the following manner by section with the following brief overview:

Section 1. Introduction – Provides a general overview and purpose for the study, and a discussion of previous work conducted in the watershed.
Section 2. Watershed Description – Discussion of watershed characteristics, topography, and land use.
Section 3. Methods and Instrumentation – This section presents the methods and instrumentation used to conduct flow monitoring, water quality monitoring, sampling, and surveying.
Section 4. Monitoring Results Summary – This section presents the results of each study element.
Section 5. Sediment Load Analysis – Discussion of sediment load and volume.
Section 6. Summary, Conclusions, and Recommendations – Overall findings and recommendations based on the study results.
Section 7. References

Water quality parameters within Los Peñasquitos Lagoon and watershed were measured over the course of six months to provide calibration and validation data for the models that will be used for this specific lagoon. Several types of monitoring and sampling techniques were used to assess and characterize the lagoon. These included continuous monitoring of hydrodynamic and water quality parameters, wet weather monitoring conducted throughout storm events at targeted site locations within the lagoon, bathymetric surveying conducted periodically throughout the year at the lagoon mouth, and sediment sampling and analyses conducted within two weeks after one monitored storm event.

Three storm events were monitored for the Los Peñasquitos Lagoon TMDL Monitoring Study between October 14, 2007 and March 31, 2008. Each of the monitored storms met the Order criteria of 0.20 inch of rainfall or greater. Rainfall events were most frequent during January and February, while March and April were dry. Two of the three monitored storm events coincided with monitoring that occurred for the County of San Diego Regional Monitoring Program.

Los Peñasquitos Lagoon receives perennial freshwater flows from three subwatersheds (Carmel Creek, Los Peñasquitos Creek, and Carroll Canyon Creek). Of the three creeks feeding into the lagoon, Los Peñasquitos Creek drains the largest land area (37,028 acres), followed by Carmel Creek (11,180 acres) and Carroll Canyon Creek (11,004 acres).

Over the course of three monitored storm events, total suspended solids (TSS) concentrations varied considerably among the three creek and two lagoon sampling locations. Analyses indicated that TSS concentrations were above the Copermittee wet weather water quality benchmark of 100 mg/L at Carroll Canyon Creek 76% of the time (28/37 samples), while 5% of samples collected from Los Peñasquitos Creek (2/37 samples) and 3% of samples collected from Carmel Creek (1/37 samples) were above the water quality benchmark across monitored storm events in 2007–2008. At the Lagoon Segment and Ocean Inlet sites, TSS concentrations were measured above the water quality benchmark 6% (2/32 samples) and 20% (7/35 samples) of the time, respectively, across the three monitored storm events. Figure ES-1 presents the range of concentrations of TSS over the three storm events sampled for each subwatershed. As indicated in Figure ES-1, samples from the Carroll Canyon subwatershed showed the highest mean concentration and maximum concentrations.

As a result of its steep drainage area, concrete-lined channels, and limited vegetation, Carroll Canyon Creek demonstrated a much shorter time of concentration as well as higher peak flows compared to Carmel Creek and Los Peñasquitos Creek which have natural channels with dense vegetation growing within their creek beds. In addition, upstream mitigation projects (e.g., El Cuervo Norte Project) further reduced flow velocities and increased retention times in the Los Peñasquitos Creek (above the sampling site) that likely resulted in sediment removal. The Sorrento Creek Channel is maintained by the City of San Diego and is located further downstream from the confluence of Carroll Canyon Creek and Los Peñasquitos Creek (below the Carroll Canyon sampling site). This channel also reduced sediment loading to the Lagoon.

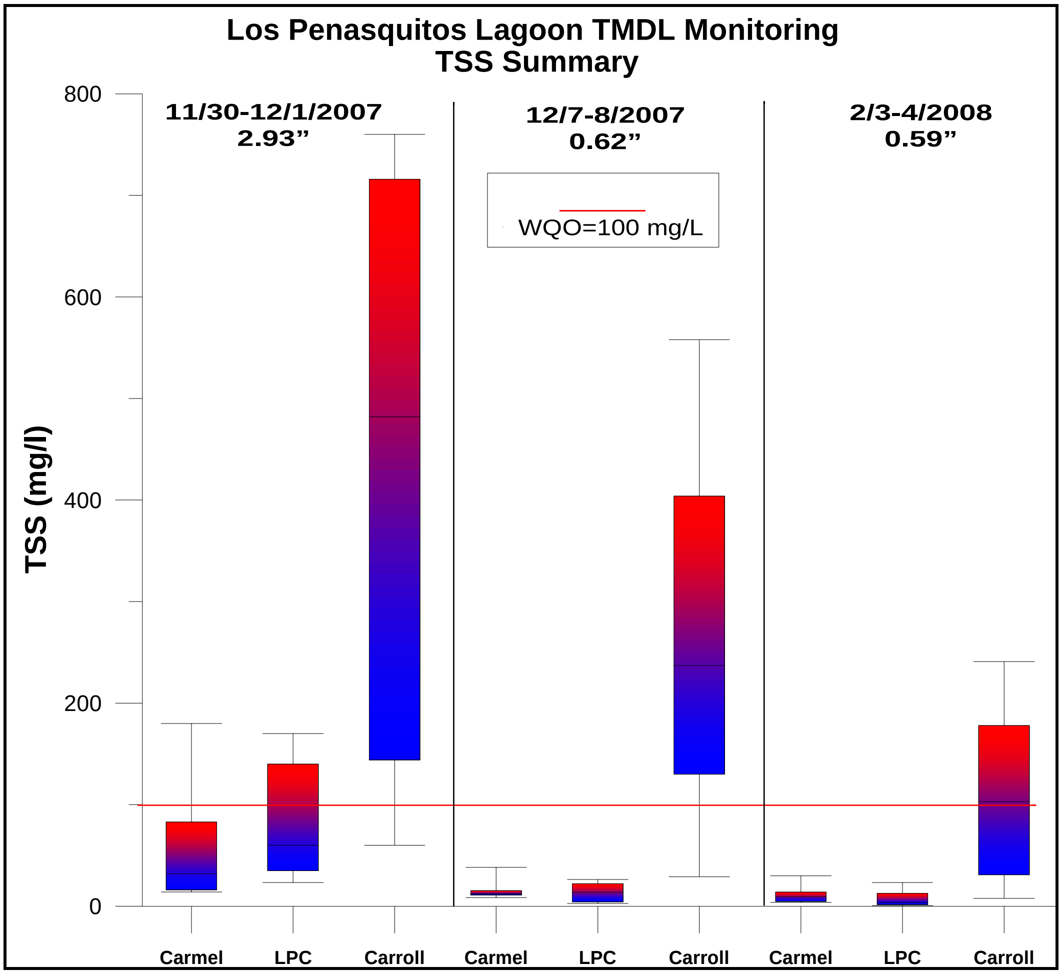

Figure ES-1. Box and Whisker Plot of Creek TSS Concentrations across Three Monitored Storm Events

Several notable differences in land use composition exist among the three subwatersheds and may help to explain observed differences in TSS, concentrations and loading, and flow characteristics. The Carroll Canyon Creek drainage area has a significantly higher percentage of industrial and commercial land use (five times more) than either the Carmel Creek or Los Peñasquitos Creek drainage areas, and contains the greatest percentage of impervious surface among the three drainage areas (Figure ES-2). While the creek beds of Los Peñasquitos Creek and Carmel Creek are natural channels, Carroll Canyon Creek is channelized and contains little vegetation for approximately two miles prior to the point at which it merges with Los Peñasquitos Creek. Conversely, the upper portion of the Los Peñasquitos Creek drainage area contains the highest percentage of vacant land and rural residential land use among the three subwatersheds. Although Los Peñasquitos Creek is a considerably larger watershed with approximately 3.5 times the drainage area of each of the other two creeks, the estimated annual sediment load during a typical storm year is approximately 1/18th that of Carroll Canyon and twice that of Carmel Creek. Calculated TSS loads from the three storm events that were monitored during the 2007–2008 storm season are shown in Figure ES-3. The physical characteristics of Carmel Creek (a natural channel with areas of dense vegetation) are similar to those seen in Los Peñasquitos Creek. Although Carmel Creek has a similar sized drainage area to Carroll Canyon Creek, its flow during storm events rises and falls at a much slower pace, allowing sediment loads sufficient time to drop out of the water column prior to reaching Los Peñasquitos Lagoon.

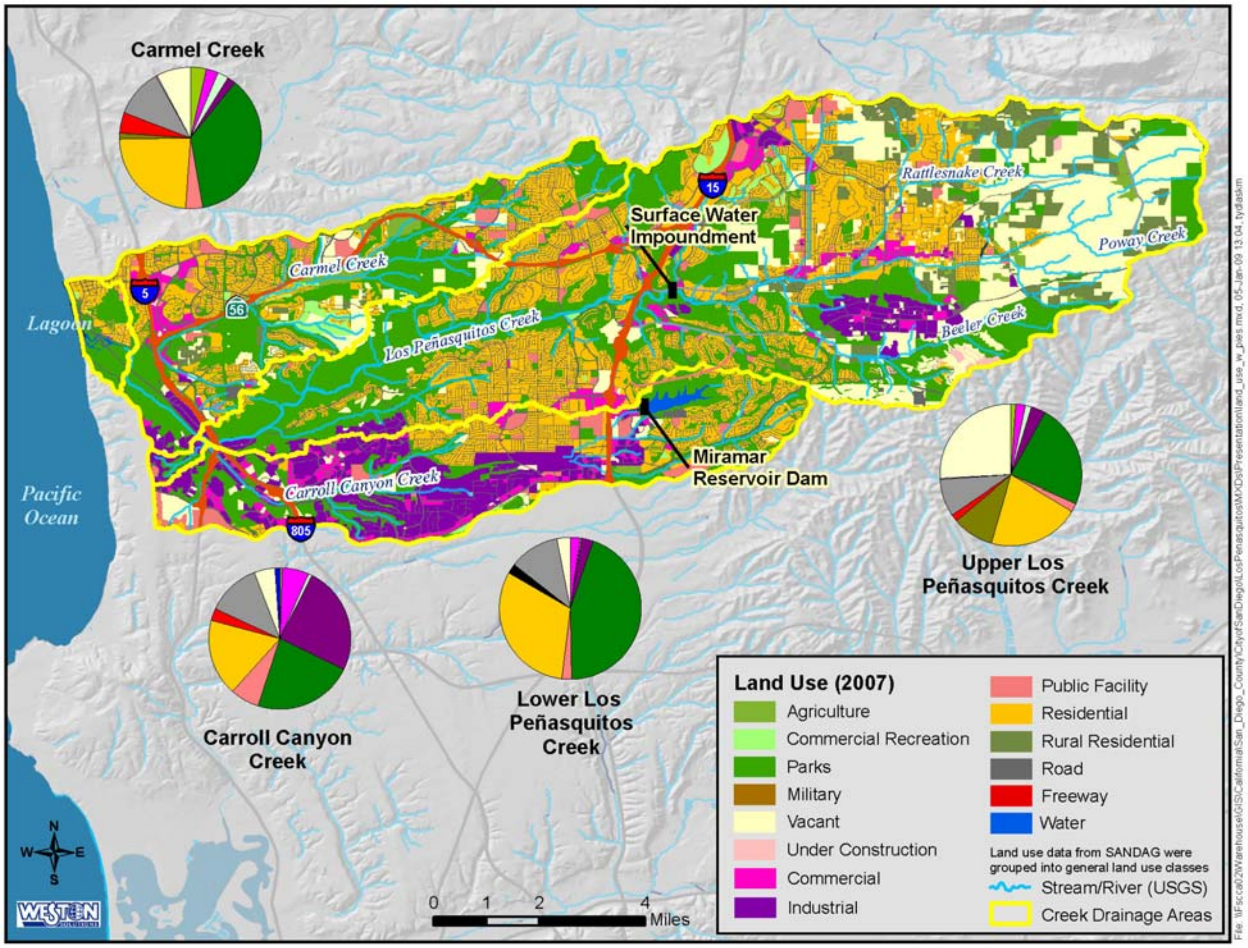

Figure ES-2. Land Use in Los Peñasquitos Watershed

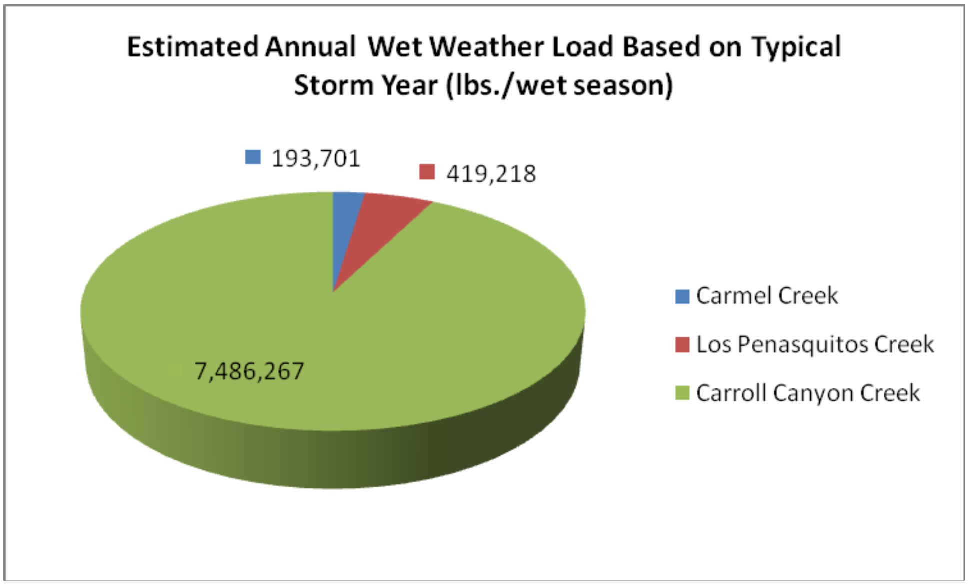

Figure ES-3. Estimated TSS Wet Weather Annual Load Feeding into Los Peñasquitos Lagoon from Watershed Inputs

As a result of the monitoring and investigation conducted in Los Peñasquitos Lagoon and the watershed to comply with the Order, several conclusions are presented:

- Lagoon mouth closures, though infrequent in their occurrence, result in degraded water quality conditions in the lagoon [primarily through dissolved oxygen (DO) depletion].
- Lagoon mouth closures are primarily a result of coastal processes, structures that confine the natural meandering of the creek mouth (Highway 101, NCTD railway, and I-5), and not from excessive sediment loading from the watershed.
- TSS concentration benchmark exceedances from the watersheds are highest and most frequent in Carroll Canyon Creek.
- The Los Peñasquitos Creek Watershed is primarily open space and parks, has a mostly natural channel system and has dense stands of vegetation in the creek. Flow rates react to rainfall events characteristic of a natural channel setting, and it tends to have few TSS results above the Copermittee TSS wet weather benchmark. However, localized areas within the upper and lower watershed may have higher sedimentation rates.
- Carmel Creek had the lowest peak flow rates likely due to heavy vegetation in the channel. Carmel Creek also has a sustained year-round baseflow which is likely due to the increased residential growth in the local area and is suspected to be a result of over-irrigation. In addition, shallow groundwater tables in this area also contribute to sustained baseflow. The continual dry weather flow has resulted in some loss of estuarine habitat due to encroaching freshwater habitat and plant species.
- Hydromodification within the Carroll Canyon Creek watershed have increased peak flow rates during rain events, allowing for greater transport of suspended sediment. Impervious surfaces in combination with Carroll Canyon Creek's concrete-lined channel in the lower portion of the watershed have increased its capacity to transport sediment to the Lagoon with higher peak flows and shorter concentration times for most storm events

compared to Los Peñasquitos Creek and Carmel Creek. However, further studies are needed to identify the sources of sediment in these watersheds.

- The total load of sediment is shown on Figure ES-3. Based on these loads, the total volume of sediment flowing from each of the creeks into the Lagoon during a typical year was calculated to be 72 cubic yards (cy) of sediment for Carmel Creek, 155 cy for Los Peñasquitos Creek, and 2,773 cy for Carroll Canyon Creek. In 2003, the Sorrento Creek Channel Maintenance Project removed an estimated 26,928 cy of sediment from four areas near the confluence of Los Peñasquitos Creek and Carroll Canyon Creek. Although it is not well documented when previous maintenance dredging was performed in these areas, it is believed to have been performed approximately two years prior to the documented dredging event in 2003. By removing nearly 27,000 cy of sediment, the City of San Diego essentially removed Los Peñasquitos Creek's and Carroll Canyon Creek's estimated total contribution of sediment to the lagoon for a nine year period. As a result, it is recommended that scheduled dredging of these maintenance areas continue approximately every five years or as needed in order to minimize sediment accumulation within the main portion of Los Peñasquitos Lagoon.
- Management actions are being implemented to address sedimentation on a regular basis by numerous agencies (City of San Diego Street Division, Park and Recreation, and Storm Water Pollution Prevention Program; Los Peñasquitos Lagoon Foundation (LPLF); and State Parks). However, further interagency coordination and documentation of activities is needed to improve documentation of sediment quantities removed.

Sixty-eight percent of the samples which had TSS concentrations above the Copermittee wet weather water quality benchmark were collected from the Carroll Canyon Creek site. Similarly, Carroll Canyon Creek accounted for 92% of the estimated sediment load entering the lagoon via the creek system during monitored storms in 2007–2008. As a result, Carroll Canyon is recommended as a priority area for possible BMP implementation in an effort to reduce sediment loads to Los Peñasquitos Lagoon from the watershed. Initial efforts are targeted at identifying and documenting areas with evidence of excessive erosion and with the potential to mobilize soils. Management decisions regarding options for implementation of BMPs should be made in accordance with the integrated approach presented in the City of San Diego's Strategic Plan for Watershed Activities.

As previously stated, mouth closures of the lagoon appear to be primarily the result of coastal processes, such as long-shore currents and tidal activity that constricts the lagoon mouth through sand deposition over time. Currently, the LPLF, in coordination with State Parks and the Coastal Conservancy, contracts with an engineering company to reopen the lagoon mouth through excavation once it is documented that the mouth is closed and water quality parameters indicate impairments, as defined by the Coastal Development Permit. The most cost-effective, short-term solution to this phenomenon appears to be to continue to dredge the lagoon mouth and utilize the sand that is excavated for nearby beach replenishment if it is deemed an appropriate measure based on the quality of sand and other factors.

1.0 INTRODUCTION

Los Peñasquitos Lagoon (Lagoon) is a 0.5 square mile coastal lagoon and is part of the Torrey Pines State Reserve in northern San Diego County. The Lagoon receives freshwater inputs from an approximately 95-square-mile watershed comprised of three major canyons (Carroll, Los Peñasquitos, and Carmel canyons). Both the Lagoon and its watershed are part of the Los Peñasquitos Watershed Management Area. Given the status of "preserve" by State Parks, the Lagoon is one of the few remaining native salt marsh lagoons in California, providing a home for several endangered species (e.g., least Bell's vireo, Belding's savannah sparrow, light-footed clapper rail, and salt marsh daisy). The Lagoon also serves as a stopover for the Pacific Flyway, offering migratory birds a safe place to rest and feed as well as providing refuge for coastal marine species that use the Lagoon to feed and hide from predators. Listed as a Critical Coastal Area, the Lagoon is the closest lagoon to the only two Areas of Special Biological Significance located within San Diego, the San Diego Marine Life Refuge and the San Diego–La Jolla Ecological Reserve. The Lagoon is currently under consideration for National Estuarine Research Reserve status under the National Oceanic and Atmospheric Administration (NOAA) as well as a Wetland of International Significance under the United Nation's Ramsar Program.

The purpose of this report is to provide a sediment assessment of the Los Peñasquitos Watershed and the Los Peñasquitos Lagoon monitoring conducted during the 2007–2008 wet weather monitoring season in response to Investigation Order R9-2006-0076 – *Owners and Operators of Municipal Separate Storm Sewer Systems, California Department of Transportation, Hale Avenue Resource Recovery Facility, and North County Transit District Responsible for the Discharge of Bacteria, Nutrients, Sediment, and Total Dissolved Solids into Impaired Lagoons, Adjacent Beaches, and Agua Hedionda Creek* (Order). This Order required that monitoring be conducted in each of the seven lagoons listed. Los Peñasquitos Lagoon was one of the seven lagoons identified and was listed only for sedimentation and siltation.

The Order required the responsible dischargers to the Los Peñasquitos Watershed Management Area to conduct specific water quality and flow monitoring at the base of the watershed and within the Lagoon. Water quality monitoring data reports are required to be submitted to the RWQCB for the purposes of parameterizing, calibrating, and validating the watershed and lagoon models being developed. The models will be used to estimate existing loading, develop TMDLs, and identify sources of pollutants. The responsible dischargers to the Los Peñasquitos Watershed listed in the Order are presented in Table 1-1 by category.

Table 1-1. List of Responsible Dischargers to the Los Peñasquitos Watershed (HU 906)

Municipal Dischargers	County, State, and Other Facilities
• City of San Diego • City of Poway (watershed lead) • City of Del Mar	• County of San Diego • Caltrans

Several addendums to the original Order followed during the development and execution of this project. Relevant items in the Addendums to Los Peñasquitos Lagoon are described below. Copies of the Order and each addendum are provided in Appendix A for reference.

- **Addendum 1 (November 1, 2006)** – This addendum allowed for postponing the work plan deadlines by one month so long as field activities were initiated by October 1, 2007.
- **Addendum 2 (June 21, 2007)** – The work plan written by the Southern California Coastal Water Research Project, *San Diego Coastal Lagoons TMDL Monitoring Work Plan*, was received by the RWQCB on June 18, 2007. This work plan superseded the study questions in *Directive A1.a* through *A1.h3* of the Order. The monitoring requirements of the Order in *Directive A2* through *A8* were superseded by the Monitoring Program Work Plan. Finally, quarterly data submittal requirements were refined and specified.
- **Addendum 3 (October 5, 2007)** – Addendum 3 specified requirements to conduct ocean inlet land elevation surveys on a periodic basis.

In addition to the assessment of Lagoon monitoring in accordance with the Order, this report also presents additional evaluations. These additional evaluations were performed for the purpose of providing management actions prior to the outcome of the modeling efforts and technical reports provided by the RWQCB. The following questions are presented:

- How much sediment is entering the Lagoon from the watershed and ocean inlet?
- How do sediment concentrations compare to water quality objectives?
- What contributes to sediment input, and how does it get to the Lagoon?
- What is currently being done to control sediment?
- What are possible future management actions based on the findings of the monitoring?

1.1 Project Basis and §303(d) Listing

The Lagoon was placed on the Clean Water Act Section §303(d) list of impaired water bodies in 1996 for sedimentation and siltation (Coastal Conservancy Wetland Profile 2008). The primary reasons for Lagoon listing include increased frequencies of lagoon mouth closures at the ocean inlet and fragmented tidal channels as well as increased sedimentation associated with urban development. Industrial development and urban encroachment in the watershed and along the periphery of the Lagoon have altered the hydrology of the western portion of the watershed and modified the geomorphic conditions of the three main tributaries (Carroll Canyon, Los Peñasquitos, and Carmel creeks) that empty into the Lagoon, resulting in sedimentation in the

Lagoon–watershed interface and within lagoon channels. Impacts associated with such sedimentation include reduced tidal mixing within lagoon channels, degradation, and in some cases, net loss of riparian and salt marsh vegetation, increased vulnerability to flooding for surrounding urban and industrial developments, turbidity associated with siltation in lagoon channels, and constriction of a main wildlife corridor.

Historically, the lagoon mouth, subject to the forces of ocean processes (e.g., currents, sediment distribution, and wave activity) and flows from the watershed, meandered up and down the beach. However, transportation infrastructure within the Lagoon, and urban development along its western boundary, reduced the ability of the Lagoon to remain open naturally. In 1925, a raised and armored, railway berm was constructed across the center of the Lagoon. With few trestles and culverts, this berm served to cut off historic tidal channels within the Lagoon and obstructs the natural flow of water from the watershed through the Lagoon to the ocean inlet. In 1932, Highway 101 was constructed on an elevated, armored berm along the Lagoon's western boundary, effectively separating a majority of the Lagoon from the beach and Pacific Ocean. A bridge with 74 support columns was built at the northwest end of the Lagoon to maintain the ocean inlet and allow for tidal flushing. However, restricting the lagoon mouth to this specific confined area resulted in the increased frequency and duration of mouth closures in the Lagoon (LeGrange, 1985; Coppock, 1985; Coastal Environments, 2002; Coastal Environments, 2003a; Coastal Environments, 2003b; Coastal Environments, 2004; Coastal Environments, 2005; Wells, 2000). In 2005, the City of San Diego replaced the Highway 101 bridge that spanned the Lagoon in order to reduce the number of columns from 74 to four. This improvement in bridge design has allowed the lagoon mouth to remain open for longer periods of time. However, the mouth still closes at least one time per year (Crooks et al., 2007; Coastal Environments, 2006; Coastal Environments, 2007; Coastal Environments, 2008a; Coastal Environments, 2008b). Long-term monitoring at the Lagoon has shown that extended mouth closures prevent tidal flushing of the Lagoon and result in decreased DO, stagnation of Lagoon waters, damage to terrestrial habitat from flooding, and can eventually lead to fish kills in the Lagoon (Nordby and Covin, 1988; Nordby, 1989; Nordby, 1990; Norby and Zedler, 1991; Boland, 1991; Boland, 1992; Boland, 1993; Gibson et al., 1994; Williams and Gibson, 1995; Williams, 1996; Williams, 1997; Williams et al., 1998; Williams et al., 1999; Ward et al., 2000; Ward et al., 2001; West and Cordery, 2002; West and Cordery, 2003; West and Cordery, 2004; Crooks et al., 2005; Crooks et al., 2007).

Land use within the watershed has altered natural landscapes, tributary characteristics, and native habitats since the late 1700s (Mudie et al., 1974). However, recent development within the watershed seems to have had the greatest impacts to the geomorphology of the watershed and to lagoon environments (Prestegaard, 1979; SANDAG, 1982; Greer, 2001; White and Greer, 2002; Kimley-Horn, 2003; Coastal Environments, 2003d; Coastal Environments, 2003e). The urban growth within the watershed has led to the development of urban infrastructure within the watershed in the form of roadways (e.g., Carmel Valley Road) and highways (e.g., Highway 101, I-5, I-805, and S-56) and has led to increased impervious surfaces. Along with this growth in population came the impacts associated with extensive urban development. Year-round freshwater flows into the Lagoon from the watershed began to occur in 1995 and have continued to the present day (Williams, 1996; Williams, 1997; Williams et al., 1998; Williams et al., 1999; Ward et al., 2000; Ward et al., 2001; West and Cordery, 2002; West and Cordery, 2003; West and Cordery, 2004; Coastal Environments, 2003e; Crooks et al., 2005; Crooks et al., 2007). The increase in urban runoff has been associated with the recent development of the western portion of the watershed in Carmel Valley during the 1990s. The conversion of land use from open space to urban areas has increased impervious surfaces, reducing the ability for storm water to seep into the ground and sending this water into storm drains. Increased dry weather runoff has also been frequently observed. Impacts related to changes in watershed hydrology, such as increased dry weather flows and higher volumes of freshwater flows during storms events, have led to the loss of native salt marsh habitat in the eastern portion of the Lagoon due to encroaching freshwater and transitional habitats (Williams, 1997; Williams et al., 1998; Williams et al., 1999; Ward et al., 2000; Ward et al., 2001; Greer, 2001; West and Cordery, 2002; West and Cordery, 2003; West and Cordery, 2004; White and Greer, 2002; Coastal Environments, 2003d; Crooks et al., 2005; Crooks et al., 2007).

1.2 Model Development and Outcomes

The RWQCB determined the need to develop a watershed model and estuary model to understand the fate and transport of sediments from the watershed to the Lagoon and the interaction of the transport to/from the Lagoon from the ocean inlet. Tetra Tech, Inc. (Tetra Tech), under contract with the RWQCB, is responsible for the development of each model. The model selected for the watersheds is the Hydrologic Simulation Program Fortran (HSPF). The model selected for the estuary is the Environmental Fluid Dynamics Code (EFDC). EFDC can simulate water and water quality constituent transport in geometrically and dynamically complex water bodies, such as vertically mixed shallow estuaries, lakes, and coastal areas. The model results will be presented by Tetra Tech following the completion of the Lagoon TMDL Monitoring Program.

The key program questions developed by the RWQCB and stakeholders, elements to answer those questions, and expected outcomes are presented in Table 1-2. Blue-shaded boxes indicate questions that are addressed by this report, while boxes that are not highlighted will be addressed using modeling performed by Tetra Tech and presented in a report to the RWQCB.

Table 1-2. Monitoring Program Work Plan Key Questions, Elements, and Project Outcomes

Key Questions to be Answered	Project Element(s) that Addressed these Questions	Project Outcomes
1) What are the relative sediment contributions from each land use type or from regulated facilities?	• This question was addressed by the model developed by Tetra Tech. Tetra Tech's model incorporates land use in its assessment of watershed sediment contributions to the Lagoon.	• Understanding of the relative land use sources will help to determine source locations for future BMPs.
2) What are the concentrations of TSS at the base of the watershed before it enters Los Peñasquitos Lagoon?	• Water quality and flow measurements were conducted at the base of three watersheds draining into the Lagoon during three storm events. Analytical results and flow measurements were used to determine TSS loads entering Los Peñasquitos Lagoon.	• TSS loads entering the Lagoon were calculated and used in developing models to generate the Lagoon's sediment TMDL.

Table 1-2. Monitoring Program Work Plan Key Questions, Elements, and Project Outcomes

Key Questions to be Answered	Project Element(s) that Addressed these Questions	Project Outcomes
3) What is the daily rainfall in the watershed?	• A weather station located in the watershed was monitored using the website: weatherunderground.com. This website provided daily rainfall, wind speed and direction, air temperature, and percent humidity measurements. The weather station was located east of I-5 in Torrey Woods Estates / Carmel Valley, San Diego, California. The weather station call number is: KCASAND153	• Daily rainfall totals were used to provide information for the model inputs.
4) What is the total annual (and daily) flow and mass loads of TSS from the watershed to Los Peñasquitos Lagoon?	• Water quality measurements were conducted within the Lagoon during three storm events. Analytical results and flow measurements were used to determine TSS loads in Los Peñasquitos Lagoon. • Wet weather sampling was conducted throughout the storm hydrograph to allow for comparison of loads during initial, peak, and post-peak flows. A pollutograph was developed from these data to assess the loading of TSS over the storm period (hydrograph).	• The calculated TSS load to Los Peñasquitos Lagoon helped to establish baseline sediment loads. Calculated loads were based on concentrations of TSS within the Lagoon at different times during a storm's hydrograph.
5) What is the concentration of TSS at the ocean inlet prior to entering the Lagoon?	• Ocean inlet monitoring of TSS occurred during three storm events. Additional hydrodynamic and water quality monitoring (temperature, conductivity, turbidity, and water level) at the ocean inlet occurred continuously from October 2007 through March 2008.	• Ocean inlet sampling results assessed storm impacts related to TSS concentrations and sediment exchange to and from the Lagoon.
6) What is the net annual flux of TSS from the impaired Lagoon to the coastal ocean?	• Ocean inlet monitoring of TSS occurred during three storm events. Additional hydrodynamic and water quality monitoring (e.g., temperature, conductivity, turbidity, and water level monitoring) at the ocean inlet occurred continuously from October 2007 through March 2008. Surficial sediment sampling within the lagoon was performed after one storm event.	• TSS loads exiting the lagoon were calculated from models based upon the measured TSS concentrations at the ocean inlet as compared to the Lagoon Segment Site in concert with sediment grain size analyses from each location. Based upon these data, the models will determine the net annual flux of TSS leaving the Lagoon and entering the Pacific Ocean.
7) What is the concentration of TSS within Los Peñasquitos? Does this concentration exceed water quality objectives?	• Ocean inlet and lagoon segment monitoring of TSS was performed during three storm events. Additional hydrodynamic and water quality monitoring (e.g., temperature, conductivity, turbidity, and water level) at the Ocean Inlet Site and the Lagoon Segment Site occurred continuously from October 2007 through March 2008.	• Measured TSS concentrations were compared against Basin Plan water quality objectives.

Table 1-2. Monitoring Program Work Plan Key Questions, Elements, and Project Outcomes

Key Questions to be Answered	Project Element(s) that Addressed these Questions	Project Outcomes
8) What are the physical factors that control lagoon hydrodynamics and sediment transport?	• Water quality monitoring of turbidity and TSS in addition to post-storm sediment sampling and continual water quality data were used to calibrate and validate the model.	• Post-storm sediment sampling assessed how one storm impacts sediment bulk characteristics.
9) What is the total annual load reduction of sediment needed so that sedimentation is reduced to meet water quality, physical, and biological habitat objectives?	• This question will be answered through the development of the model.	• Model results will be provided to the stakeholders.

1.3 Lagoon/Watershed Maintenance and Restoration Activities

The LPLF, the City of San Diego, State Parks, and Friends of Los Peñasquitos Canyon Preserve have been responsible for numerous maintenance and restoration activities within the watershed and Lagoon. Some of the activities related to habitat restoration and sediment removal are discussed below.

El Cuervo and El Cuervo Norte Projects – City of San Diego

The City of San Diego has been active in restoration activities within the watershed that have been designed to reestablish native vegetation. The City of San Diego implemented several projects within Los Peñasquitos Canyon Preserve. These projects were funded by the City of San Diego in response to mitigation requirements for the City's construction of State Route 56 that connects I-5 with I-15. In Spring and Summer 2001, the City of San Diego implemented the El Cuervo Project which was designed to restore native vegetation in the project area. In 2005, the City of San Diego implemented the El Cuervo Norte Project that created nine acres of wetland and restored 14.3 acres of degraded wetland habitat. The El Cuervo Norte Project diverts flows from a channelized portion of Los Peñasquitos Creek into a constructed system of braided stream channels (Dudek, 2003). While it was designed to restore wetland habitat, an indirect benefit of this project is that it helped to reduce downstream sedimentation rates by reducing stream velocities and allowing sediment to settle within a natural basin located in the western portion of the project area (Figure 1-1).

Los Peñasquitos Restoration Basin – Los Peñasquitos Lagoon Foundation

The LPLF, in conjunction with the State Coastal Conservancy, the City of San Diego, State Parks, and the San Diego RWQCB, has worked toward the creation of a restoration project designed to abate sediment input from Los Peñasquitos Creek. Funded through State and Coastal Conservancy grants in 2002, the LPLF proceeded to re-characterize the hydrology and sediment transport of the three main tributaries that empty into Los Peñasquitos Lagoon with the goal of creating sediment management alternatives for each tributary (Kimley-Horn, 2003). In 2004, a site was selected along a stretch of Los Peñasquitos Creek for a sediment basin with a capacity of 10,000 cubic yards (cy) designed to intercept sediment flows during two-year to five-year storm events. Funding from the State and Coastal Conservancy grants was allocated to LPLF in 2006 for basin construction. A long-term maintenance agreement with the City of San Diego was approved by City Council in July 2008, and basin construction will commence in late September 2008. Construction will conclude December 2008 with the basin becoming operational by Winter 2009.

Lagoon Extension Weir System – Torrey Point Road – State Parks

Several weirs were constructed in the late 1970s by State Parks to address accelerated storm water runoff from a storm drain located along the northern boundary of the Lagoon at Torrey Point Road. The lack of maintenance at this site has resulted in erosion near the storm drain outfall and along the foundations of the weirs. Additionally, the substandard design and performance of this BMP does not achieve the intended goal of slowing storm runoff velocities and results in scouring of sediment below the outfall area. Recent site inspections and surveys by State Park staff and qualified engineers have led to the consideration of an alternative that would remove the weirs and replace them with native vegetation and an energy dissipater.

Sorrento Creek Channel Maintenance Project – City of San Diego

The City of San Diego conducts a sediment maintenance program at the confluence of Los Peñasquitos and Carroll/Sorrento creeks (Sorrento Creek Channel Maintenance Project, Figure 1-1). This program is designed to remove vegetation and sediment from the creek beds to prevent backflows during storm events and reduce vulnerability to flooding for nearby buildings located in Pacific Sorrento Business Park. The initial efforts consisting of vegetation and sediment removal are believed to have occurred in 1998 and 2001, but are not well documented. Efforts to determine dates and volumes of dredge material removed by the City of San Diego Streets Division were unsuccessful. The most recent sediment removal effort occurred in September 2003. The September 2003 effort removed an estimated 26,928 cy of sediment from four areas: Carroll Creek (576 cy), Los Peñasquitos (6,960 cy), Sorrento Creek Desilting Basin (8,748 cy), and Sorrento Creek Confluence (10,644 cy) (San Diego, City of, 2003; Dudek, 2004). Recent efforts have focused on vegetation removal between September and October 2004 when it was determined that sediment removal would not be needed. Furthermore, the City of San Diego modified its sediment removal methods in 2005 to reduce impacts to surrounding habitat caused by the maintenance project. Before 2005, the City of San Diego created in-channel access routes for equipment (i.e., a long-reach excavator and 10–20 trucks) using 20,000 cy of fill (San Diego, City of, 2005). The revised method proposed by the City of San Diego would no longer use the in-channel access route and instead would involve the use of a hydraulic dredge floating on a barge. The City of San Diego has not implemented this revised method but is in the process of permit application and has near term future plans for implementing the project (Ibid).

Los Peñasquitos Lagoon EEMP – Flintkote Sediment Basin and Energy Dissipator

The Flintkote Basin and Energy Dissipator Project was initiated in 1998 by State Parks and the City of San Diego and was partially funded through a Caltrans Environmental Enhancement Mitigation Program (EEMP). The project was designed to address both storm runoff and sediment flows from the canyon located behind and above the old superintendent home located along Flintkote Road on the southeastern edge of Los Peñasquitos Lagoon. Development along the canyon rim in the 1990s created impervious surfaces and manmade drainage systems that resulted in increased storm water runoff into the canyon that scoured natural drainage areas and generated large sediment flows into the Lagoon area below the canyon walls. State Parks and the City of San Diego worked together to design and implement an energy dissipater and a separate sediment basin to mitigate these impacts. Both structures were located below the canyon walls and along the affected drainage areas to intercept storm water and sediment before it could reach the Lagoon. The pre-construction stage (e.g., site reconnaissance and basin design) of the project was initiated in Spring 2005. The project was completed in 2006 and is functioning according to design and expectations (State Park pers. comm., 2007).

Los Peñasquitos Lagoon Ocean Inlet Maintenance

Since 1985, the LPLF has conducted mechanized lagoon mouth openings at the ocean inlet (Figure 1-1) in response to degraded water quality within lagoon channels during extended mouth closures. The frequency of these openings depends on several factors, including long-shore sediment transport, wave activity, rainfall, and water quality conditions set by the project's Coastal Development Permit. However, monitoring of the mouth openings since the 1960s have shown that LPLF must open the mouth mechanically at least one time per year and as often as three times (LeGrange, 1985; Coppock et al., 1985; Boland, 1993; Wells, 2000; Coastal Environments, 2002; Coastal Environments, 2003a; Coastal Environments, 2003b; Coastal Environments, 2003c; Coastal Environments, 2004; Coastal Environments, 2005; Coastal Environments, 2006; Coastal Environments, 2007; Coastal Environments, 2008a; Coastal Environments, 2008b; Hastings, 2007). Using heavy equipment (e.g., excavators, front loaders, and dump trucks), mouth openings range from breaches of the lagoon mouth to large-scale excavations. Breaches occur during the winter months in response to extended mouth closures that result in degraded Lagoon water quality below conditions set by the project's Coastal Development Permit. Small-scale openings of this style are typically completed within one day and remove approximately 2,000–3,000 cy of sediment to reestablish tidal mixing. This type of opening is considered more cost effective than the larger emergency opening during the winter months when the North Pacific storm track is active, and the potential for large storm driven waves still persists, making the lagoon mouth vulnerable to repeated closings. Larger emergency openings tend to occur in the late spring and are designed to ensure that the lagoon mouth remains open during the summer months when water quality is more vulnerable to degradation due to increased surface temperatures. Studies of the lagoon mouth maintenance program have found that the lagoon mouth is less vulnerable to closures during summer months since long-shore transport and wave activity have less impact to the inlet when compared to winter months (Boland, 1993). Late spring emergency openings take approximately five to eight days of excavation and remove approximately 12,000–30,000 cy of sediment from the mouth area. Spoils for both types of openings consist of approximately 92–95% sand which is placed on the beach approximately 300 yards south of the inlet and along the median high tide mark (Coastal Environments, 2008b; Hastings, 2007).

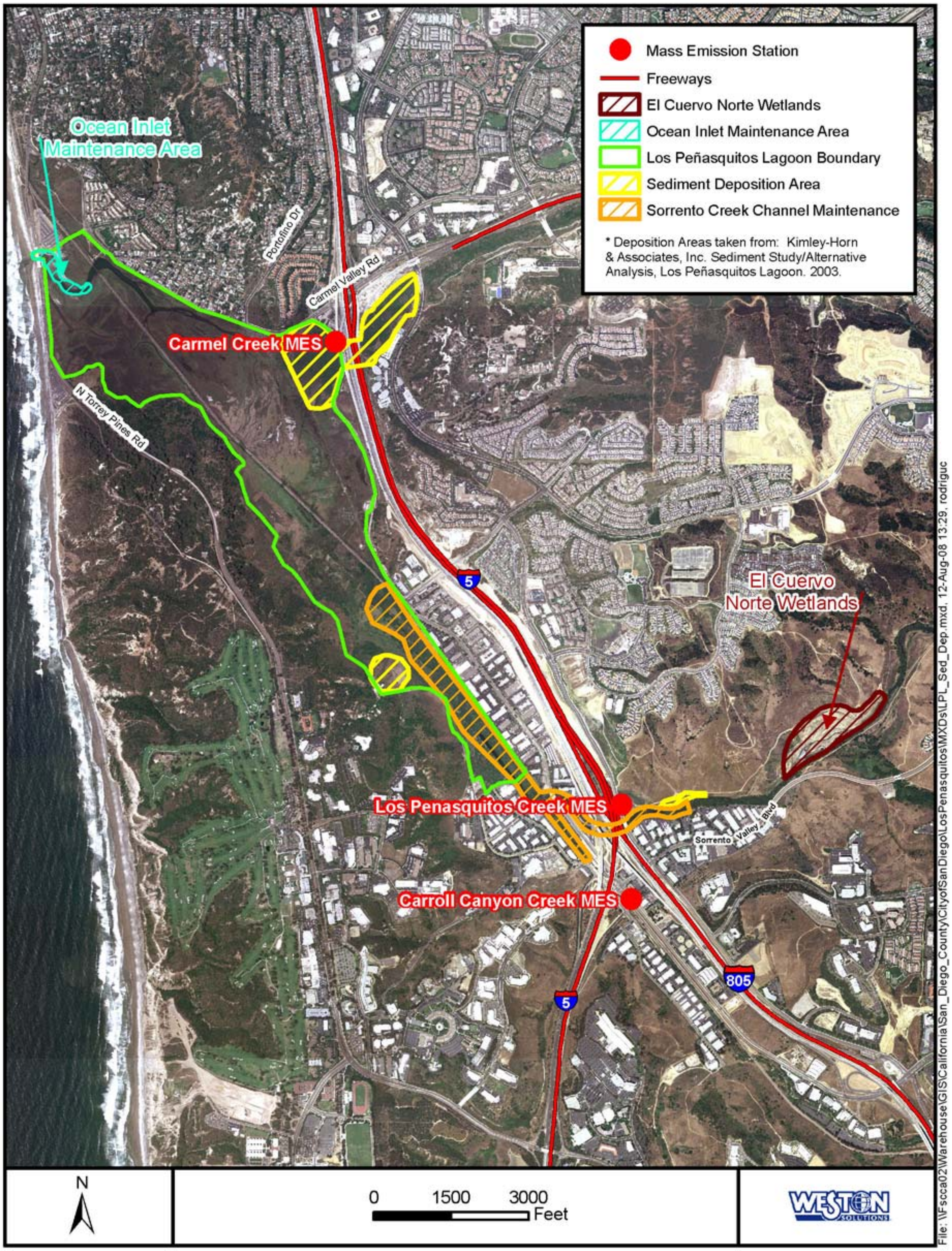

Figure 1-1. Map of Existing Maintenance, Restoration, and Documented Sediment Deposition Areas

2.0 WATERSHED DESCRIPTION

The Los Peñasquitos Watershed is located within west–central San Diego County and includes portions of the cities of San Diego, Poway, and Del Mar and unincorporated areas of San Diego County (Figure 2-1). The area extends from the foothills east of the City of Poway to the coastal plain where the watershed drains into Los Peñasquitos Lagoon before flowing into the Pacific Ocean through a narrow mouth at Torrey Pines State Beach. The watershed is approximately 95 square miles in size (60,419 acres) and encompasses the drainage areas of Los Peñasquitos Creek, Carmel Creek (north of Los Peñasquitos Creek), and Carroll Canyon Creek (south of Los Peñasquitos Creek).

2.1 Creek Drainage Areas

The San Diego Basin Plan divides the watershed into two hydrologic areas (HAs): Miramar Reservoir (HA 906.10) and Poway (HA 906.20). The Miramar Reservoir HA comprises the western portion and contains the drainage areas of Carmel Creek and Carroll Creek as well as the lower portion of Los Peñasquitos Creek. The Poway HA, located to the east, is covered entirely by the upper Los Peñasquitos Creek Watershed (Figure 2-2). The drainage areas for each major creek are shown in Table 2-1.

Table 2-1. Creek Drainage Area Acreages

Drainage Area	Hydrologic Area	Acres
Carmel Creek	906.10	11,180
Los Peñasquitos	906.10 and 906.20	37,028
Carroll Canyon Creek	906.10	11,004

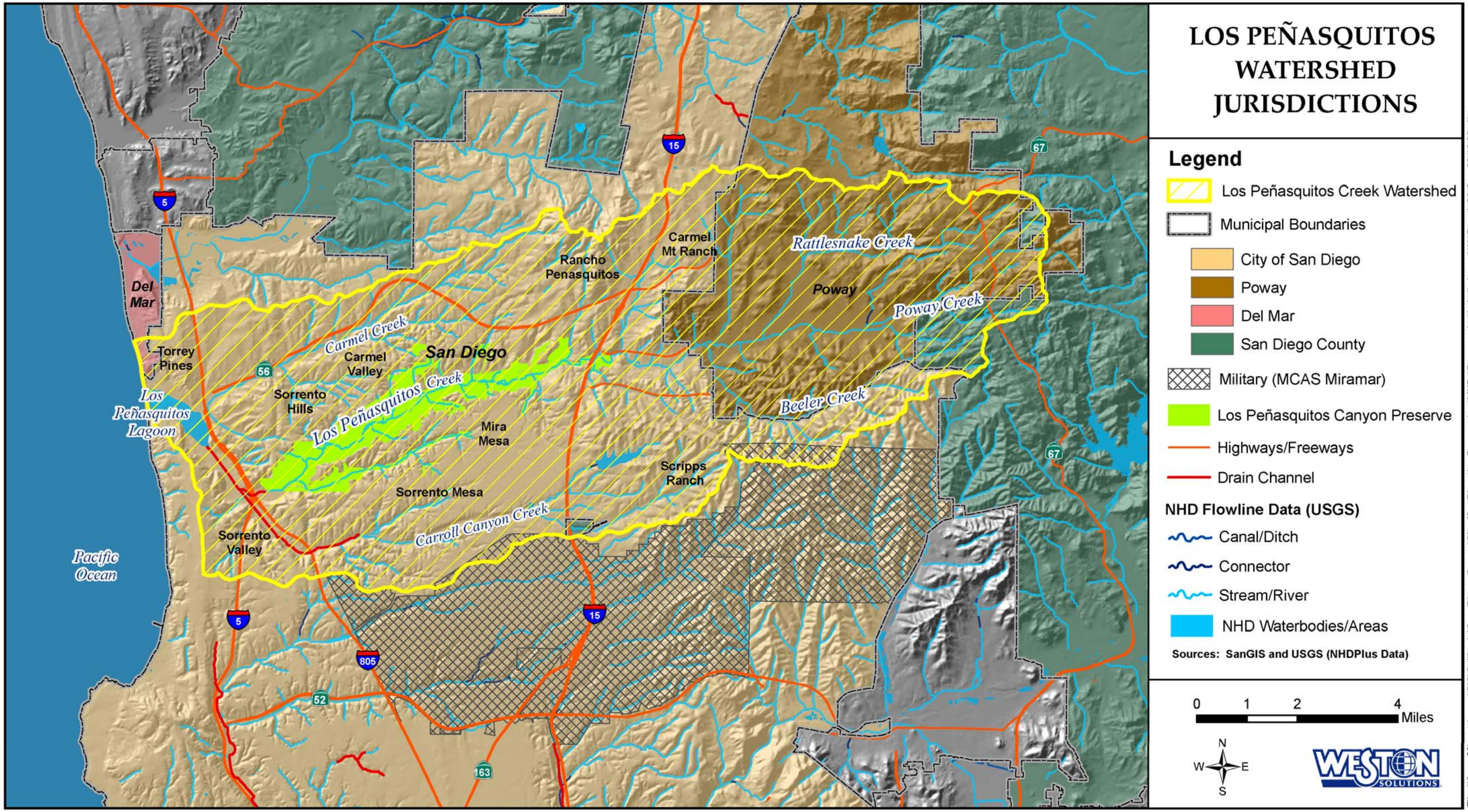

Figure 2-1. Los Peñasquitos Watershed Location and Jurisdictions

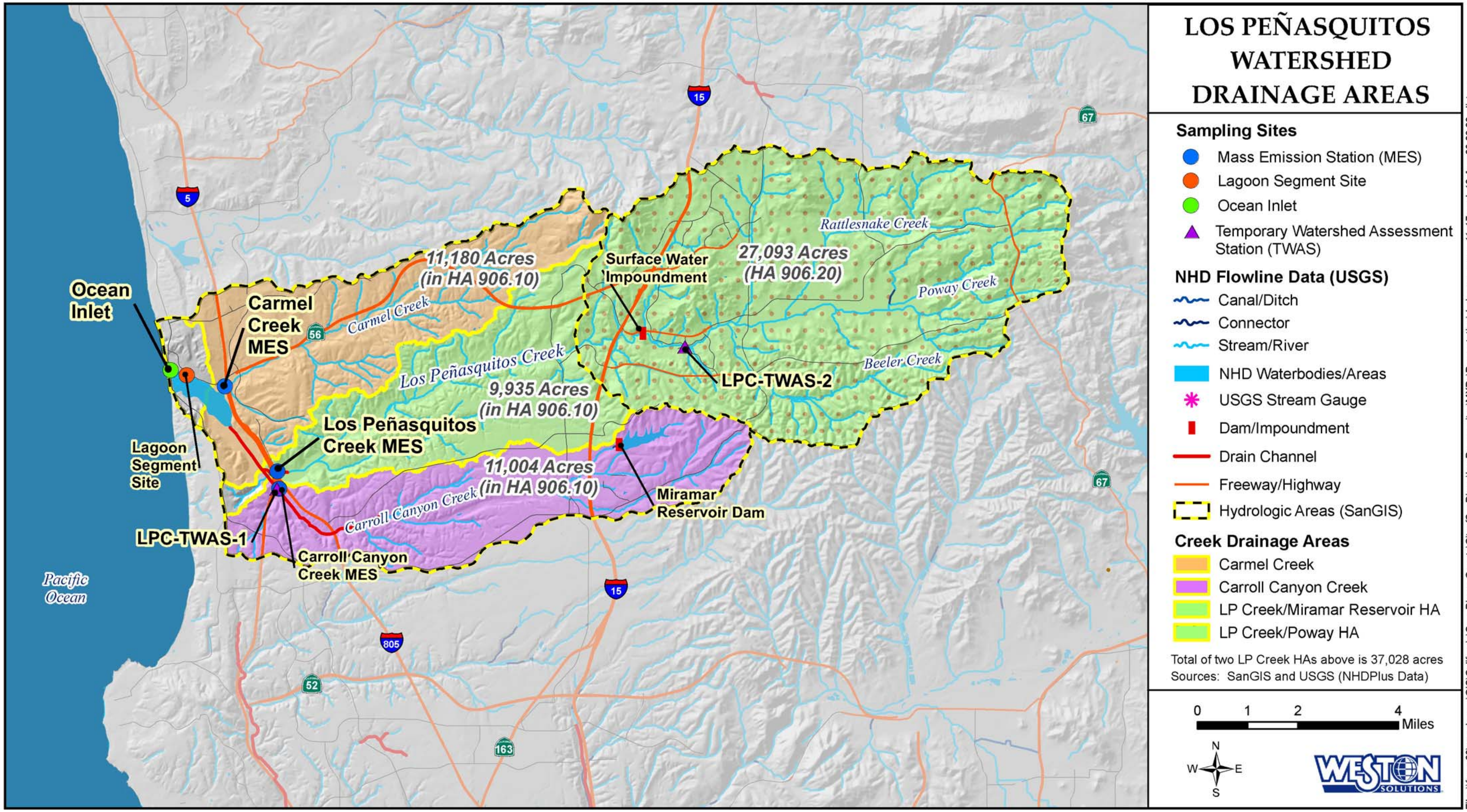

Figure 2-2. Creek Drainage Areas in Los Peñasquitos Watershed

The three creek drainage areas flow to Los Peñasquitos Lagoon. Carmel Creek flows directly into the northeast portion of the Lagoon, while Carroll Creek and Los Peñasquitos Creek merge and enter the southern portion of the Lagoon via a maintained channel. Carroll Canyon Creek is channelized from approximately 3 miles east of I-5 at Carroll Road. West of I-5, the channel flows approximately 2 miles north before joining the channelized portion of Los Peñasquitos Creek which commences approximately 0.25 mile east of the I-805 and I-5 merge. A northeastern tributary of Carroll Creek originates at Miramar Reservoir, the other major surface water body in the watershed. The Los Peñasquitos Creek also contains a surface water impoundment approximately 0.75 miles east of I-15 and within the Poway HA (Figure 2-3). The surface water impoundment is a constructed dam approximately 8-ft high by 90-ft wide. Dense vegetation occurs on the pond's northern, southern, and eastern boundaries. Verbal communications with City of San Diego Park and Recreation staff indicates the dam was constructed in the 1950s by a local cattle rancher to provide ponded water for livestock.

Figure 2-3. Los Peñasquitos Creek Surface Water Impoundment East of I-15

2.2 Topography and Soils

The topography of the watershed varies from sea level on the western boundary to greater than 2600 ft in the eastern foothills. The upper portion of the watershed is relatively steep with stream channels traversing deep, narrow valleys, except for the relatively flat Poway Valley (Figure 2-4). Soils in the Poway area are formed by the uplifted granitic rock of the Southern California Batholith, Santiago Peak volcanic deposits, and Eocene Poway conglomerates (USDA, 1973).

The western portion is characterized by a relatively flat-topped mesa divided by deep-cut canyons along the three major creeks with tributaries in smaller side canyons incised into the mesa. Drainage tends towards Los Peñasquitos Lagoon, which lies within a low area behind Torrey Ridge. The soils in this area are primarily thick marine and non-marine sedimentary deposits, underlain by Eocene sands, shales, and conglomerate of the Poway and La Jolla groups and overlain by thin layers of Quaternary marine terrace deposits of the Linda Vista Formation (Prestegaard, 1979). A notable outcropping of Santiago Peak volcanics appears in the central portion of the lower watershed. Most of the drainages and streambeds include highly erosive sandy to silty alluvium deposited over the surrounding substrate. Los Peñasquitos Lagoon and lower Los Peñasquitos Canyon were formed after rising sea levels inundated the deep-cut canyons, and marine and non-marine sediments were deposited, filling the lower sections (USDA, 1973).

The geology in the area of the Lagoon is described by the Torrey Pines Association (Torrey Pines Association Website, 2008, http://www.torreypine.org/geology/geology.html) and includes, from oldest to most recent, the Delmar Formation, the Torrey Sandstone, the Linda Vista Formation, and the Bay Point Formation. The Delmar Formation is mostly a greenish–yellow mudstone and siltstone and is somewhat resistant to erosion. Next is the Torrey Sandstone, mostly quartz with some feldspar, usually white but often stained light brown by iron oxide from the rocks above. The rock was deposited as a sandbar. The loose sand was cemented later by calcite from water flowing through the sand. The Linda Vista Formation is the hard red rock on top of the Torrey Sandstone. It resists erosion more than the Torrey Sandstone under it so it acts as a cap rock, protecting the softer rock beneath. The Bay Point Formation is made of poorly cemented, light brown sandstone and make up the scenic badland formations observed in the area. The Torrey Pines Association notes that erosion of these sediment formations is primarily a natural process that occurs as a function of rainfall, wind, and biological activities such as root prying and animal burrowing. However, manmade erosion as a result of over irrigation and other activities also occur.

Large portions of the Los Peñasquitos Watershed have moderately to highly erodible soils. Figure 2-5 displays the soil erodibility factor (K-factor) from the Soil Survey Geographic (SSURGO) Database (USDA, 2003) for soils in the watershed. The K-factor is one of five inputs to the Revised Universal Soil Loss Equation (RUSLE) and represents both the susceptibility of soil to erosion and the rate of runoff. Soils can have low K values (<0.2) because they resist detachment (e.g., clay soils) and/or due to low runoff (coarse textured soils). Medium textured soils, such as the silt loam soils, have moderate K values (approximately 0.25–0.4) because they are moderately susceptible to detachment, and they produce moderate runoff. Soils that have high silt content have the highest K-factors (> 0.4) as they easily detach, tend to crust, and produce high rates of runoff (Institute of Water Research, 2002).

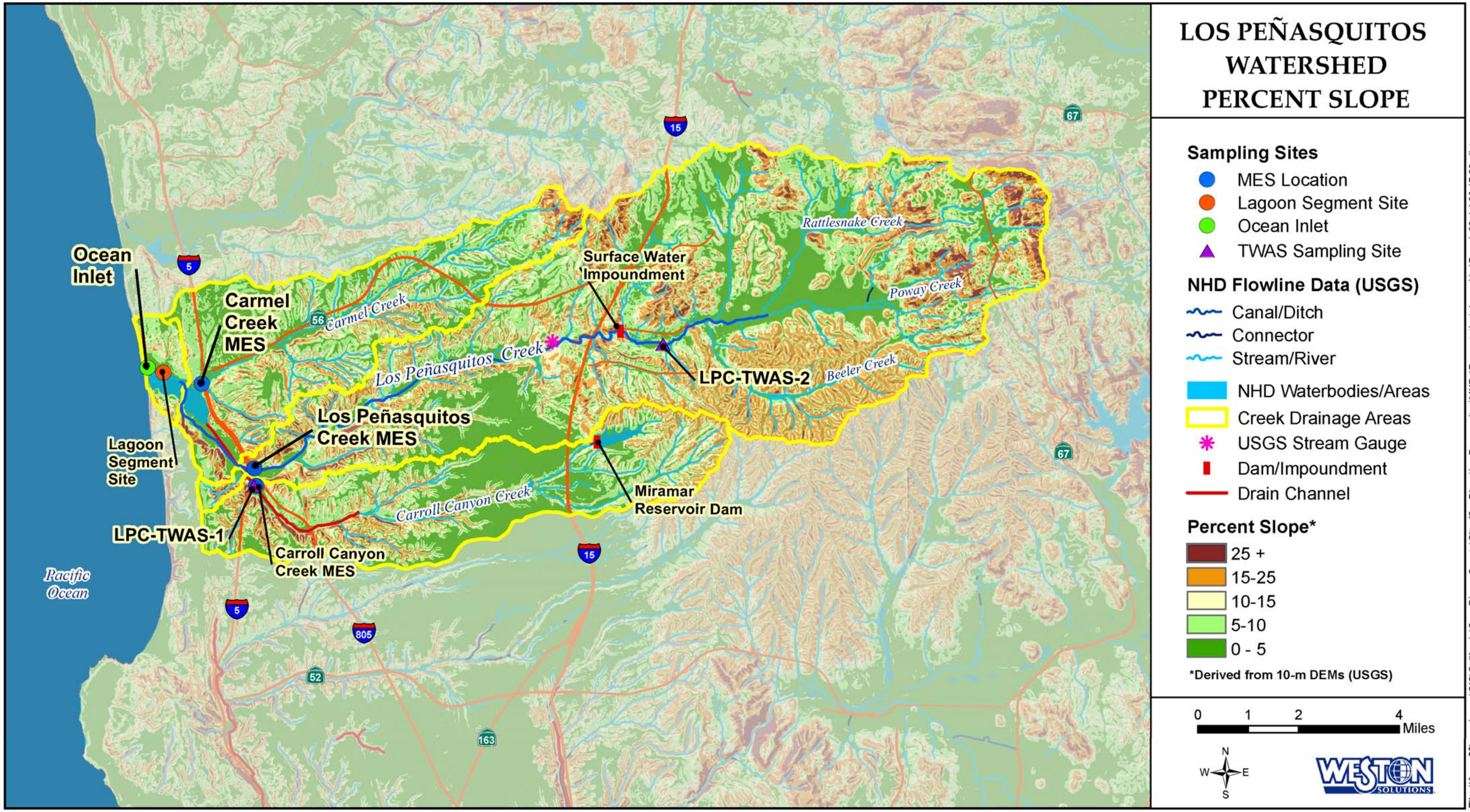

Figure 2-4. Steep Slopes in Los Peñasquitos Watershed

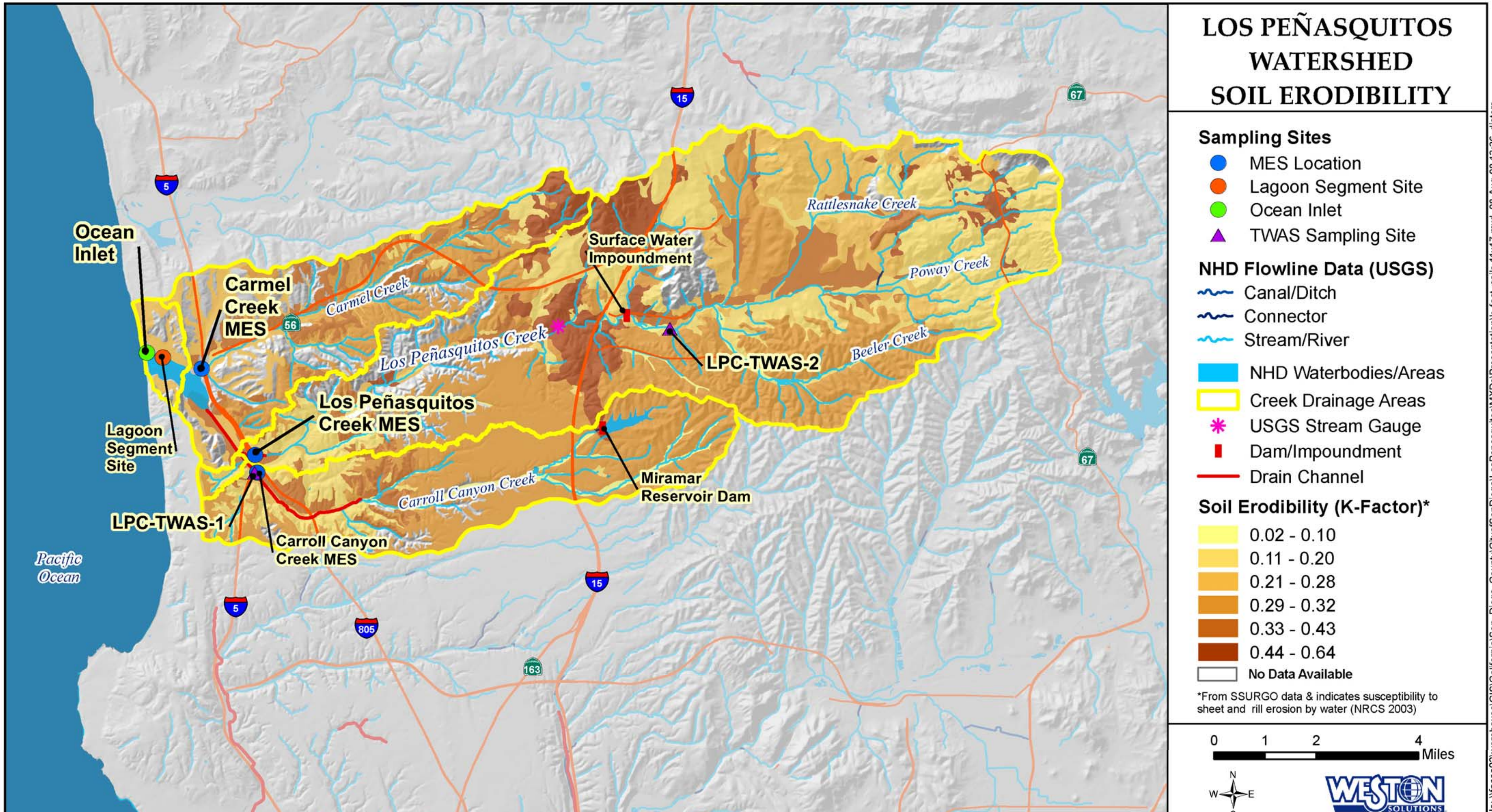

Figure 2-5. Soil Erodibility in the Los Peñasquitos Watershed

2.3 Land Use

The Los Peñasquitos Watershed is the fourth most populated watershed in San Diego County with an estimated population of more than 254,000 people (Weston, 2008). Urban development has altered the watershed's hydrology such that seasonal creeks have become perennial. This was first detected at Los Peñasquitos Lagoon in 1995 and continues to the present day (Williams, 1996; Williams, 1997; Williams et al., 1998; Williams et al., 1999; Ward et al., 2000; Ward et al., 2001; West and Cordery, 2002; West and Cordery, 2003; West and Cordery, 2004; Crooks et al., 2005; Crooks et al., 2007). Urban land uses in the watershed increased from 9 to 37% between the years 1966 and 2000 (White and Greer, 2005).

Based on the 2007 land use data distributed by SANDAG, the primary land uses within the Los Peñasquitos Watershed are open space park/preserve (29.5%), residential (26.7%, excludes spaced rural residential), vacant/undeveloped (15.2%), freeway (2.4%) and other roads and utilities (10.15%). Other groupings of land use classes within the watershed include agriculture, commercial recreation, industrial, public facility, water, and areas under construction (Figure 2-6). Of the total watershed area, the Los Peñasquitos Creek drainage area represents approximately 61% and is representative of the major land use proportions in the overall watershed. However, there are several notable differences in land use composition among the three creek drainage areas and between the two HAs that comprise the watershed as shown on Figure 2-6 and in Table 2-2.

The upper portion of the Los Peñasquitos Creek drainage area within the Poway HA (902.20) has the highest percentages of vacant land (25.7%) and rural residential use (9.6%) based on land use analysis by creek and HA. Conversely, the lower portion of the Los Peñasquitos Creek drainage area which lies within the Miramar Reservoir HA (906.10) has less than 3% vacant land and no rural residential use. This lower creek area has the highest percentage of residential development (31.6%) but also the largest proportion of park/open space (44.5%), largely due to the Los Peñasquitos Canyon Preserve (Table 2-2). Among the three creek drainages (i.e., Los Peñasquitos Creek, Carmel Creek, and Carroll Canyon Creek), the most significant difference is shown in the distribution of industrial and commercial land use which is considerably higher in the Carroll Canyon Creek drainage area. Industrial (24.9%) and commercial (6.3%) land uses comprise approximately 31% of this drainage area as compared to a total of less than 6% in each of the other two creek drainage areas (Figure 2-6).

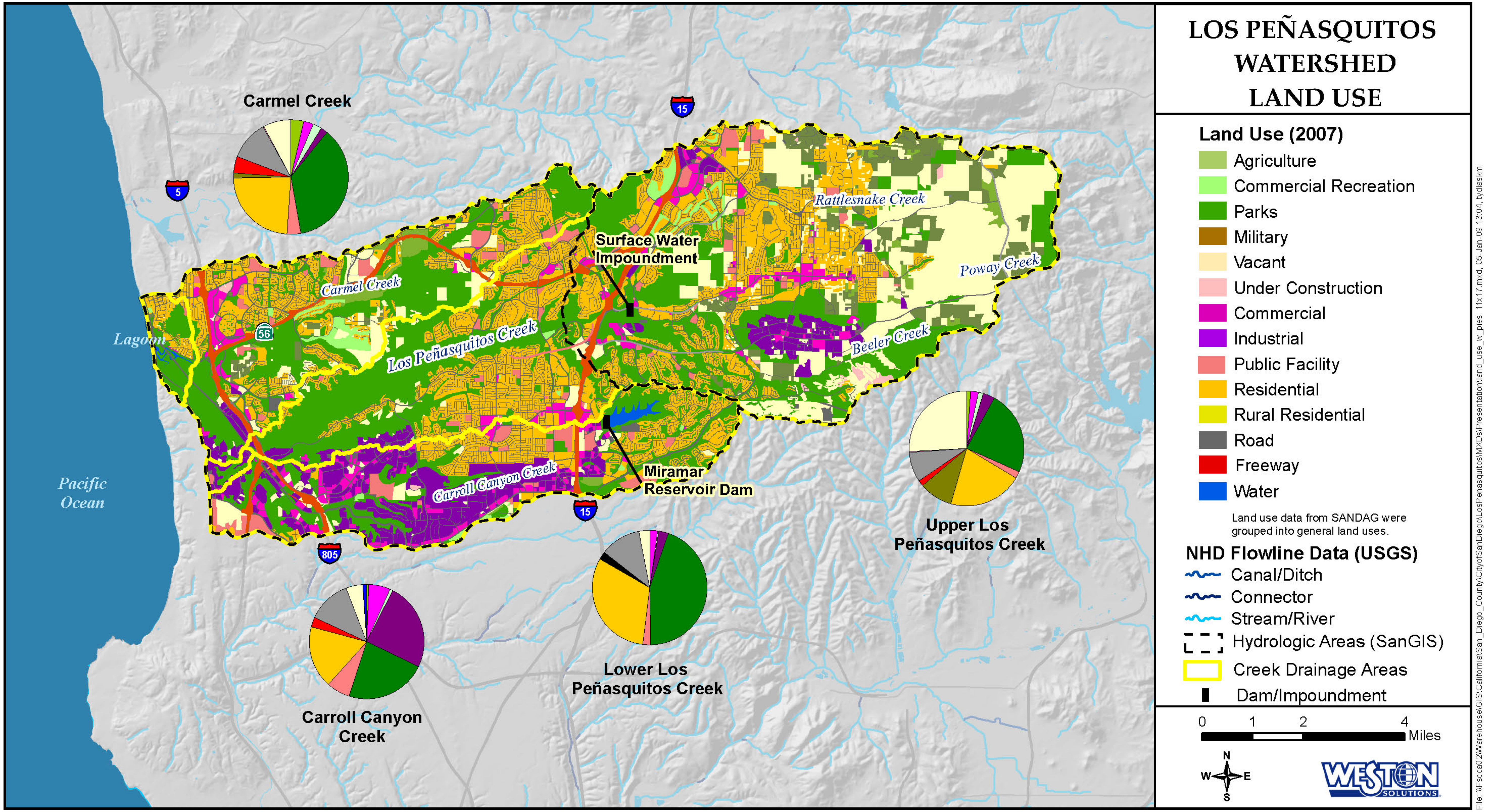

Figure 2-6. Land Use in Los Peñasquitos Watershed

Table 2-2. Land Use Percentages by Drainage Area

Land Use Class	Percent (%) of Drainage Area				
	Los Peñasquitos Creek Poway HA	Los Peñasquitos Creek Miramar Reservoir HA	Los Peñasquitos Creek Total	Carroll Canyon Creek	Carmel Creek
Agriculture	1.1	0	0.8	0.4	3.7
Commercial	2.4	2.2	2.3	6.3	2.8
Commercial recreation	1.2	0.3	0.9	0.7	2.5
Industrial	3.4	2.7	3.2	24.9	2.0
Parks	23.6	44.5	29.2	22.7	36.2
Public facility	2.0	2.1	2.1	6.6	4.1
Residential	20.8	31.6	23.7	17.6	23.4
Rural residential	9.6	0.0	7.0	0.0	1.4
Freeway	1.46	2.2	1.66	2.72	4.69
Other Roads and Utilities	8.29	11.48	9.15	12.18	11.15
Under construction	0.5	0.0	0.4	0.1	0.2
Vacant	25.7	2.9	19.6	4.6	7.9
Water	0.0	0.0	0.0	1.2	0.0
Total (%)	100	100	100	100	100

The land use variation among drainage areas translates into differences in impervious cover that influence storm water runoff, dry weather flows, erosion, and sediment transport. Using an estimate of percent impervious cover for each land use class in Table 2-2, the upper portion of the Los Peñasquitos Creek drainage area has an estimated impervious cover of approximately 29%. The lower portion of the Los Peñasquitos Creek drainage area has 37% impervious surface, while the Carmel Creek drainage area has 36% impervious cover. The Carroll Canyon Creek drainage area has the highest estimated impervious cover at 54%, largely due to the higher percentage of industrial and commercial land use located in this watershed.

3.0 METHODS AND INSTRUMENTATION

The focus of the monitoring program was to address data needs with regard to current watershed loading and water quality models in accordance with the approved QAPP (Weston, 2007). Water quality parameters within Los Peñasquitos Lagoon were measured over the course of six months to provide calibration and validation data for the models that will be used for this specific lagoon. Several types of monitoring and sampling techniques were used to assess and characterize the Lagoon. These included continuous monitoring of hydrodynamic and water quality parameters, wet weather monitoring conducted throughout storm events at targeted site locations within the Lagoon, bathymetric surveying conducted periodically throughout the year at the lagoon mouth, and sediment sampling and analyses conducted within two weeks after a monitored storm event.

3.1 Flow

Wet weather flow monitoring was conducted at the base of Los Peñasquitos Creek, Carroll Canyon Creek, and Carmel Valley Creek leading into the Lagoon (Figure 3-1 and Figure 3-2). Flow measurements were taken at each MES using a Sigma 950 or 920 flowmeter with area velocity meters and pressure transducers placed into the thalweg of each creek channel to obtain stream velocity and stage. Stage measurements were then used in Manning's Equation and were derived from physical measurements of the channel taken at each location prior to a given storm event. An estimated flow rate using the stage, slope, area, and roughness of the stream channel was then generated using Manning's Equation.

A cross-sectional survey of each MES sampling location was conducted prior to the wet weather season in order to compute creek discharge into the Lagoon using Manning's Equation. The cross-sectional survey involved performing a stream rating using survey equipment to accurately calculate the existing underwater bathymetry of the channel from which flow will be measured as well as the topography of the land surrounding the channel that may be flooded during a storm event. Approximately 20 measurements were taken at regular intervals across each stream channel. Data from field measurements were then entered into a computer model that calculated the stream's cross-sectional profile from the depth and distance-from-bank measurements. Total flow across the channel was determined by using this data to produce a discharge table based on stream stage and Manning's Equation. Area velocity measurements were used as a secondary assessment of flow. Results were recorded as instantaneous flow measurements in cubic feet per second (cfs).

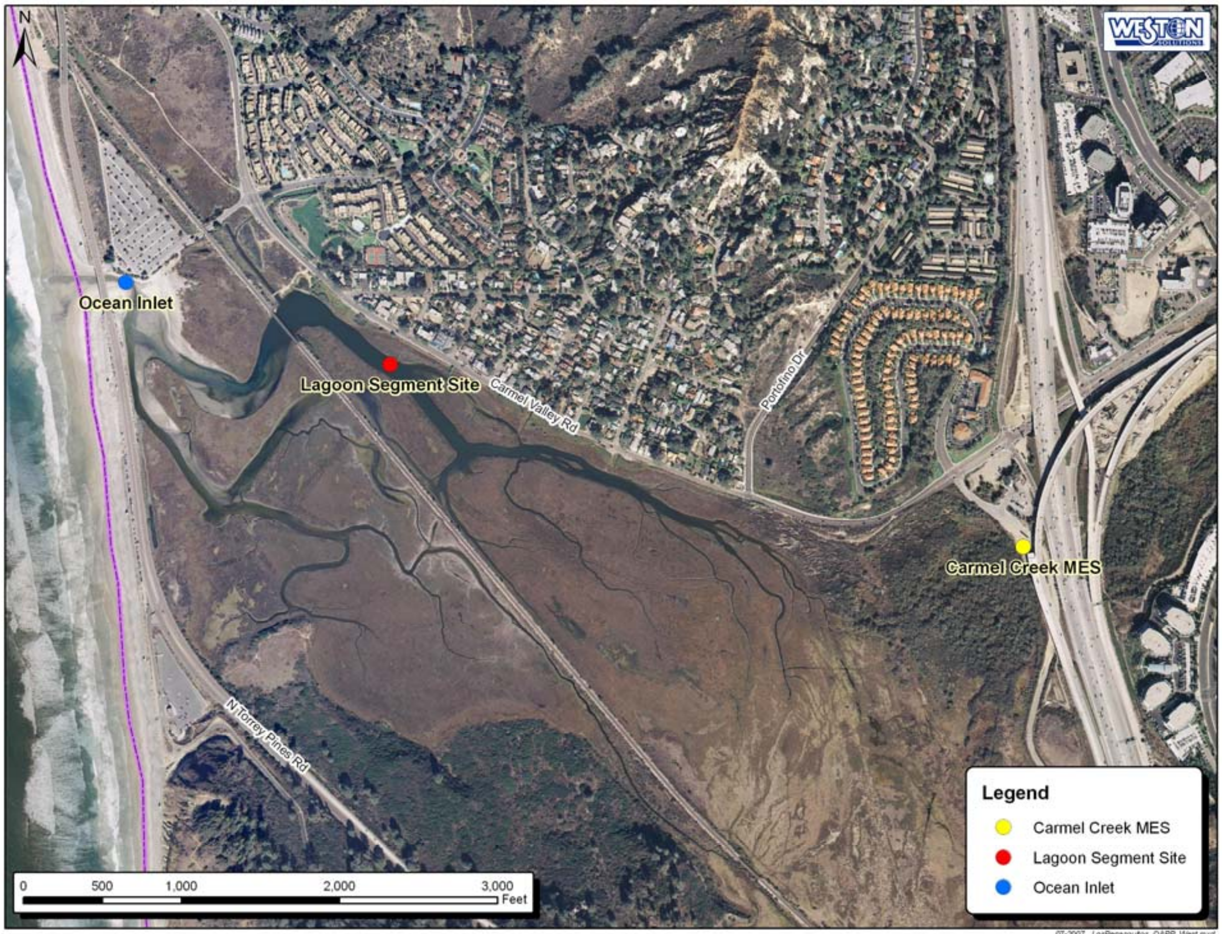

Figure 3-1. Map of Ocean Inlet, Lagoon Segment, and Carmel Valley Creek MES Sampling Locations

Figure 3-2. Map of Los Peñasquitos Creek and Carroll Canyon Creek MES Locations

3.2 Continuous Water Quality Monitoring – Data Sondes

Water quality data loggers (sondes) were installed at five locations for this project. The sondes were placed at the mouths of the three creeks leading into the Lagoon (Carmel Creek, Los Peñasquitos Creek, and Carroll Canyon Creek) above the upstream boundary of the estuary, within the main body of the Lagoon (off Via Borgia), and at the ocean inlet (just east of the North Torrey Pines Road Bridge) (Figure 3-1 and Figure 3-2). YSI 6920 Multiparameter Water Quality Sondes were deployed from mid-October 2007 through mid-April 2008 and were used to monitor water depth, temperature, turbidity, specific conductivity, pH, and DO. Monthly maintenance and calibration were performed to ensure that each of the water quality sondes was functioning properly. Sondes were housed in protective PVC sleeves that were anchored in place by stainless metal strapping attached to a hard substrate (Figure 3-3). At the Lagoon Segment Site, the PVC sleeve was attached to a steel rod that was hammered vertically into the soft sediment (Figure 3-4) and supported via three mushroom anchors for stability.

Figure 3-3. Data Sonde and Protective Sleeve

Figure 3-4. Vertically Anchored Lagoon Segment Sonde

The sondes were set up to log data at 15-minute intervals. Maintenance included removing biofouling organisms and algae, replacing batteries, and ensuring correct operation as per the operating manuals. Recorded sonde data were saved in the unit's internal memory until downloaded onto a portable laptop computer during monthly maintenance and calibration inspections. Water level was measured at the Lagoon Segment Site and the Ocean Inlet Site using water quality sondes, while water levels were measured at the MES using pressure transducers associated with the MES flow equipment.

3.3 Storm Event Sampling – Autosamplers

Water sampling was performed throughout storm events using Sigma SD 900 autosamplers. Pollutograph sampling, consisting of ten or more discrete samples collected over the rise and fall of the creek and lagoon hydrographs, was performed at each of the locations shown on Figure 3-1 and Figure 3-2. Prior to the arrival of a storm, autosamplers were placed at each of the five sampling sites located at the base of Carmel Creek, Los Peñasquitos Creek, Carroll Canyon Creek, at the Lagoon Segment Site (Figure 3-5), and at the Ocean Inlet Site (Figure 3-6). Autosamplers were checked periodically throughout the sampling period to ensure proper sample collection. In the event that an autosampler was not operating properly, samples were collected using a manual grab pole.

Figure 3-5. Autosampler Located at the Lagoon Segment

Figure 3-6. Autosampler Located at the Ocean Inlet

Autosampler pacing was adjusted to allow for an appropriate number of samples to be collected over the course of the storm event. Depending upon the site, ten or twelve water samples collected throughout the creek or lagoon hydrograph were typically analyzed for each storm event. In the event that more than ten samples were collected at an MES site or more than 12 samples were collected at the Lagoon sites for a given storm event, samples were selected to undergo chemical analysis based upon their time of collection relative to the creek's or lagoon's hydrograph. Water samples were collected in pre-cleaned, 1-L high-density polyethylene bottles. Ultimately, TSS results from storm event sampling will be used to calibrate the Lagoon water quality models with respect to the transport of TSS into and through Los Peñasquitos Lagoon during a storm event.

A total of three storms were sampled at each of the five sampling locations. Best efforts were made using pre-storm forecasts to sample storms with rainfall amounts between 0.2 to 1 inch or greater. Table 3-1 lists the constituents that were analyzed during storm sampling at the MES, Lagoon Segment, and Ocean Inlet sites. A composite sample, comprised of water collected throughout the storm from a single sample location, was analyzed for particle size. Particle size composite samples were analyzed for each of the five sample locations during the first and second storm events.

Table 3-1. Constituents Measured During Storm Events at Each Sampling Location

Analyte	Mass Emission Sites	Lagoon Segment	Ocean Inlet
Flow	●	–	–
TSS	●	●	●
% Sand/silt/clay for pollutograph composites	●	●	●

3.4 Analytical

Field measurements were recorded using YSI 6920 water quality sondes at each of the five sampling sites (Carmel Creek, Los Peñasquitos Creek, Carroll Canyon Creek, Lagoon Segment, and Ocean Inlet). The sondes were programmed to log water quality parameters of temperature, conductivity, turbidity, pH, and water depth in 15-minute intervals. Data that were collected and stored on the sondes were downloaded monthly onto laptop computers during scheduled maintenance activities. The analytical methods that were used to measure field parameters are detailed in Table 3-2.

Table 3-2. Field Analytical Methods

Analyte	Target Reporting Limits	Analytical Method		Achievable Laboratory Limits	
		Analytical Method/SOP	Modified for Method Yes/No	MDLs	Method
Temperature	0.1ºC	Calibrated and measured following YSI manufacturer instructions for 6920 V2 model	No	–	0.01ºC
Conductivity	0.0025 mS/cm		No	–	0.001–0.1 mS/cm (range-dependent)
Turbidity	0.5 NTU		No	–	0.1 NTU
Water level	–		No	–	0.001 m

Water samples were collected in appropriate pre-cleaned containers supplied by the analytical laboratory. Each sample container was affixed with a label with the station ID, sample code, matrix type, analysis type, project ID, and date and time of collection. Water samples were collected via autosamplers and grab sample poles.

The analytical methods used for chemical analyses (Table 3-3) provided the lowest method detection limits practical. TSS and grain size analyses were performed by CRG Marine Laboratories, Inc. (CRG) and Core Laboratories, respectively.

Table 3-3. Laboratory Analytical Methods

Analyte	Target Reporting Limits	Analytical Method		Achievable Laboratory Limits	
		Analytical Method/SOP	Modified for Method Yes/No	Method Detection Limit	Laboratory Reporting Limit
TSS	0.5 mg/L	SM 2540D	No	0.1 mg/L	0.2 mg/L
Grain size (% sand, silt, and clay)	1%	ASTM D-422 (1963) EPA (1995) or Plumb (1981)	No	–	–

3.4.1 Quality Assurance

Flow Analysis

Field measurements or sample collections were made using autosamplers or grab sample devices from a safe location near the water's edge. In no instances did personnel enter the water during a storm event. Field measurements for conductivity, temperature, water level, and turbidity were made using YSI data sondes in accordance with the manufacturer's specifications. Calibration was performed on a monthly basis, or more frequently, if conditions warranted. Proper storage and maintenance procedures were followed. Measured sonde values were compared to standard reference materials (SRMs), and corrections were made to account for any drift.

American Sigma flowmeters with pressure transducers were installed to measure velocity and stage height of the water at each MES location. Flow sensors and autosampler intake hoses were installed on the bottom of each creek's channel, in the center of the channel. Similarly, sondes were installed near the center of each creek's channel whenever possible. Due to debris flow in Carroll Canyon Creek during the first storm event, the autosampler intake hose was relocated downstream along the western side of the channel at Carroll Canyon Creek. At the Lagoon Segment Site, the sonde was installed in the center of the lagoon at the confluence of two channels, while at the Ocean Inlet Site, the sonde was located in the deepest part of the channel along the northern bank.

Using the data collected by the flowmeters, pollutograph sample intervals were set to collect samples approximately every 30 to 60 minutes for a total of 24 discreet samples collected over the course of 12 to 24 hours. The automated sampler collected grab samples via a peristaltic pumping mechanism. Water samples were pumped through a Teflon intake device and Teflon tubing into 1-L bottles. Bottles were kept on ice during the storm event and placed into coolers with COCs for transfer to the analytical laboratories. Field crews ensured that the sampling bottles were filled properly to their 1-L capacity during sampling events. A field log was completed at each site for each storm event. The field data log sheets included empirical observations of the site and water quality characteristics.

Chemistry Analyses

The quality assurance / quality check (QA/QC) for sampling processes begins with proper collection of the samples in order to minimize the possibility of contamination. Water samples were collected in laboratory-certified, contaminant-free bottles. The chemistry analysis of the samples was performed under the guidelines of the QA/QC programs established by CRG. These guidelines include laboratory duplicates and comparison to laboratory blanks.

The ongoing evaluation of relative precision and accuracy performance was accomplished by the generation of control charts. Control limits were generated utilizing the mean and standard deviation of the data set. Upper and lower "warning" limits were twice the standard deviation from the mean of the set of results for accuracy charts and twice the standard deviation from the origin for precision charts. Upper and lower "out-of-control" limits were three times the standard deviation from the mean for accuracy charts and three times the standard deviation from the origin for precision charts. When relative precision or accuracy results suggested atypical performance, an investigation into the problem was initiated. If a sample result was outside the out-of-control limits, the sample was reanalyzed. If samples could not be reanalyzed, the result was flagged with an appropriate descriptive qualifier.

CRG reported the relative standard deviation (RSD) and the relative percent difference (RPD) for QA/QC analyses that were performed. The RSD is a measure of the reproducibility of an analysis. This was determined by dividing the standard deviation (of a sample rather than the population) by the mean for the same set and then multiplying by 100%. Duplicate samples were collected during storm events at the peak of runoff and analyzed for TSS for the purpose of calculating the RSD and RPD. Results of laboratory QA/QC analyses are summarized in Appendix C.

3.5 Post-Storm Sediment Sampling – Ekman Dredge

The collection and analysis of post-storm event sediment samples was performed in order to calibrate the lagoon sediment transport and water quality models, specifically with respect to the impact of a storm event on the spatial characteristics of lagoon sediments. Post-storm event sampling occurred within two weeks after the third storm event monitored at the MES, Lagoon Segment, and Ocean Inlet sites. The third monitoring event of the program was recommended by RWQCB staff and SCCWRP during a post-fire storm meeting held at the City of Encinitas on December 6, 2007. A total of 26 sites were sampled throughout the Lagoon (Figure 3-7). These sites focused on habitats not previously sampled in recent studies. Due to accessibility constraints and concerns regarding the disturbance of listed bird species residing within the Lagoon, Site 16 was not sampled, and Site 17 was relocated from its pre-plotted, original location.

Figure 3-7. Post-Storm Sediment Sampling Locations in Los Peñasquitos Lagoon – February 11, 2008

Sediment sample collection began on February 11, 2008, within two weeks of the monitored storm event of February 3, 2008. Sediment samples were collected using an Ekman dredge deployed from a kayak and consisted of surface grab samples, no more than 2 cm deep.

An Ekman dredge (Figure 3-8) is a light-weight sampling apparatus recommended for collecting samples from a variety of semi-soft substrates, such as silt, silt mixed with clay, and silt mixed with sand (USEPA, 2001). This allows for effective sample collection in various environments, including lakes, rivers, estuaries, and lagoons. WESTON's Ekman dredge collects 3.5 liters of sediment and has two doors on top that allow for access to visually inspect the grab sample and remove undisturbed surface sediment.

Figure 3-8. Sediment Sampling with an Ekman Dredge

To prevent cross contamination of samples, reusable sediment sampling equipment was scrubbed and rinsed with site water prior to sampling each station.

The following criteria were used to determine a sample's acceptability:

- The sampler was not overfilled with material to the point that the sediment surface is pressing against the top of the sampler or is extruded through the top of the sampler.
- Overlying water was present, indicating minimal leakage.
- The overlying water was not excessively turbid, indicating minimal disturbance.
- The sediment was relatively undisturbed with no sign of channeling or sample washout.
- The desired penetration depth was achieved.
- There was no sign of sediment loss or penetration at an angle.

If a sample failed to meet the above criteria, it was rejected and discarded away from the sampling station. Consecutive sampling attempts were located as close as was reasonably possible to the initial sampling location.

Penetration depth was determined by measuring the distance from the top of the sampler to the sediment interface using a clean stainless steel ruler and subtracting this distance from the inside depth of the sampler. If the sample was uneven but the sediment surface was intact, an average of the measurements from opposite sides of the sampler was used in determining the penetration depth. A logbook containing field data sheets was used to record the time, date, station coordinates, tide, water depth, sample depth, field crew, sample description, overlying water description, and other observations. Sample characteristics that were recorded include:

- Sediment type (e.g., silt and sand).
- Texture (e.g., fine-grain, coarse, and poorly sorted sand).
- Color.
- Presence of shells.
- Percentage of organic debris.

- Stratification (if any).
- Presence of a sheen.
- Odor.
- Presence of biological structures (e.g., worm tubes and/or shrimp molts).
- Percentage of water in sample.

After the sample had been characterized, the top 2 cm of sediment were removed using a 2-cm deep, stainless-steel scoop and placed into a Ziplock™ bag. Unrepresentative material, such as large sticks, shells, or trash, were carefully removed and discarded. After the surface sediment was placed into a labeled Ziplock™ bag, the bag was placed into a cooler and stored on ice with a completed chain-of-custody form until they could be transported to the analytical laboratory. Grain size analyses were performed within the method recommended six-month holding time.

3.6 Surveying

Periodic land-based elevation surveys were conducted at the mouth of Los Peñasquitos Lagoon during the monitoring season (October 2007 through April 2008) to document changes in channel morphology. A total of four surveys were conducted by a licensed California land surveyor (O'Day Consultants, Inc.). These surveys were conducted in such a way that a cross section of the land elevations at the ocean inlet could be determined. For each survey, a sufficient number of points were shot along the cross-section of the ocean inlet using a staff rod and a land-based transit to characterize the width, depth, and shape of the inlet and its banks (Figure 3-9). The cross-sectional survey was conducted at the location along the length of the inlet where the bottom of the inlet reached its highest elevation. Survey reports and elevation maps were then produced for each of the four surveys.

Figure 3-9. Performance of a Cross Sectional Survey at the Ocean Inlet

In addition to the four lagoon mouth surveys, a single comprehensive survey was performed in March 2008 to accurately measure the bathymetry throughout the entire Lagoon. Several elevation benchmarks along the northern portion of the Lagoon were used as horizontal control points for the transit during this survey. During the survey, one surveyor remained on land to operate the transit while a second surveyor carrying a staff rod was ferried by kayak to points located throughout the Lagoon. A minimum of three elevations (left bank, right bank, and center channel) were shot across the channel at each of the pre-determined survey locations, except in instances where the survey points were already in close proximity to one another, such as was the case at the lagoon mouth (Figure 3-10). In total, over 300 elevations were shot, providing an accurate survey of the channel bathymetry within Los Peñasquitos Lagoon. Survey data is provided in Appendix E.

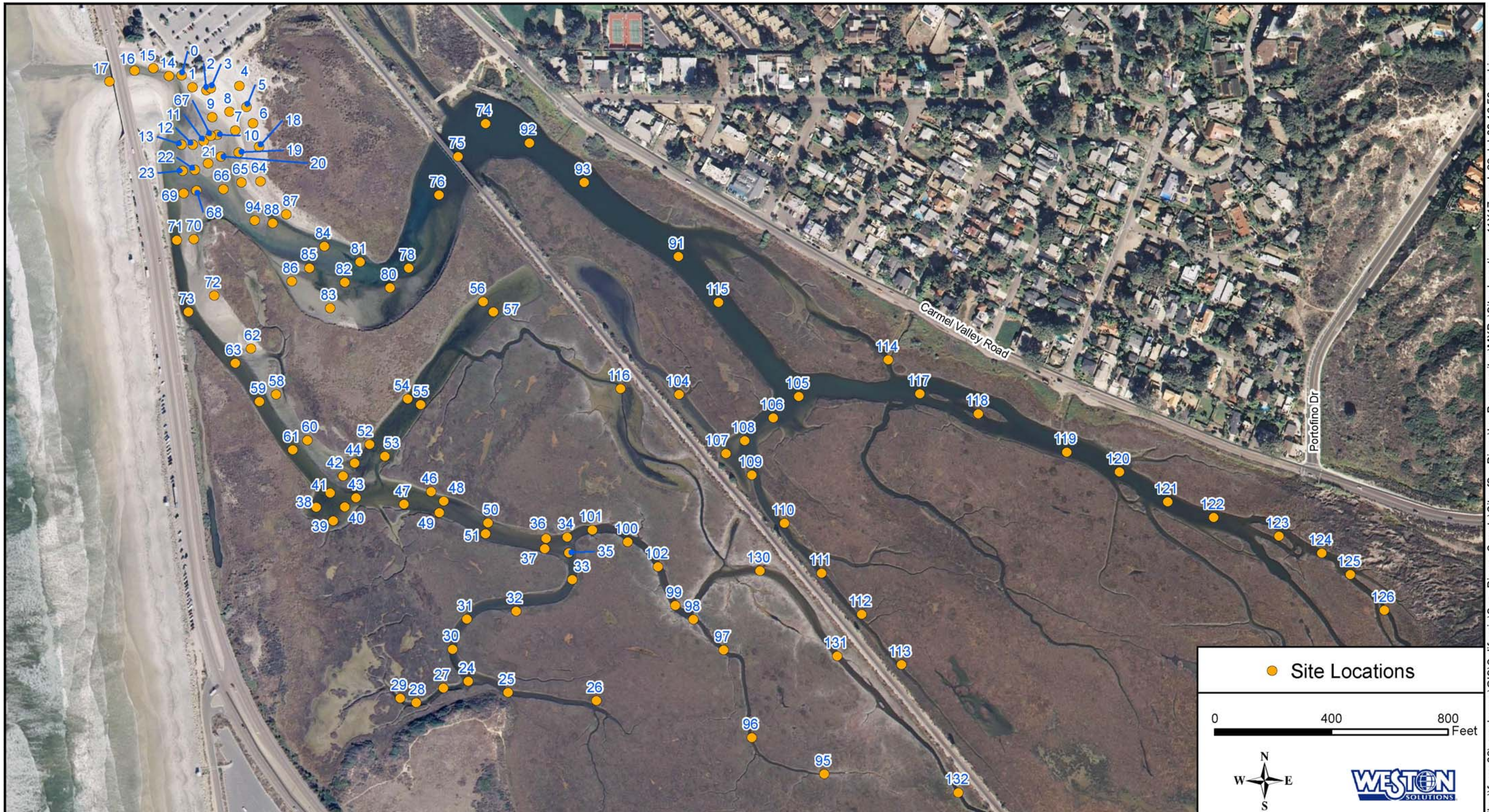

Figure 3-10. Bathymetric Survey Points Conducted in Los Peñasquitos Lagoon – March 2008

4.0 MONITORING RESULTS SUMMARY

Results from storm event monitoring and continuous monitoring during the 2007–2008 wet weather season (October 1, 2007 through April 30, 2008) are presented in this section.

4.1 Rainfall, Flow, and Analytical Results

4.1.1 Rainfall Summary

Three storm events were monitored for the Los Peñasquitos Lagoon TMDL Monitoring Study between October 14, 2007 and March 31, 2008. Results of the monitored rainfall events from the Los Peñasquitos MES, which are representative of the three drainage areas, are summarized in Table 4-1. Each of the monitored storms met the Order criteria of 0.20 inch of rainfall or greater. During the 2007–2008 storm season, there were several unmonitored storm events that fit the monitoring criteria. Rainfall events were most frequent during January and February, while March and April were dry. Two of the three events coincided with monitoring that occurred for the County of San Diego Regional Monitoring Program.

Table 4-1. Los Peñasquitos Mass Emission Station Rainfall Summary

Date of Storm Event	Number of Previous Dry Days	Duration of Storm (hours)	Rainfall (inches)	Average Intensity of the Storm (inches/hour)
November 30, 2007	220	19	3.05	0.16
December 7, 2007	8	6	0.56	0.09
February 3, 2008	7	11	0.54	0.05

4.1.2 Annual Hydrographs

Flow rates were continually measured at the base of each of the creeks feeding into Los Peñasquitos Lagoon during the wet weather season and during monitored storm events for the purpose of estimating constituent loading resulting from storm water runoff. Flow rates are a function of the channel and the hydraulic head or level of the water flowing through the channel. Characteristics such as channel slope, channel composition (whether the channel is natural or concrete), and channel vegetation play a role in how fast the water will travel during a given point in time (time of concentration). Of the three monitoring sites in which flows were measured, the Carroll Canyon Creek sampling site is located in a concrete lined channel. Los Peñasquitos Creek and Carmel Creek sampling sites are located in naturally lined channels with considerable amounts of vegetation in the stream channel. Annual hydrographs depicting flow and monitored storm events for each MES are shown on Figure 4-1 through Figure 4-3. Individual storm hydrographs are shown in Section 4.2, Water Quality Results, as “pollutographs” which illustrate the concentration of TSS as a function rainfall and flow rates.

The highest peak flow at Carmel Creek was less than the highest peak flow at the other two sites during the three storms. As rain falls, there is an initial localized response in flow as shown as the first peak, followed by an additional watershed response as shown in the second (same size or smaller) peak. Following the end of the rainfall event, flow slowly decreases back to base flow, often several days later. During the first storm, a similar dual peaked flow hydrograph was observed as a result of the rain pattern. During the first storm, peak flow rates were measured at 196 cfs. Peak flows during the second and third storms were less than 60 cfs.

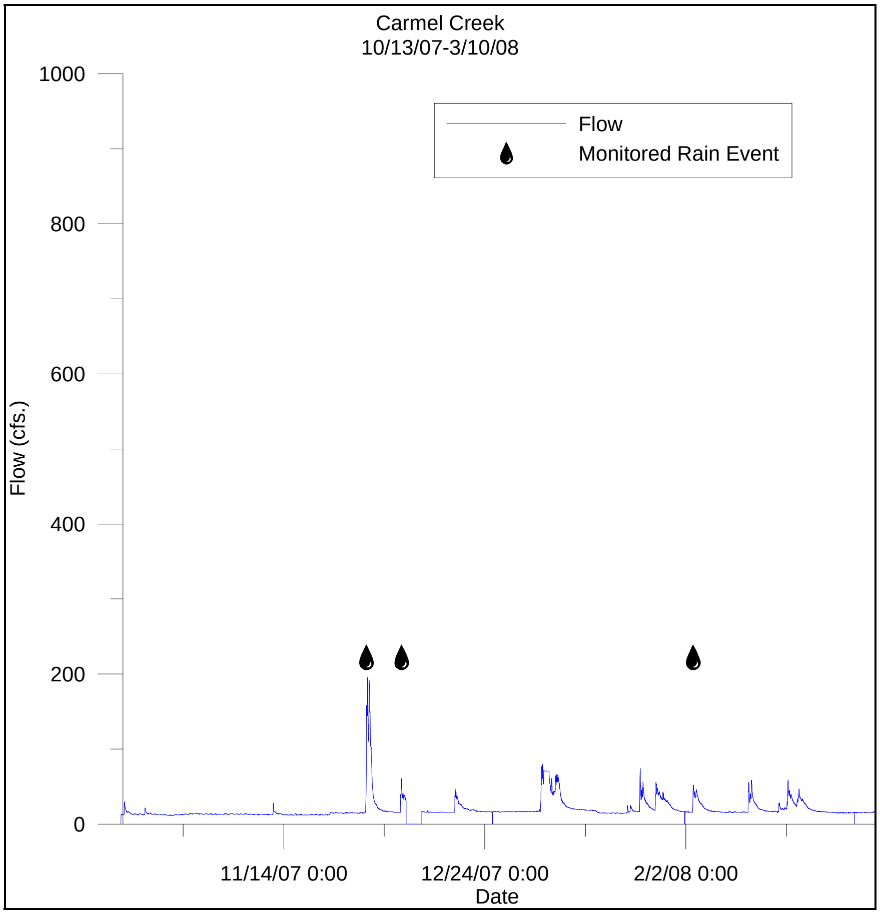

Figure 4-1. Carmel Creek Annual Flow Hydrograph

Los Peñasquitos Creek is bound by dense vegetation and a dam upstream of the sampling location which may restrict the flow. A delay in Los Peñasquitos Creek's response to rainfall is seen during each of the monitored storm events when compared against hydrographs from the other two sites (Figure 4-1, Figure 4-2, and Figure 4-3). Structural impediments downstream of the sampling location in the form of bridge abutments and vegetation may also serve to impede flow and trap sediment prior to flow reaching the Lagoon. A surface water impoundment located east of I-15 and a recent re-vegetation and restoration project, as previously mentioned in Section 1, serve to reduce flow from the eastern watershed. The average base flow at the start of the monitoring season was measured at 2.06 cfs. The flow remained below 5.0 cfs with the exception of a few small peaks from unmonitored storms during the months of September and

October 2007. During the first monitored storm event on November 30, 2007 (3.05 inches), the peak flow was measured at 833 cfs as a second band of rain fell over the watershed. Flow rates during subsequent storms were much lower during the second and third monitored storm events, 140 cfs and 211 cfs, respectively. The flows gradually returned to base flow within 24 hours following the last two storms.

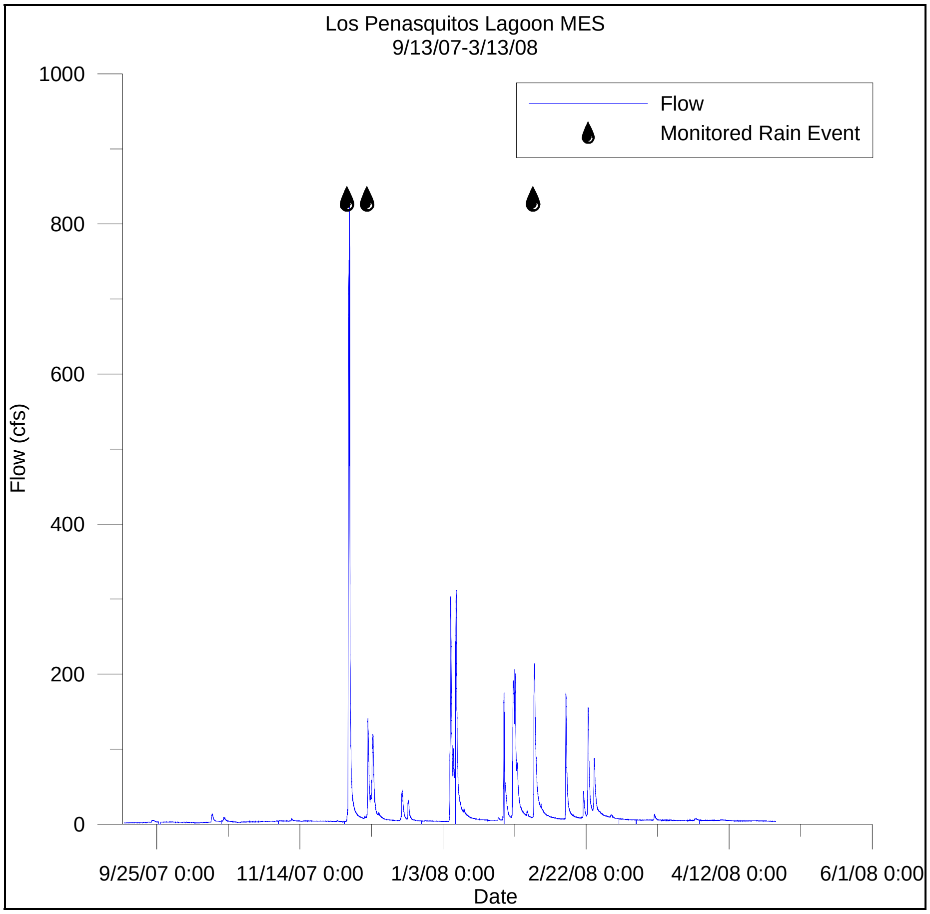

Figure 4-2. Los Peñasquitos Creek Annual Flow Hydrograph

Flow rates in Carroll Canyon Creek respond relatively quickly to rainfall events. Water flows through a concrete channel that is mostly devoid of vegetation. The average base flow measured for the month of September 2007 was 0.06 cfs. This site yielded high peak flows during the three monitored storms in comparison to the other two monitored creek sites. During the first and largest monitored storm event (November 30, 2007, 3.05 inches of rain), two peaks were measured at 996 cfs and 990 cfs, respectively. The second storm (December 7, 2007, 0.56 inch of rain) produced a peak flow of 502 cfs while the third storm (February 3, 2008, 0.54 inch of rain), produced a peak flow of 309 cfs. Flow in Carroll Canyon Creek during Storm Event 3 was short in duration, with flows increasing shortly after rainfall began and then decreasing within hours of the termination of rainfall. The combination of steep slopes and the relatively high percentage of impervious surfaces within the Carroll Canyon Creek subwatershed is conducive to producing peak flows that have greater magnitudes and shorter durations than either Carmel

Creek or Los Peñasquitos Creek, which contain lower percentages of impervious surfaces and more gradual slopes.

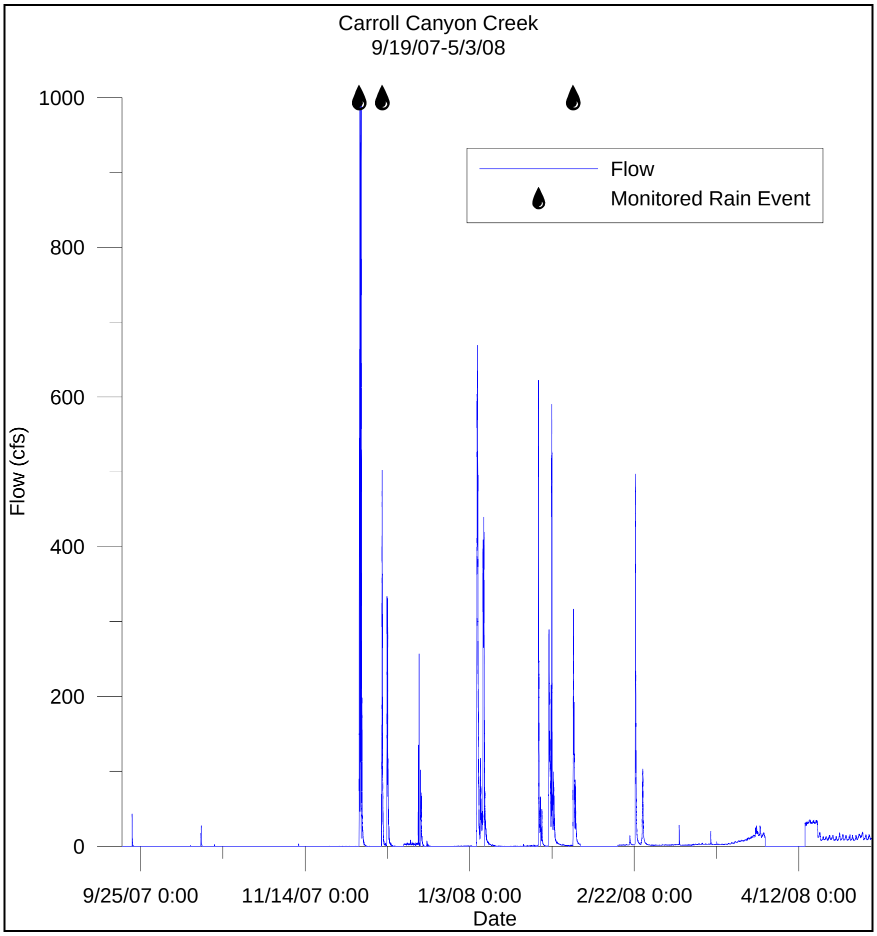

Figure 4-3. Carroll Canyon Creek Annual Flow Hydrograph

4.2 Water Quality Results

This section summarizes the results of the 2007–2008 monitoring of Los Peñasquitos Lagoon and the three creeks that feed into the Lagoon.

4.2.1 2007–2008 Monitoring Season Flow and TSS Results

TSS concentrations were measured at five locations during the 2007–2008 wet weather season over the course of three storm events. Event hydrographs for each monitored event for each site are shown as pollutographs with their respective TSS sample concentrations (Figure 4-4 and Figure 4-5) and are also provided in tabular form in Appendix B. For the purpose of comparison with existing benchmarks, the results are compared to the Copermittee wet weather TSS benchmark of 100 mg/L. A summary of the percentage of exceedance for each site during monitored storm events is shown on Figure 4-6 and Figure 4-7.

Storm Event 1 – November 30–December 1, 2007
Among the three creek sites, TSS concentrations were higher at Carroll Canyon Creek than at either Los Peñasquitos Creek or Carmel Creek. TSS concentrations ranged from 60 mg/L to 760 mg/L at Carroll Canyon Creek, while the range at Los Peñasquitos Creek was 23 mg/L to 170 mg/L, and the range at Carmel Creek was 14 mg/L to 180 mg/L (Figure 4-4). Average TSS values at each creek site were 418 mg/L at Carroll Canyon Creek, 54 mg/L at Carmel Creek, and 70 mg/L at Los Peñasquitos Creek.

TSS concentrations at the Lagoon Segment Site ranged from 18 mg/L to 109 mg/L and averaged 39 mg/L during the first storm event. As a result of high winds knocking over the autosampler midway through the storm, measured TSS concentrations represented only the latter portion (last 10 hours) of the storm event's hydrograph. Storm Event 1 at the Ocean Inlet Site was characterized by a significant amount of variability in TSS concentration. TSS ranged from 11 mg/L to 751 mg/L and was likely heavily influenced by tidal and wave action in the mouth of the inlet.

Storm Event 2 – December 7–8, 2007
TSS concentrations among the three creek sites were significantly lower during Storm Event 2 than during Storm Event 1. Although TSS concentrations were lower for this storm event, a similar pattern to that seen in Storm Event 1 was evident. During Storm Event 2, TSS concentrations ranged from 29 mg/L to 558 mg/L at Carroll Canyon Creek, while the range at Los Peñasquitos Creek was not detected (reporting limit of 5 mg/L) to 26 mg/L, and the range at Carmel Creek was 8.5 mg/L to 38 mg/L. Average TSS values were significantly higher at Carroll Canyon Creek (270 mg/L) than at either Carmel Creek (17 mg/L) or Los Peñasquitos Creek (12 mg/L) (Figure 4-4).

TSS concentrations at the Lagoon Segment Site varied little, ranging from 11 mg/L to 29 mg/L (average of 17 mg/L) during the second storm event. In contrast, TSS concentrations at the Ocean Inlet Site were characterized by significant variability, ranging from 5.3 mg/L to 697 mg/L and was again likely influenced heavily by tidal and wave action.

Storm Event 3 – February 3–4, 2008
During Storm Event 3, TSS concentrations among the three creek sites were considerably lower than during either Storm Event 1 or Storm Event 2. Again, Carroll Canyon Creek had the highest TSS concentrations of the creek sites, ranging from below the detection limit at the onset of the storm to 241 mg/L during the storm's peak flow. Of the creek sites, only Carroll Canyon had TSS concentrations that were above the water quality benchmark.

TSS concentrations at the Lagoon Segment Site ranged from 15.3 mg/L to 124 mg/L (average of 40.7 mg/L) during the second storm event, while at the Ocean Inlet Site, TSS ranged from 5.5 mg/L to 30.0 mg/L.

TSS Results Summary
Carroll Canyon TSS results showed that 9 of 10 samples (90%) collected during the first storm event were above the TSS water quality benchmark, while 10 of 12 samples (83%), and 7 of 12 samples (58%) collected from the second and third storms, respectively, were above the benchmark (Figure 4-7). An increase in TSS concentration at Carroll Canyon Creek was well

correlated with peak flow during Storm Event 1 and Storm Event 3 (Figure 4-4). For Storm Event 1 and Storm Event 3, the TSS concentration at Carroll Canyon Creek generally increased as flow increased and decreased as flow decreased. During Storm Event 2, however, a spike in TSS concentration appeared to correspond with a spike in rainfall, preceding the increase in flow. TSS concentrations then declined as rainfall tapered off despite the brief increased in flow.

At Los Peñasquitos Creek, only two of 34 samples (6 %) collected over the three storm events were above the water quality benchmark of 100 mg/L TSS. During the Storm Event 1, 20% of samples were above the water quality benchmark for TSS, while during the second and third monitored storm events, no samples were above the benchmark (Figure 4-7). Increases in TSS concentrations during storm events 1 and 2 at Los Peñasquitos Creek preceded increases in flow (Figure 4-4). In these two events, peak TSS concentrations occurred approximately four hours prior to peak flow; during peak flow, TSS concentrations were approximately 25% and 64% of peak levels for storm events 1 and 2, respectively.

Similar to Los Peñasquitos Creek, TSS results at Carmel Creek were below the benchmark during the three storm events with the exception of one sample collected during Storm Event 1. A total of 32 out of 34 samples had TSS concentrations below the water quality benchmark of 100 mg/L. It should be mentioned that flow at Carmel Creek was significantly lower than at either Los Peñasquitos Creek or Carroll Canyon Creek during the three monitored storm events (Figure 4-4). In each of the storm events, increased TSS concentrations preceded increased flows.

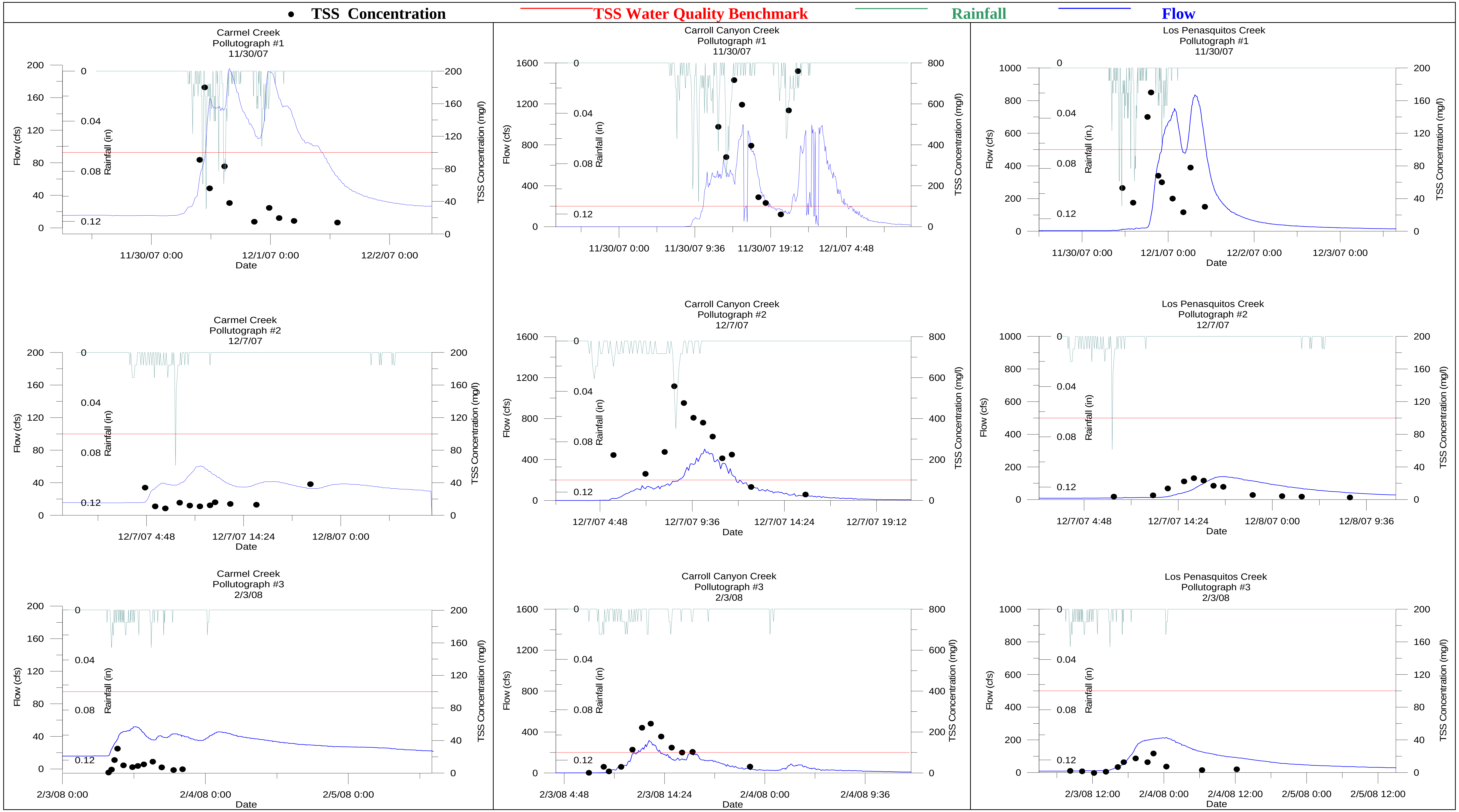

Figure 4-4. Summary of Flow, Rainfall, Sample Times, and TSS Concentration at Creek Sites during Three Monitored Storm Events

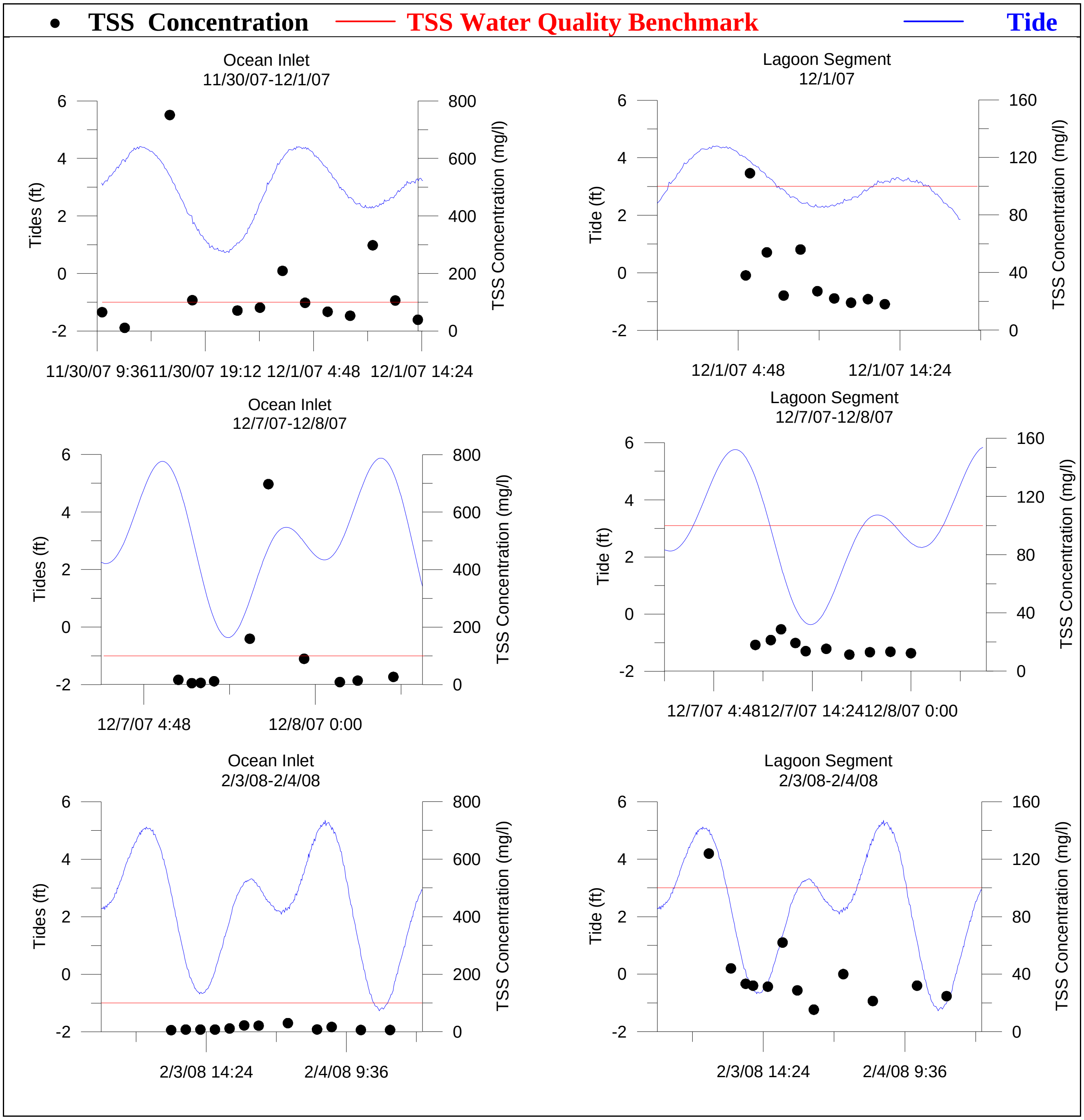

Figure 4-5. Summary of Sample Times, TSS Concentrations, and Tides at the Lagoon Segment and Ocean Inlet Sites during Three Monitored Storm Events

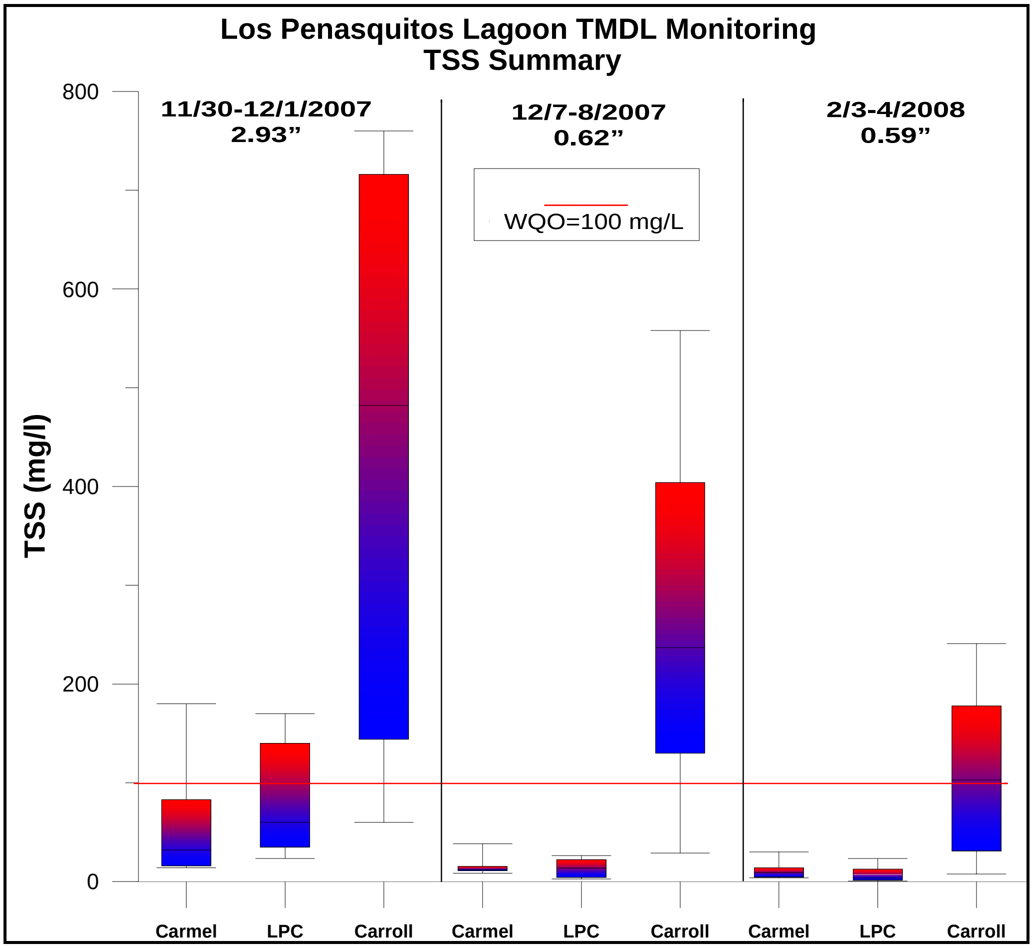

Figure 4-6. Box and Whisker Plot of Creek TSS Concentrations across Three Monitored Storm Events

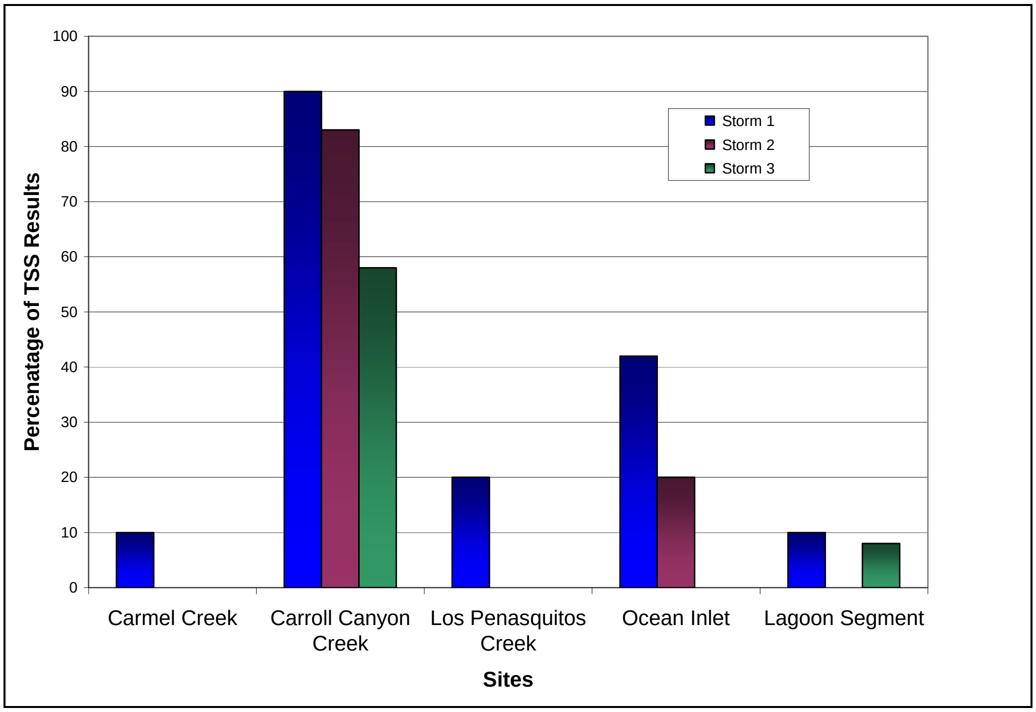

Figure 4-7. Percentage of TSS Results above Water Quality Benchmark Value of 100 mg/L

The Ocean Inlet and the Lagoon Segment sites are located in close proximity to the Pacific Ocean and are tidally influenced. Forty-two percent of samples collected at the Ocean Inlet Site, and 10% of samples collected at the Lagoon Segment Site were above the wet weather water quality benchmark for TSS during the first storm event (Figure 4-7). No correlation between elevated TSS values and rising or falling tides was observed at either site (Figure 4-5). Of the samples collected during Storm Event 2, two samples were detected above the water quality benchmark for TSS at the Ocean Inlet Site, while no samples were detected above the water quality benchmark (100 mg/L) at the Lagoon Segment Site. The samples which exceeded the water quality benchmark for TSS were both collected on the rising tide. During Storm Event 3, 0% of Ocean Inlet Site samples and 8% of Lagoon Segment Site sample (one sample) were measured above the water quality benchmark for TSS.

4.3 Grain Size Analysis of TSS

Grain size analysis of composite water samples from each site was performed on water collected during Storm Event 1, while only creek site composites were analyzed for Storm Event 2. Pollutograph samples collected over the course of a given storm event were flow-weight composited into a single water sample for analysis of particle size. A summary of results from particle size analyses is contained in Table 4-2. Complete particle size analyses are provided in Appendix B.

In Storm Event 1, sediment contained in water collected from creek sites was predominantly fine-grained material, consisting of approximately 70% silt and 15–20% clay. The three creek sites and the Lagoon Segment Site each contained approximately the same proportion of suspended sand, silt, and clay in their water. In contrast, the Ocean Inlet Site sample contained a much higher percentage of coarse-grained materials (41% sand) and a significantly lower percentage of fine-grained materials (48% silt and 11% clay) than any of the other sites, likely as a result of tidal and wave influences.

Table 4-2. Particle Size Summary from Composited Water Samples

Storm Event	Site	Percent by Weight of Sediment Type			
		Gravel	Sand	Silt	Clay
Storm 1 (3.05 inches)	Los Peñasquitos Creek	0	12	74	14
	Carmel Creek	0	11	71	19
	Carroll Canyon Creek	0	8	72	19
	Ocean Inlet	0	41	47	11
	Lagoon Segment	0	8	70	22
Storm 2 (0.56 inch)	Los Peñasquitos Creek	0	42	49	9
	Carmel Creek	0	42	44	14
	Carroll Canyon Creek	0	26	39	35

The water collected from Los Peñasquitos Creek and Carmel Creek during Storm Event 2 was nearly identical in its percent composition of sand, silt, and clay suspended particulates. Suspended sediment in Carroll Canyon Creek water was composed of a greater percentage of clay and a lower percentage of sand and silt than sediment contained in Los Peñasquitos Creek and Carmel Creek waters. Overall, water samples collected from creek sites during Storm Event 2 (0.56 inch of rainfall) contained a greater percentage of coarse grained materials (26–42% sand) than samples collected during Storm Event 1 (3.05 inches of rainfall) (8–12% sand).

4.4 Post-Storm Sediment Grain Size Sampling Results

Surficial sediment samples (top 2 cm) were collected using an Ekman dredge from 26 site locations within Los Peñasquitos Lagoon between February 11, 2008 and February 15, 2008 (Figure 4-8). This sampling was performed within a two-week period of time after a monitored storm event (February 3, 2008). Sediment samples underwent grain size distribution analysis for percent composition of gravel, sand, silt, and clay. In addition to grain size analysis, water quality measurements were recorded at each site location. A summary of the sediment sampling results and water quality measurements are presented in Appendix B.

Results from grain size analysis indicate that sites located near the lagoon mouth contained the highest percentage of coarse-grained materials in their surficial sediments (Figure 4-9). Sites 1, 2, 3, 13, and 14 were located in closest proximity to the lagoon mouth and were each comprised of over 95% sand. Since these sites are tidally influenced, the majority of sand at these locations may be entering the Lagoon from the ocean during high tides. In general, sites located on the southern fork of the Lagoon, southwest of the railroad tracks, were comprised of higher percentages of coarse-grained materials (sand and gravel) than sites located along the northern fork of the Lagoon. Four of the five sites that contained greater than 1% gravel were located along the Lagoon's southern fork. Higher percentages of coarse-grained materials at these locations than at locations along the Lagoon's north fork may be the result of a combination of coarse grains washing down from the nearby cliffs located along the southern boundary of the Lagoon and bed-load transport of eroded soils from other upstream sources within the Carroll Canyon Creek and Los Peñasquitos Creek subwatersheds.

Figure 4-8. Ekman Dredge Showing Top Layer of Sediment

In contrast to the south fork of the Lagoon, surficial sediment samples from sites located upstream from the railroad bridge on the Lagoon's northern fork were comprised primarily of fine-grained materials. These sample locations (sites 5, 6, 7, 8, 9, 10, 11, 12, and 19) contained between 63 and 91% fine-grained materials (silts and clays). Wider, deeper channels in this portion of the Lagoon may facilitate increased deposition of fine-grained sediments and result in less scouring during periods of increased flow. Water depths averaged 3.65 ft for the north fork Lagoon locations (sites 4–12 and Site 19) and 1.6 ft for the southern fork locations (sites 14–18 and sites 20–23).

Grain size distribution varied widely among the four sites located in the eastern portion of the Lagoon (Figure 4-9). Sites 25 and 27 were comprised primarily of sand while sites 24 and 26 were comprised of mostly fine-grained materials. Reasons for this likely involve hydrological characteristics of the channel. Dense vegetation is found around sites 24 and 26 which may allow fine particulates to drop out of the water column. Significant amounts of organic debris, such as leaf litter, were also found at these locations.

Figure 4-9. Grain Size Distribution in Western Portion of Lagoon

4.5 Data Sonde Monitoring

Monitoring of hydrology and core chemical parameters was conducted continuously from October 2007 through mid-April 2008 via in situ data sondes. Sondes were installed at five locations, one at each of the three MES, one at the Lagoon Segment Site, and one at the Ocean Inlet Site. The core parameters that were continuously monitored included temperature, pH, conductivity, DO, turbidity, and water level. MES were used to measure flow and water level at each of the creek sites. Sondes were used to measure water level at the Lagoon Segment and Ocean Inlet sites.

The goal of the continuous monitoring was to better understand the physical factors controlling lagoon hydrodynamics and sediment transport. The data provided by the data sondes will ultimately be used to calibrate and validate watershed hydrology and lagoon hydrodynamic models. The continuous monitoring also provided data to determine daily, monthly, and seasonal patterns of the water quality parameters. The most significant change to the water quality parameters at each sonde location appeared to be from freshwater runoff during rainfall events. There did not appear to be any significant changes observed to the water quality measurements as a result of illicit discharges or other unusual events.

The most noticeable changes to the water quality parameters were associated with the storm events at the MES locations. The three creeks showed similar responses to rainfall during the monitoring period. The runoff associated with the rain events resulted in an increase in the water level, a decrease in specific conductivity, and an increase in turbidity. Results of the water quality parameters measured for the month of February at the Los Peñasquitos Creek MES are shown on Figure 4-10 as an example of the sonde data that was collected over six months at each of the five sampling locations. A complete record of the sonde data from each site is shown in monthly graphs provided in Appendix D.

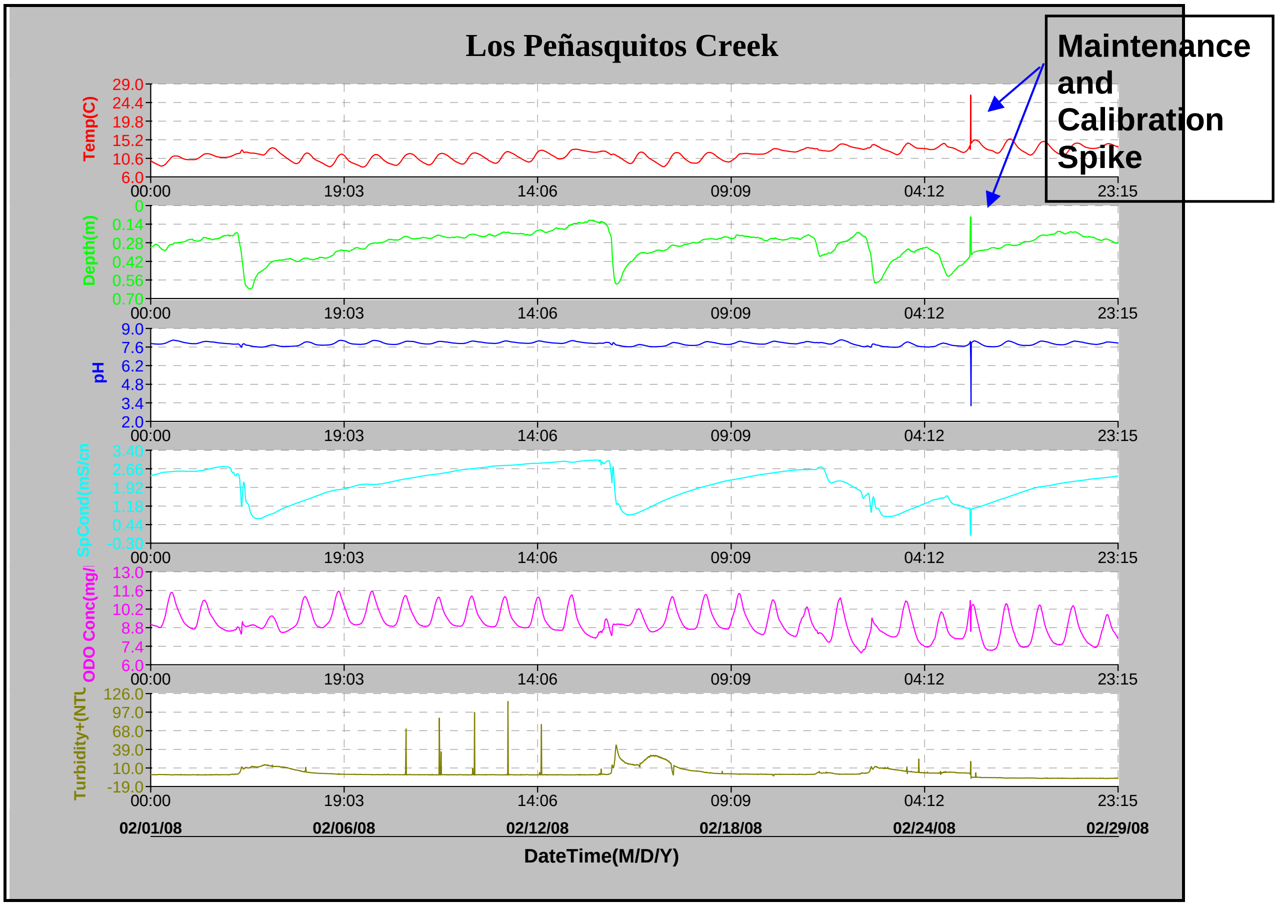

Figure 4-10. Water Quality Measurements at Los Peñasquitos Creek during February 2008

The water quality measurements within the Lagoon were less obvious during rainfall events. The Lagoon Segment Site generally exhibited a measurable decrease in specific conductance due to the input of freshwater into the Lagoon, while the Ocean Inlet Site responded with a smaller decrease in specific conductance. Temperature, pH, and DO consistently showed a diurnal pattern across the data sonde locations throughout the entire monitoring period. Turbidity was an important parameter to the transportation of sediment through the subwatersheds during rainfall events. The data sonde at Carroll Canyon Creek continually showed the highest increases in turbidity during storm events.

Several challenges were associated with the six-month deployment of continuous monitoring equipment. The initial installation of the data sondes was postponed due to a conflict with the end of the nesting season for listed bird species in the Lagoon. To avoid impacting the nesting habitat of the birds, the continuous monitoring equipment was not installed until the beginning of October 2007. Monitoring began on October 11, 2007 and ran through mid-April 2008. Throughout the monitoring period, the data sondes required monthly calibrations and maintenance to deal with bio-fouling, sedimentation, debris buildup, power consumption, and sensor drift. To ensure data quality, a schedule was established to clean, service, calibrate, and replace the batteries of the data sondes. There were a few data gaps and bad data points associated with this monthly maintenance. During calibration and maintenance, when the sondes were removed from the water, they typically recorded inaccurate spikes for a short period of time. Maintenance and calibration typically lasted 15–30 minutes, and normal measurements resumed once the sondes were returned to the water. Maintenance and calibration spikes are noted in the data tables contained in Appendix D. As a result of improper battery installation during a two-week period spanning the last week of November through the first week of December, several of the sondes did not record data over this time period. Data from this time period, however, was collected by the LPLF and may be available upon request.

4.5.1 Summary Sonde Statistics by Month

Statistical reports of the water quality parameters measured at the five data sonde locations were calculated and can be found in Appendix D. The three subwatershed MES locations showed similar trends in both specific conductance and DO throughout the monitoring period. The factors that may have influenced the water quality measurements include freshwater runoff from rain events, sunlight, temperature fluctuations of air and water, irrigation runoff, and creek habitat. From October through December, as the input from rains increased, the MES locations showed a decrease in the mean specific conductivity, likely as a result of dilution by freshwater runoff. The three MESs also showed an increasing trend in DO as the mean temperature dropped, daily sunlight decreased, and freshwater runoff increased.

The largest rain event occurred in late November 2007 while the largest monthly total of rainfall occurred in January 2008. The lowest mean specific conductivity levels and the highest mean DO levels during the entire monitoring period were recorded in December 2007 and January 2008 across three of the MES locations. As the mean temperature increased from January through the middle of April, three MES locations' specific conductivity generally increased while DO generally decreased.

Carroll Canyon Creek recorded the highest monthly mean turbidity measurements and the largest standard deviations out of the three of the MES locations. The higher turbidity at Carroll Canyon may be due to the type of runoff associated with the watershed and the concrete channel where the data sonde was located.

The inlet of the Lagoon became increasingly constricted over the course of the monitoring season and eventually closed completely sometime during the middle of March 2008 (Figure 4-11). The tidal exchange of water between the Lagoon and ocean decreased dramatically at this time to the point that the only input of seawater into the Lagoon occurred during extreme high tides. As the inlet closed both the lagoon segment and ocean inlet sondes measured abrupt changes in temperature, water level, and DO.

Figure 4-11. Closure of Lagoon Mouth in March 2008

As early as the first week in March 2008, the ocean inlet data sonde had become buried beneath the newly deposited sand. For the remainder of the monitoring period, the Ocean Inlet Site recorded unusual measurements due to its position under the sand. After the inlet closed completely, the sonde stationed at the Lagoon Segment Site recorded a gradual increase in water level and temperature. The pH and specific conductivity then decreased, followed by a decrease in DO levels.

Closure of the lagoon mouth can result in conditions that may impact aquatic life within the Lagoon. Stagnation of the Lagoon's waters typically results in increased water temperature and decreased DO levels. If these conditions persist, benthic infauna and fish can be impacted that may lead to impacts throughout the food web (Coastal Environments, 2004).

5.0 SEDIMENT LOAD ANALYSIS

This subsection presents the summary of estimated wet weather loads for the monitored storm events within the Los Peñasquitos Watershed. Dry weather loads were not estimated, as the ambient monitoring results indicate that TSS loadings from the dry weather events are negligible. Table 5-1 presents the draft data for ambient dry weather and wet weather events during the 2007–2008 monitoring year from the Copermittee Monitoring Program for the Los Peñasquitos Watershed. The quantity of flow during dry weather is minimal and has limited energy to transport sediments (TSS) through the channels to the lagoon. Wet weather loads were estimated for three storm water monitoring events. An estimate of the annual volume of sediment transported is provided for comparison to the maintenance activities occurring in the Sorrento Creek Sediment Maintenance Project at the confluence of Carroll Canyon Creek and Los Peñasquitos Creek.

Table 5-1. Comparison of Dry Weather versus Wet Weather Water Quality Data – Copermittee Monitoring Program

Analytes	Units	Los Peñasquitos Creek MES	LPC-TWAS-1 (AKA Carroll Canyon Creek)	LPC-TWAS-2*	Carmel Creek (average of TWAS-1 and LPC)**
Ambient Event 1 – September 26–28, 2007					
TSS-FWC	**mg/L**	5.3	0.5	0.65	2.9
Turbidity	**NTU**	3.25	2.23	4.4	
Storm Event 1 – November29, 2007 – December 1, 2007					
TSS-FWC	**mg/L**	130	260	113	195
Turbidity	**NTU**	73	164	84	
Storm Event 3 – February 3, 2008					
TSS-FWC	**mg/L**	26	40	200	33
Turbidity	**NTU**	14.9	65	147	
Ambient Event 2 – June 3, 2008					
TSS-FWC	**mg/L**	8	1.7	9.7	4.85
Turbidity	**NTU**	5	2.3	6	

FWC = flow-weighted composite
MES = Mass Emission Station
TWAS = Temporary Watershed Assessment Station
LPC = Los Peñasquitos Creek

* LPC-TWAS-2 is located in the upper reaches of Los Peñasquitos Creek and provides information from the County of San Diego Regional Monitoring Program.

** Carmel Creek was not monitored for flow-weighted composites under the Copermittee Monitoring Program. Mean TSS values from Los Peñasquitos Creek and Carroll Canyon Creek flow-weighted composite samples were used to estimate values for this site.

Loads are characterized by the drainage area, the quantity and intensity of precipitation, land uses and earth disturbance activities in the respective drainage area, and BMPs and land management practices implemented within the watershed. In this case, sediment (TSS) has been listed as the pollutant of concern in the Los Peñasquitos Watershed. In general, TSS can be considered as the constituent of concern whose source is directly attributed to land use type, earth disturbance activities, BMPs, and natural existing sediment strata in the watershed.

5.1 Wet Weather Load Estimate

Three storm events were monitored for the Los Peñasquitos Lagoon TMDL Monitoring Study between October 1, 2007 and March 31, 2008. Estimates for TSS loads per storm were derived using the event mean concentration (EMC) of the collected samples, the estimated storm water runoff rate, and the duration of the storm.

Flow values during each event were obtained from flow meter data. The average base flow was estimated using a graphical hydrograph separation technique: wet and dry weather flow values were plotted to identify an average base flow trend. The estimated base flow was subtracted from the flow values to estimate the rate of storm water runoff. The following equation was used to estimate the TSS load during storm events:

$$L = Q \text{ x } C \text{ x } CF$$

where

L = estimated load (lbs/day)
Q = storm water flow (mgd)
C = event mean concentration (EMC) (mg/L)
CF = Conversion Factor to convert mg/L to lbs/day (8.34)

The estimated load (lbs/day) for the three storm events at each monitoring location are shown in Table 5-2. The estimated loads are then represented as load per storm by multiplying the loads by the duration of the monitoring event.

Table 5-2. Load Estimates for Creeks within Los Peñasquitos Watershed

Storm Event (date)	Average Storm water Flow (mgd)	Flow Weighted TSS EMC (mg/L)	Average TSS Load (lbs/day)
Carmel Creek			
Storm Event 1 – November 30, 2007	20.77	97.75	16,932
Storm Event 2 – December 7, 2007	19.36	14.59	2,356
Storm Event 3 – February 3, 2008	17.68	10.09	1,488
Los Peñasquitos Creek			
Storm Event 1 – November 30, 2007	251.54	54.17	113,640
Storm Event 2 – December 7, 2007	42.90	13.54	4,844
Storm Event 3 – February 3, 2008	58.34	11.98	5,829
Carroll Canyon Creek			
Storm Event 1 – November 30, 2007	293.27	451.30	1,103,821
Storm Event 2 – December 7, 2007	148.40	315.32	390,258
Storm Event 3 – February 3, 2008	80.88	159.75	107,758

Table 5-3 summarizes the size of the storm, the monitoring event duration, and the estimated average monitoring event load for each subwatershed. Figure 5-1 through Figure 5-3 shows the comparison of the loads by monitoring events as well as a comparison amongst Los Peñasquitos Creek, Carmel Creek, and Carroll Canyon Creek subwatersheds.

Table 5-3. Estimates of Load per Storm for Creeks within Los Peñasquitos Watershed

Storm Event (date)	Rainfall (inches)	Monitoring Event Duration (hours)	Average TSS Load (lbs/storm)
Carmel Creek			
Storm Event 1 – November 30, 2007	3.05	19	13,400
Storm Event 2 – December 7, 2007	0.56	18	1,800
Storm Event 3 – February 3, 2008	0.54	13	800
Los Peñasquitos Creek			
Storm Event 1 – November 30, 2007	3.05	20	94,700
Storm Event 2 – December 7, 2007	0.56	24	4,800
Storm Event 3 – February 3, 2008	0.54	28	6,800
Carroll Canyon Creek			
Storm Event 1 – November 30, 2007	3.05	10	459,900
Storm Event 2 – December 7, 2007	0.56	10	162,600
Storm Event 3 – February 3, 2008	0.54	14	62,900

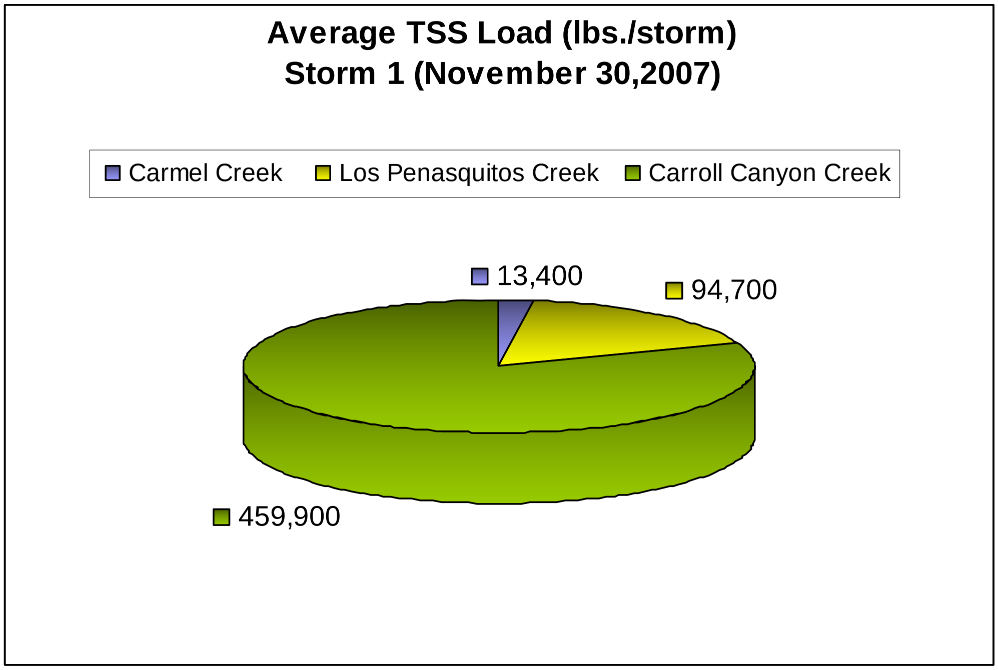

Figure 5-1. Comparison of TSS Loads for the Monitored Storm Event 1

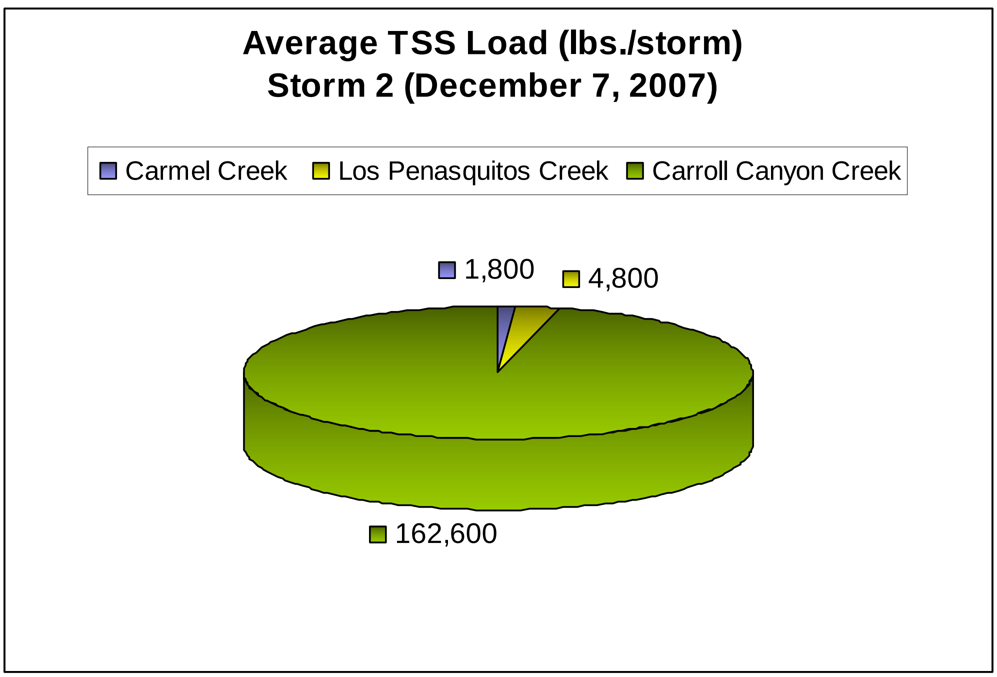

Figure 5-2. Comparison of TSS Loads for the Monitored Storm Event 2

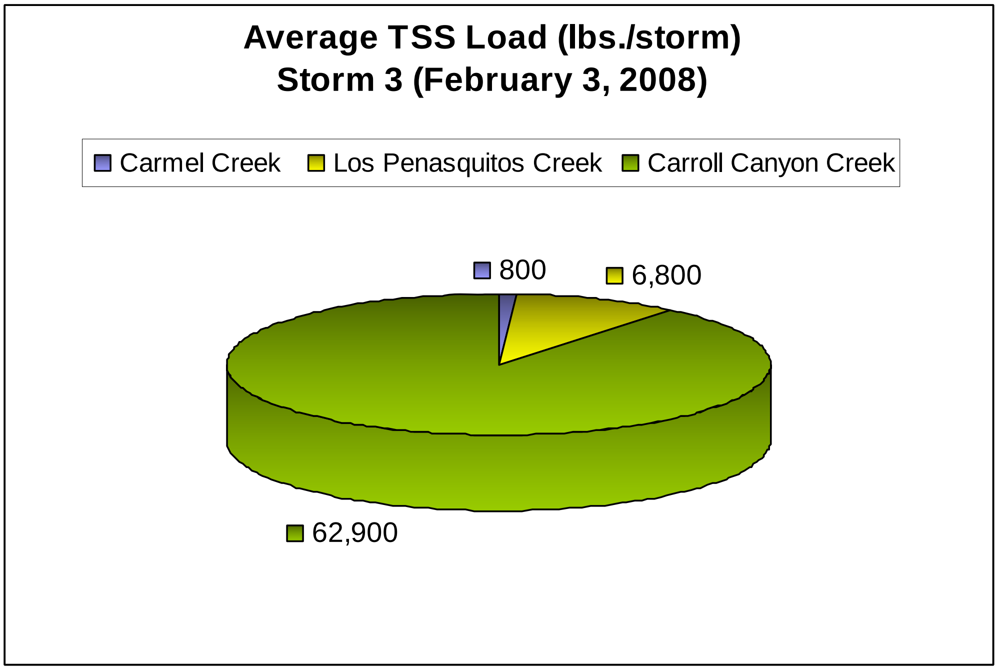

Figure 5-3. Comparison of TSS Loads for the Monitored Storm Event 3

Among the three subwatersheds, TSS loads were much higher at Carroll Canyon Creek than at either Los Peñasquitos Creek or Carmel Creek. TSS loads ranged from 459,900 lbs/storm to 62,900 lbs/storm during the first and third storm events, respectively, at Carroll Canyon Creek. At Carmel Creek, TSS loads were lower than at the other creek sites, ranging from 13,400 lbs/storm to 800 lbs/storm. Los Peñasquitos Creek was estimated to have generated TSS loads ranging from 94,700 lbs/storm to 6,800 lbs/storm during the first and second storm events, respectively. Average flow weighted TSS EMCs at each creek site were 309 mg/L at Carroll Canyon Creek, 41 mg/L at Carmel Creek, and 27 mg/L at Los Peñasquitos Creek. TSS loads among the three creek sites were lower during Storm Event 2 and Storm Event 3, which were smaller storm events, than during Storm Event 1. However, Storm Event 2 had significant load contribution in Carroll Canyon Creek due to the short duration of the storm.

Physical properties of Carroll Canyon Creek include a higher impervious percentage of total area than the other subwatersheds and steep and channelized conveyance structures leading to the Lagoon. This compares to greater open space in the other subwatersheds as a percentage of total area increasing time of concentration. Furthermore, the creek channels in these subwatersheds remain well vegetated with flood ways to allow storm flow velocities to be reduced and sediment loads to settle out prior to discharge into the Lagoon. Mitigation projects upstream of the sampling point in Los Peñasquitos Creek also provide for further reduction in sediment loading by reducing storm flow velocities and retention times. The Sorrento Creek Maintenance Channel downstream of the confluence of Los Peñasquitos and Carroll Canyon Creeks provide for retention of storm flows and removal of the sediment loading from both of these creeks. The following subsection presents an estimate of total loading from each of the subwatersheds and compares that to the volume of sediment removed from the sediment control structures between the creek confluence and the Lagoon.

5.2 Total Annual Wet Weather Load Estimate

The total annual wet weather TSS load was estimated by relating the observed flow values from USGS monitoring station No. 11023340 to each drainage area. The USGS stream gage is located on Los Peñasquitos Creek and is shown on Figure 2-2. Flow transformation factors were developed for each monitoring location based on the relationship between flows observed during the three monitoring events and the flows recorded at the USGS stream gage. Average total annual wet weather sediment loads were estimated for each site by applying the transformation factors to the USGS gage flows that were greater than the estimated base flow. The volumes of the storm water hydrographs were summed for the year and the annual storm water volume was multiplied by the average wet weather TSS concentration to estimate annual sediment loads for each drainage area.

USGS Mean Daily Flow Transformations

Mean daily flows were downloaded from the USGS National Water Inventory System for gage No. 11023340. Flows observed by WESTON during the three monitoring events were time-weighted to produce the best possible estimate of mean daily flow. USGS values were compared to the flow values and were drainage area-weighted. USGS Gaging Station No. 11023340 drains 27,093 acres. A hydraulic response correction factor was also applied to the USGS flow values to account for variations in land use, slope, and channelization in areas draining to the monitoring sites. A hydraulic response correction value less than one represents a correction for areas that generate less runoff per unit precipitation than does the USGS gage drainage area. Shallower slopes or increased surface storage may account for these types of correction values. Conversely, higher impervious area percentage and the steep and channelized conveyance structures of Carroll Canyon Creek subwatershed result in a hydraulic response correction factor greater than one.

The combined area-weighting and response correction factors resulted in a best fit correlation between USGS and observed flows. The area-weighting and response correction factors for the monitoring locations are presented in Table 5-4. The values in Table 5-4 were derived by the following equations:

Transformed USGS Mean Flow = USGS Mean Flow x Drainage Area Weighting Factor x Hydraulic Response Correction Factor.

Flow Transformation Ratio = Observed Mean Daily Flow / Transformed USGS Mean Flow.

Table 5-4. Flow Transformations

Storm Event	Observed Mean Daily Flow (cfs)	USGS Mean Daily Flow (cfs)	Drainage Area Weighting Factor (unitless)	Hydraulic Response Correction Factor (unitless)	Transformed USGS Mean Daily Flow (cfs)	Flow Transformation Factor = Ratio Observed:Transformed USGS (unitless)
Los Peñasquitos Watershed, Drainage Area = 37,028 Acres						
Nov 30, 2007	410.0	432.0	1.367	0.53	312.9	1.31
Dec 7, 2007	63.6	101.0	1.367	0.53	73.2	0.87
Feb 3, 2008	102.1	180.0	1.367	0.53	130.4	0.78
Average of flow transformation factors for three events =						0.99
Carroll Canyon Creek Watershed, Drainage Area = 11,004 Acres						
Nov 30, 2007	421.3	432.0	0.406	2.75	482.5	0.87
Dec 7, 2007	171.9	101.0	0.406	2.75	112.8	1.52
Feb 3, 2008	113.8	180.0	0.406	2.75	201.0	0.57
Average of flow transformation factors for three events =						0.99
Carmel Creek Watershed Drainage Area = 11,180 Acres						
Nov 30, 2007	39.6	432.0	0.413	0.57	101.6	0.39
Dec 7, 2007	38.4	101.0	0.413	0.57	23.8	1.62
Feb 3, 2008	42.0	180.0	0.413	0.57	42.3	0.99
Average of flow transformation factors for three events =						1.00

Base flow Separation

Base flow at the USGS gage station was determined for each month to account for variation between the wet and dry seasons using a graphical hydrograph separation technique. The mean daily flow values from the USGS gage were plotted from within a total 42-year period of record, until a base flow trend could be identified. Figure 5-4 shows the annual USGS mean daily flow hydrographs with an indication of the base flow value for each month. Only the USGS flow values greater than base flow were used for the total annual wet weather TSS load calculation because the ambient monitoring results indicate that TSS loadings from the dry weather events are negligible.

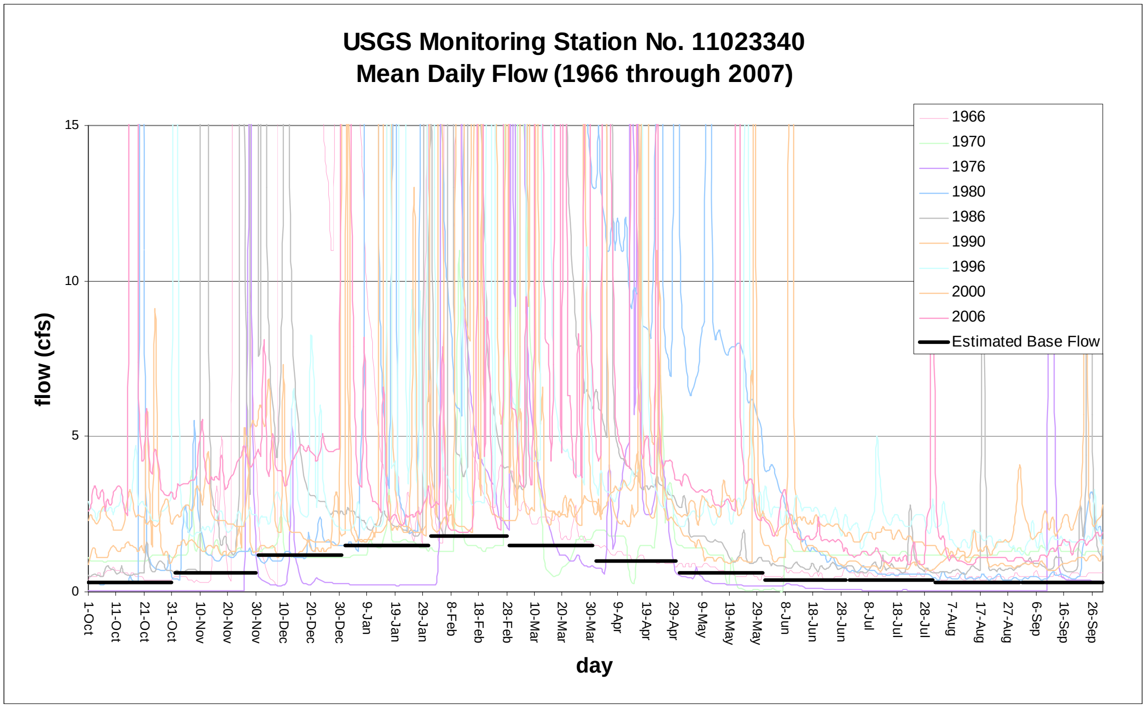

Figure 5-4. Base Flow Separation for USGS Monitoring Station No. 11023340

Annual Wet Weather TSS Load Estimation

The annual wet weather TSS load from each drainage area was determined using the transformed USGS gage flows for the period between 1966 and 2007 that were greater than the estimated base flow. Each daily storm water flow rate (in cubic feet per second) was multiplied by the number of seconds in a day (86,400) to produce a daily volume in cubic feet. The daily volumes were summed to produce an annual volume of storm water runoff.

A copy of the Excel spreadsheet that contains the above-described calculations is included in Appendix F of this report. The average TSS EMC determined during the monitoring effort was applied to the annual storm water runoff volume to produce an estimated annual loading in dry pounds (Table 5-5).

Table 5-5. Total Estimated Annual Wet Weather Load for a Typical Storm Year

TSS Load		Creeks of Los Peñasquitos Watershed			Los Peñasquitos Watershed Total
		Carmel Creek	Los Peñasquitos Creek	Carroll Canyon Creek	
Total Annual Wet Weather Load Based on Average Typical Storm Year	Lbs./year	193,701	419,218	7,486,267	8,099,186
	Percent	2.4	5.2	92.4	100

5.3 Sediment Volume Estimation

The total annual load values were used to estimate the approximate volume of sediment transported from each subwatershed to the lagoon. The volume of TSS contributing to the sediment volume is estimated using a saturated density of 100 lb/cubic ft which is consistent with the grain size analysis of water samples that were sampled for particle size distribution[1]. The volume of TSS is estimated using the formula below:

$$A = \mathrm{CF}\ \text{x}\ \frac{B}{C}$$

where

A = volume of TSS (cubic yards)
B = mass (lbs)
C = saturated sediment density (lbs/cubic foot)
CF = Conversion Factor to convert cubic feet to cubic yards (0.037)

Table 5-6 shows the estimated TSS volume that contributes sediment to the lagoon. The TSS volume that contributes to the sediment volume in the lagoon is approximately 3,000 cubic yards per year.

1

Bowles, Foundation Analysis and Design McGraw-Hill Book Company 1982.

Table 5-6. Estimated TSS Volume Contributing to the Sediment to the Lagoon

	Carmel Creek	Los Peñasquitos Creek	Carroll Canyon Creek	Los Peñasquitos Watershed
Total annual sediment volume based on average typical year (cubic feet)	1,937	4,192	74,863	80,992
Volume of sediment (cubic yards)	72	155	2,773	3,000

6.0 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Conclusions and recommendations provided in this report are based on results of wet weather monitoring and continuous water quality monitoring throughout the 2007–2008 wet weather season as well as on historical data collected in previous water quality monitoring projects in Los Peñasquitos Lagoon and/or Los Peñasquitos Watershed. Monitoring that occurred during the 2007–2008 storm season captured storm events typical of a normal rainfall year, with one rainfall event characteristic of a two-year to five-year storm event.

6.1 Summary and Conclusions

The reduction of sedimentation/siltation is currently a management priority within Los Peñasquitos Watershed and Los Peñasquitos Lagoon. Sedimentation associated with urban encroachment can impact lagoon and riparian habitat by reducing tidal mixing, changing hydrological circulation patterns, narrowing lagoon channels, raising lagoon elevation, degrading water quality, and altering native vegetation. In recent times, sand and sediment deposition at the Lagoon’s ocean inlet has blocked the lagoon waters from mixing with ocean waters at certain times due to wave, wind, and tidal action during large North Pacific storms. When this occurs, emergency dredging of the mouth of the Lagoon has typically been performed to prevent the lagoon waters from being closed off completely from tidal mixing, an essential component to the Lagoon’s estuarine ecosystem. This study was conducted to better understand the fate and transport of TSS entering, moving through, and leaving the Lagoon during storm events so that informed management decisions can be rendered to reduce future sedimentation/siltation. Water quality, TSS, and sediment data from this study will be used to calibrate and validate hydrodynamic models aimed at determining sediment sources, loads, and areas within the Lagoon that have a high propensity for depositional fallout. Ultimately, both structural and non-structural BMP strategies may be employed to address sedimentation and siltation within Los Peñasquitos Lagoon and its headwaters.

Los Peñasquitos Lagoon receives perennial freshwater flows from three subwatersheds (Carmel Creek, Los Peñasquitos Creek, and Carroll Canyon Creek) draining two distinct HAs. Of the three creeks feeding into the Lagoon, Los Peñasquitos Creek drains the largest land area (37,028 acres), followed by Carmel Creek (11,180 acres) and Carroll Canyon Creek (11,004 acres). Several notable differences in land use composition exist among the three subwatersheds and may help to explain observed differences in TSS, sediment grain size, and flow characteristics. The Carroll Canyon Creek drainage area has a significantly higher percentage of industrial and commercial land use (five times more) than either the Carmel Creek or Los Peñasquitos Creek drainage areas, and contains the greatest percentage of impervious surface among the three drainage areas. Channelization of Carroll Canyon Creek occurs for approximately 2 miles prior to it merging with Los Peñasquitos Creek. This channelization may act to maintain peak flow velocities which would promote sediment loads to remain in suspension rather than to allow sediment to drop out of the water column prior to entering the Lagoon. Conversely, the upper portion of the Los Peñasquitos Creek drainage area contains the highest percentage of vacant land and rural residential land use among the three subwatersheds. While Los Peñasquitos Creek is a considerably larger watershed with approximately 3.5 times the drainage area of each of the other two creeks, the estimated annual sediment load is approximately 1/18th that of Carroll Canyon and approximately four times that of Carmel Creek. The physical characteristics of Carmel Creek—a natural channel with areas of dense vegetation—are similar to those seen in Los Peñasquitos Creek. Although Carmel Creek has a similar sized drainage area to Carroll Canyon Creek, its flow during storm events rises and falls at a much slower pace, allowing for sediment deposition to occur prior to reaching Los Peñasquitos Lagoon.

Hydrographs created from the three monitored storm events indicate that peak flow velocities were between five and ten times greater in Carroll Canyon Creek than in Carmel Creek during each monitored storm event. The higher percentage of industrial and commercial land use in the Carroll Canyon Creek drainage area, in comparison to the Carmel Creek drainage area, correlates to a greater percentage of impervious surface in Carroll Canyon and facilitates rapid surface water runoff into the creek, leading to high peak flow velocities.

Over the course of three monitored storm events, TSS concentrations varied considerably among the three creek and two lagoon sampling locations. Analyses indicated that TSS concentrations were above the Copermittee wet weather water quality benchmark of 100 mg/L at Carroll Canyon Creek 76% of the time (26/34 samples), while samples collected from Los Peñasquitos Creek and Carmel Creek were above the water quality benchmark across all monitored storm events 6% (2/34 samples) and 3% (1/34 samples) of the time, respectively. At the Lagoon Segment and Ocean Inlet sites, TSS concentrations were measured above the water quality benchmark across the three monitored storm events 3% (1/32 samples) and 20% (7/35 samples) of the time, respectively. Among the three creek sites, TSS loads were found to be markedly higher at Carroll Canyon Creek than at either Los Peñasquitos Creek or Carmel Creek. As a result of its steep drainage area, concrete-lined channels, and limited vegetation, Carroll Canyon Creek responds relatively quickly to rainfall events compared to either Carmel Creek or Los Peñasquitos Creek, which have natural channels with dense vegetation within the creek beds.

Water quality parameters changed most noticeably as a result of freshwater input during storm events at the creek mass emission station locations. Rain events at each of the three creeks caused an increase in water level and DO, a decrease in specific conductivity, and an increase in turbidity. Carroll Canyon Creek continually showed the highest increases in turbidity during storm events. Changes in water quality parameter concentrations within the Lagoon were less obvious during rainfall events. The Lagoon Segment Site usually exhibited a measurable decrease in specific conductance due to the input of freshwater into the Lagoon, while the Ocean Inlet Site responded with a smaller decrease in specific conductance. Tidal influence was evident at both lagoon sampling locations as water depth, pH, specific conductance, and DO in general, increased as the tide came in and decreased as the tide went out. Across the three creek locations, a consistent diurnal pattern emerged for temperature, pH, and DO during periods of dry weather throughout the monitoring period. DO and pH typically increased in the late morning through mid-afternoon as the temperature rose, and then declined in the early evening as the temperature decreased.

Grain size analyses of sediment samples indicated that sites located near the ocean inlet contained the highest percentage of coarse-grained materials in surficial sediments. The five sediment samples located in closest proximity to the ocean inlet were comprised of over 95%

sand and cobble. This corresponds to a recent grain size analysis performed on behalf of the LPLF for their lagoon mouth maintenance program. The LPLF analysis found that sediment sampled within the ocean inlet was consistent with sediment types found at Torrey Pines State Beach and offshore (Coastal Environments, 2008b). Conclusions from these studies, along with over 23 years of empirical evidence acquired through the LPLF mouth maintenance program, support the belief that the majority of sediment located at the ocean inlet is of marine origin, and its deposition is a function of coastal processes, including long-shore sediment distribution combined with wave and tidal activities during the winter months. This process is magnified during major winter storm events that increase shoreline erosion along the beaches north of the inlet and subsequently deposit sand and cobble in the lagoon mouth area via storm surge. While the sand can be removed from the mouth area through tidal action and water flowing out of the Lagoon, the cobble remains in place and eventually forms a cobble sill that creates a hardened structure across the lagoon mouth. As the coastal conditions switch from fast moving storms from the North Pacific during winter months and into local wind-generated swells characteristic of the spring, sand becomes piled up on the cobble sill and the lagoon mouth eventually closes for extended periods of time. While high tide cycles and elevated surf can wash over this barrier and provide temporary improvements to water quality, tidal mixing is reduced to the most western edge of the Lagoon. Wider, deeper channels in this portion of the Lagoon may facilitate increased deposition of fine-grained sediments and result in less scouring during periods of increased flow.

The higher peak flow velocities of Carroll Canyon Creek may have contributed to the higher percentage of coarse-grained material observed in surficial sediments the southern lagoon fork than in the northern lagoon fork. Within Carroll Canyon Creek, higher and longer sustained peak flows, in comparison to pre-development conditions, may result in hydromodification of the natural channels. Transported sediment from these hydromodification processes may ultimately settle out in the Lagoon. A large sand and gravel processing facility, located in the upper portion of Carroll Canyon, may also influence sediment loads entering Carroll Canyon Creek and ultimately the Lagoon via both surface runoff and aerial deposition. Further study is needed to identify evidence of hydromodification in natural channels, causes of increased erosion, and the contribution from aerial deposition to lagoon sediment/siltation issues.

The Los Peñasquitos Creek Watershed area is primarily open space and parks, has a mostly natural channel system, and has dense stands of vegetation in the creek. Flow rates react to rainfall events characteristic of a natural channel setting, and it historically tends to have few TSS results above the Copermittee TSS wet weather benchmark. The impoundment on Los Peñasquitos Creek acts as both a dam and a sediment trap in the upper portion of the watershed by slowing the flow of water and allowing sediment loads to settle out. Below the impoundment, flow is also slowed by dense vegetation in the form of cattails upstream of the MES. Ultimately, Los Peñasquitos Creek merges with Carroll Canyon Creek before flowing to the sediment basin into the Lagoon. While Carroll Canyon Creek waters typically return to near baseline levels within several hours after a storm passes, response times for waters to return to near baseline levels in Los Peñasquitos Creek can take up to several days depending on the size of the storm event.

Carmel Creek has a similarly sized drainage area as Carroll Canyon Creek, but contains approximately 18 percent less impervious surface. As a result, the Carmel Creek drainage area may have a greater capacity to infiltrate and/or slow the flow of water prior to it reaching the creek during rain events. Also, Carmel Creek is comprised of a natural channel with dense vegetation and highway abutments that act as impediments to flow. Sustained year-round base flows in Carmel Creek, likely resulting from over irrigation in recently developed residential areas, have lead to a loss of estuarine habitat and an increase in freshwater vegetation, such as cattails, within the creek bed. These differences equate to lower peak flows and slower moving water in Carmel Creek's drainage area. Results from this study found measured TSS concentrations and TSS loads in Carmel Creek to be significantly lower than those observed in Carroll Canyon Creek. Carmel Creek accounted for approximately 2% of the estimated total wet weather annual sediment load contributed by the creeks during a typical storm year to Los Peñasquitos Lagoon, while Los Peñasquitos Creek and Carroll Canyon Creek accounted for an estimated 5% and 92% of the annual sediment load, respectively.

Sediment loads that are carried into the Lagoon via its creek system have the capacity to impact lagoon elevations over time, and in combination with perennial freshwater flows, can affect the extent of tidal influence within the Lagoon and ultimately limit the historical range of estuarine flora and fauna. Periodic removal of sediment from the confluence area of Los Peñasquitos Creek and Carroll Canyon Creek has been performed in the past by the City of San Diego Sorrento Creek Channel Maintenance Project. The most recent maintenance was last performed in 2003 and removed nearly 27,000 cy of sediment from four areas near the confluence of Los Peñasquitos Creek and Carroll Canyon Creek. Since a total volume of approximately 2,900 cy of sediment was calculated to be the annual sediment contribution from these two subwatersheds to the Lagoon, continued sediment removal from designed maintenance channels and desilting basins would greatly reduce the volume of sediment that might otherwise settle out within the Lagoon.

Near the mouth of the Lagoon, the majority of the sand and sediment responsible for lagoon mouth closures is likely the result of natural coastal processes. In this study, sediment samples collected in the vicinity of the lagoon mouth were comprised of greater than 95 percent sand while samples located further from the lagoon mouth were comprised of increasingly higher percentages of fine-grained materials. Observations made during this study, in conjunction with discussions with LPLF and State Parks personnel support the notion that sand originating from the ocean is deposited over time at the mouth of the Lagoon during periods of high tides and large wave action. The mouth of the Lagoon, which has become increasingly constricted due to transportation corridors such as Highway 101, NCTD railway, I-5, and I-805, eventually becomes completely isolated from tidal influence. Once a mouth closure occurs, water quality conditions within the Lagoon typically begin to degrade (primarily as a result of DO depletion) within several days.

6.2 Recommendations

As a result of the monitoring and investigation conducted in the Lagoon and the watershed to comply with the Monitoring Order, several recommendations are presented:

- There currently are management actions occurring to address sedimentation on a regular basis and by numerous agencies (City of San Diego Street Division, Park and Recreation, and Storm Water Department; Caltrans; LPLF; and State Parks). However, increased interagency coordination and documentation of activities is needed. Maintenance channels and desilting basins should continue to be maintained.

- Sixty-eight percent of the samples which had TSS concentrations above the Copermittee wet weather water quality benchmark were collected from the Carroll Canyon Creek site. Similarly, Carroll Canyon Creek accounted for 92% of the estimated sediment load entering the Lagoon via the creek system during a typical storm year. As a result, Carroll Canyon subwatershed is recommended as a high priority for further investigation regarding sources of sediment loading and evidence of hydromodification. Based on the findings of these source investigations, BMP approaches can be developed; however, maintenance dredging of the Sorrento Creek sediment basin is recommended on a five-year basis until upstream BMPs are considered. BMP development is being considered by the City of San Diego in accordance with the City of San Diego's Strategic Plan for Watershed Activities. This plan may be used as a framework for future BMP development by other watershed stakeholders.

- As previously stated, mouth closures of the Lagoon appear to be primarily the result of coastal processes, such as long-shore currents and tidal activity that constricts the lagoon mouth through sand deposition over time. Currently the LPLF, in coordination with State Parks and the Coastal Conservancy, contract with an engineering company to reopen the lagoon mouth through excavation once it is documented that the mouth has become closed and water quality parameters have become impaired (as defined by the Coastal Development Permit). The most cost-effective, short-term solution to this phenomenon appears to be to continue to dredge the lagoon mouth and utilize the sand that is excavated for nearby beach replenishment if it is deemed an appropriate measure based on the quality of sand and other factors..

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN DIEGO REGION

INVESTIGATION ORDER NO. R9-2006-076

OWNERS AND OPERATORS OF MUNICIPAL SEPARATE STORM SEWER SYSTEMS, CALIFORNIA DEPARTMENT OF TRANSPORTATION, HALE AVENUE RESOURCE RECOVERY FACILITY, AND NORTH COUNTY TRANSIT DISTRICT RESPONSIBLE FOR THE DISCHARGE OF BACTERIA, NUTRIENTS, SEDIMENT, AND TOTAL DISSOLVED SOLIDS INTO IMPAIRED LAGOONS, ADJACENT BEACHES, AND AGUA HEDIONDA CREEK

The California Regional Water Quality Control Board, San Diego Region (hereinafter San Diego Water Board) finds:

1. **Condition of Impairment:** The Clean Water Act (CWA) section 303(d) requires states to develop a list of waterbodies that do not or are not expected to meet water quality standards after implementing technology-based controls. The waterbodies in Table 1 have been listed by the State Water Resources Control Board as water quality limited segments for which Total Maximum Daily Loads (TMDLs) must be developed pursuant to section 303(d). The purpose of a TMDL is to attain water quality objectives and restore the waterbody's beneficial uses.

   The eleven water quality limited segments are comprised of lagoons (in this Order "lagoons" refers to lagoons, sloughs, and creek mouths), adjacent beaches, and Agua Hedionda Creek. These waterbodies are impaired due to one or more of the following: indicator bacteria, nutrients, sediment/siltation, total dissolved solids (TDS), and/or eutrophic conditions. In order to meet water quality objectives and restore beneficial uses the San Diego Water Board is initiating development of TMDLs to address these water quality limited segments.

Table 1: List of Waterbodies addressed in TMDLs for Lagoons, Adjacent Beaches and Agua Hedionda Creek

	Hydrologic Descriptor	Waterbody	Water Quality Limited Segments	Pollutant / Stressor	Extent of Impairment
1	Lower Ysidora HSA (902.11)	Santa Margarita Lagoon	Entire lagoon	Eutrophic	1 acres
2a	Loma Alta HA (904.10)	Loma Alta Slough	Entire slough	Eutrophic	8.2 acres
2b			Entire slough	Indicator Bacteria	8.2 acres
3	Loma Alta HA (904.10)	Pacific Ocean Shoreline	At Loma Alta creek mouth	Indicator Bacteria	1.1 miles
4a	El Salto HSA (904.21)	Buena Vista Lagoon	Upper and lower portion of lagoon	Sedimentation / Siltation	202 acres
4b			Upper portion of lagoon	Nutrients	150 acres
4c			Upper and lower portion of lagoon	Indicator Bacteria	202 acres

	Hydrologic Descriptor	Waterbody	Water Quality Limited Segments	Pollutant / Stressor	Extent of Impairment
5	Buena Vista Creek HA (904.20)	Pacific Ocean Shoreline	At Buena Vista Creek	Indicator Bacteria	1.2 miles
6a	Los Monos HSA (904.31)	Agua Hedionda Lagoon	Upper and lower portion of lagoon	Sedimentation / Siltation	6.8 acres
6b			Upper and lower portion of lagoon	Indicator Bacteria	6.8 acres
7	Los Monos HSA (904.31)	Agua Hedionda Creek	Lower portion	TDS	7 miles
8a	San Elijo HSA (904.61)	San Elijo Lagoon	Upper and lower portion of lagoon	Eutrophic	330 acres
8b			Upper and lower portion of lagoon	Sedimentation / Siltation	150 acres
8c			Upper and lower portion of lagoon	Indicator Bacteria	150 acres
9	Escondido Creek HA (904.60)	Pacific Ocean Shoreline	At San Elijo Lagoon	Indicator Bacteria	0.44 mile
10	Miramar Reservoir HA (906.10)	Los Penasquitos Lagoon	Entire Lagoon	Sedimentation / Siltation	469 acres
11	Mission San Diego HSA (907.11)	Famosa Slough & Channel	Entire Lagoon	Eutrophic	32 acres

2. **Discharge of Waste:** Sediment, nutrients, TDS, and bacteria enter these water quality limited segments from point and nonpoint sources. Point sources typically discharge at a specific location from pipes, outfalls, and conveyance channels from urban runoff discharges. Nonpoint sources are diffused sources that reach receiving waters from different routes of entry and originate from multiple land uses. Pollution from these sources (point and nonpoint) is discharged to the water quality limited segments through municipal separate storm sewer systems (MS4s), which include State highways and military facilities. Other significant pollutant sources include a wastewater treatment plant and a dewatering operation that discharge into the water quality limited segments.

3. **Persons Responsible for the Discharge:** The California Department of Transportation (Caltrans)[1] and MS4 owners and operators in San Diego County,[2] Riverside County[3], Camp Pendleton and Fallbrook Naval Weapons Station (see Attachment 1) are responsible for these discharges. MS4 discharges from the non-military agencies are regulated under the terms and conditions of the Waste

[1] Order No. 99-06-DWQ, NPDES No. CAS000003, '*National Pollutant Discharge Elimination System (NPDES) Permit Statewide Storm Water Permit and Waste Discharge Requirements (WDRs) for the State of California, Department of Transportation (Caltrans).*'
[2] Order No. R9-2001-0001, NPDES No CAS0108758, '*Waste Discharge Requirements for Discharges of Urban Runoff from the Municipal Separate Storm Sewer System (MS4s) Draining the Watersheds of the County of San Diego, the Incorporated Cities of San Diego County, and the San Diego Unified Port District.*'
[3] *Order No. R9-2004-001 (NPDES Permit No. CAS0108766), 'Waste Discharge Requirements for Discharges of Urban Runoff from the Municipal Separate Storm Sewer Systems (MS4s) Draining the County of Riverside, the City of Murrieta, the City of Temecula and the Riverside County Flood Control and Water Conservation District within the San Diego Region.'*

Discharge Requirements in the orders listed in footnotes 1 through 3. Camp Pendleton and Fallbrook Naval Weapons Station are designated as small MS4s pursuant to Order No. 2003-0005-DWQ[4] but have not yet been regulated by the San Diego Water Board under that order.

The City of Escondido Hale Avenue Resource Recovery Facility (Order No. 98-10), regulated by NPDES requirements, discharges nutrients into the Escondido Creek. The North County Transit District is responsible for nutrient discharges to the Santa Margarita River from the dewatering of its Stuart Mesa Maintenance Facility.

4. Need for Monitoring Data: Water quality monitoring data are needed to develop TMDLs, and load and wasteload allocations and reductions for the water quality limited segments for each impairing pollutant. The San Diego Water Board intends to develop TMDLs, allocations, and reductions through modeling studies of the watersheds and lagoons. Hydrodynamic and water quality data for the lagoons, flow and water quality data for the major tributaries, and flow and water quality data for storm drains discharging directly into lagoons are needed to calibrate and verify the lagoon models, and to verify the watershed models in order to develop TMDLs and allocations.

5. Regulatory Authority and Necessity: Water Code section 13267 authorize the San Diego Water Board to require the submission of monitoring program reports from any person discharging pollutants into waters of the State. The monitoring data reports will allow the San Diego Water Board to assess the conditions of pollution due to sedimentation, nutrients, bacteria, and TDS contributing to impairment in the lagoons, adjacent beaches, and creek. These actions will result in the restoration and protection of water quality necessary to support the designated beneficial uses of these waterbodies. The costs to produce the monitoring program reports were estimated by the Dischargers to range between $300,000 to $500,000 per lagoon and up to $6.5 million region-wide, which included the cost of the special studies listed in Directive A8. The associated costs bear a reasonable relationship to the need for the actions, specifically the protection of water quality and beneficial uses.

Water Code section 13383 authorizes the San Diego Water Board to establish monitoring and reporting requirements for discharges regulated under NPDES requirements.

6. California Environmental Quality Act: This action is an order to enforce the laws and regulations administered by the San Diego Water Board. As such, this action is categorically exempt from the provisions of the California Environmental Quality Act pursuant to section 15308 of the California Public Resources Code.

IT IS HEREBY ORDERED, pursuant to Water Code section 13267 and 13383, that the Dischargers identified in Attachment 1 to this Order shall furnish the following reports

[4] *Order No. 2003-0005-DWQ (State General Permit No. CA000004). "Waste Discharge Requirements (WDRs) for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems".*

required by the San Diego Water Board in its investigation of the quality of waters of the State within the area of the discharge described in the above findings:

A. MONITORING PROGRAM REPORTS

A1. MONITORING PROGRAM WORKPLANS

The Dischargers shall develop and submit to the San Diego Water Board no later than August 1, 2007, one Monitoring Program Workplan for each watershed containing one or more water quality limited segments, or one Monitoring Program Workplan for each water quality limited segment, as shown in Table 1. If, within 30 days after submittal of the workplans, no comments have been received from the San Diego Water Board, the Dischargers shall implement the Monitoring Program Workplans according to the schedules in the workplans. Workplans shall not be implemented until an adequate Quality Assurance Project Plan has been submitted to the San Diego Water Board as required in Directive A9 of this Order.

The Workplans must be adequate to guide the collection of monitoring data needed to characterize dry weather flow and storm flow influenced water quality in the segments listed in Table 1 in order to complete development of TMDLs, and load and waste load allocations and reductions. The workplan study design must address the following questions, or provide data necessary to calibrate/validate the computer models used to assist in answering the following questions:

a) What are the concentrations of bacteria, nutrients, and/or sediment at the base of each watershed before it enters an impaired lagoon/slough/creek mouth, in accordance with the impairments specified in the 303(d) list? What is the TDS concentration in Agua Hedionda Creek?

b1) What are the concentrations of bacteria, nutrients, and/or sediment in each impaired lagoon/slough/creek mouth, in accordance with the impairments specified in the 303(d) list. Do they exceed Water Quality Objectives?

b2) What are the dissolved oxygen concentrations in lagoons/sloughs/creek mouths impaired for nutrients/eutrophication?

c) What are the total annual (and daily) mass loads of bacteria, nutrients, and/or sediment from each watershed to each impaired lagoon/slough/creek mouth, in accordance with the impairments specified in the 303(d) list? What is the total annual (and daily) mass load of TDS to Agua Hedionda Creek?

d) What are the measured values and fluctuations for the physical factors that contribute to the concentrations of impairing pollutant within each lagoon/slough/creek mouth, in accordance with the impairments specified in the 303(d) list? Physical factors can include: condition of tidal channels (width, depth), stream flow velocities and volumes, bathymetry, seasonality, light availability, temperature, rainfall, etc.

d1) Under what inflow conditions (flow velocities, flow volumes) are the major loads deposited within each lagoon/slough/creek mouth, in accordance with the impairments specified in the 303(d) list?

d2) What percentage of the annual load from each constituent is deposited within the lagoons/sloughs/creek mouths, in accordance with the impairments specified in the 303(d) list, versus exiting the tidal channels?

e) For waterbodies impaired by nutrients/eutrophication additional questions are required to model the nutrient dynamics of each system. These factors will affect not only the nutrient concentrations found in the water column, but also the response of plants/algae to these concentrations.

e1) What are the sediment flux rates for nutrients in these waterbodies?

e2) What is the sediment oxygen demand in these waterbodies?

e3) What are the standing crop totals and primary productivity rates for plant/macroalgae biomass in these waterbodies?

f) What are the relative contributions for impairing pollutants(s) from each land use type or from regulated industrial/municipal facilities?

g) What is the total annual load reduction of nutrients needed so that beneficial uses and water quality objectives associated with eutrophication/ low dissolved oxygen and nuisance algae growth are met?

h1) What is the total annual load reduction of bacteria needed so that recreational beneficial uses and water quality objectives are met?

h2) What is the total annual load reduction of sediment needed so that sedimentation/siltation is reduced to meet water quality objectives and to prevent lagoon mouth closings, loss of lagoon depth, and loss of important habitats?

h3) What is the total annual load reduction of TDS needed in Agua Hedionda Creek so that water quality objectives that support the MUN beneficial uses are met?

Lagoons/watersheds shall be monitored for the constituents that correspond to the pollutants/stressors indicated for the segments listed in Table 1.

A2. IN SITU DATA COLLECTION (FIELD MEASUREMENTS)
The Monitoring Program Workplan shall include, at a minimum, the constituents, sampling locations, and frequency and duration of sampling as indicated below for water temperature, specific conductivity, pH, dissolved oxygen, and flow velocity measurements needed to calibrate and verify the models to be used to calculate TMDLs in the water quality limited segments. Site-specific changes to this

sampling specification may be proposed to the San Diego Water Board along with the scientific rationale for the changes. Any proposed changes may not be implemented until incorporated into this Order by amendment.

Hourly field measurements are required to document the influence of tides and/or daily fluctuations of dissolved oxygen. The daily fluctuations of dissolved oxygen are amplified in waterbodies with nutrient/ eutrophic impairments. All the lagoons listed in this Order are subject to tidal influence and/or impaired for nutrients/eutrophication (which can lead to low dissolved oxygen concentrations). Therefore all lagoons, sloughs, creek mouths must have the following data collected:

i. Constituents

- Specific conductivity
- Water temperature
- Surface water depth (if no bathymetry data exist)
- Velocity (optional)
- Dissolved oxygen (DO) and pH (only required in lagoons impaired for eutrophic conditions/nutrients)

ii. Location

A minimum of one sample site in each segment or portion of a segment shall be selected. The sampling site shall represent ambient water conditions and shall not be influenced by storm drains or other effluent discharges.

iii. Frequency/Duration

Two two-week periods[5] of hourly monitoring for the constituents listed above.

One two-week period shall be selected between October 1, 2007, through April 30, 2008 and another two-week period between May 1, 2008, through September 30, 2008.

A3. WATERSHED POLLUTAGRAPHS AND LAGOON WATER QUALITY (STORM EVENT)

The Monitoring Program Workplan shall include, at a minimum, the constituents, sampling locations, and frequency and duration of sampling as indicated below for generation of two separate storm pollutagraphs. When planning for monitoring, forecasted storm events of 0.2 or more inches of rainfall should be considered. Site-specific changes to this sampling specification may be proposed to the San Diego Water Board along with the scientific rationale for the changes. Any proposed changes may not be implemented until incorporated into this Order by amendment.

When water depth is sufficient to submerge a probe to collect the measurement, field measurements of water temperature, pH, conductivity, and dissolved oxygen shall be collected when water quality samples listed below are collected.

[5] The two-week sampling periods shall be during the same time for all sections (A2, A3, and A4) monitoring.

i. Constituents

Waters impaired due to Indicator Bacteria (Loma Alta Slough, Buena Vista Lagoon, Agua Hedionda Lagoon, San Elijo Lagoon)

- Fecal coliform
- Total coliform
- *Enterococcus*
- Flow rate

Waters impaired due to Sedimentation/Siltation (Buena Vista Lagoon, Agua Hedionda Lagoon, San Elijo Lagoon, Los Penasquitos Lagoon)

- Total Suspended Solids
- Turbidity
- Flow rate

Waters impaired due to TDS (Agua Hedionda Creek)

- Total dissolved solids
- Flow rate

Waters impaired due to Eutrophic Condition/Nutrients (Santa Margarita Lagoon, Loma Alta Slough, Buena Vista Lagoon, San Elijo Lagoon, Famosa Slough and Channel)

- Total nitrogen
- Total phosphorus
- Flow rate

ii. Location

Watersheds:

A minimum of one sample site shall be selected in the main tributary to the water quality limited segment, upstream of the tidal prism. The sampling site shall represent ambient water conditions and shall not be directly influenced by storm drains or other effluent discharges. If a tributary has an established mass loading station, this site should be used for the pollutagraph monitoring.

Lagoons:

A minimum of one sample site in each lagoon segment or portion of a segment shall be selected. The sampling site shall represent ambient water conditions and shall not be influenced by storm drain flow or other effluent discharges.

iii. Frequency/Duration

Watersheds:

Hourly grab samples shall be collected during the storm event. From those hourly samples collected, a minimum of eight grab samples representative of the storm event shall be analyzed. Any remaining samples may be disposed. The samples shall be collected to

represent at least the first flush and peak flow to the extent that is practicable.
At a minimum, sampling shall occur during two storm events, between October 1, 2007 and April 30, 2008. Sampling of at least one early season storm is preferred.

Lagoons:
A minimum of one grab sample shall be collected in each lagoon segment during each storm event corresponding to the storm events described above for Watershed Frequency/Duration in this section. Samples should be collected as close to the peak flow of the storm event as practicable.

A4. WATERSHED MODEL (DRY WEATHER)
The Monitoring Program Workplans shall include a study to conduct a one-day survey during each two-week period of hourly sensor data collection to measure the flow rate and water quality of all storm drain discharges of visible flow into a lagoon. At a minimum, the constituents, sampling locations, and frequency and duration of sampling as indicated below for the pollutants impairing a water quality limited segment shall be included in the Workplan. Site-specific changes to this sampling specification may be proposed to the San Diego Water Board along with the scientific rationale for the changes. Any proposed changes may not be implemented until incorporated into this Order by amendment.

i. Constituents
When water depth is sufficient to submerge a probe to collect a measurement, field measurements of water temperature, pH, conductivity, and dissolved oxygen shall be collected when water quality samples listed below are collected. If water depths in the lagoon/slough/creek mouth are sufficient to collect field measurements, but not at the storm drain outfall, then a measurement may be collected in the lagoon/slough/creek mouth near the storm drain.

Waters impaired due to Indicator Bacteria (Loma Alta Slough, Buena Vista Lagoon, Agua Hedionda Lagoon, San Elijo Lagoon)
- Fecal coliform
- Total coliform
- *Enterococcus*
- Flow rate

Waters impaired due to Eutrophic Conditions/ Nutrients (Santa Margarita Lagoon, Loma Alta Slough, Buena Vista Lagoon, San Elijo Lagoon, Famosa Slough and Channel)
- Ammonia
- Total kjeldahl nitrogen
- Nitrite as N
- Nitrate as N

- Total nitrogen
- Ortho phosphate as P
- Total phosphorus
- Chlorophyll *a*
- Biochemical oxygen demand (BOD_5)
- Flow rate

ii. Location
All storm drain flow, as it exits the outfall, discharging within the confines of each lagoon or estuary.

iii. Frequency/Duration
Time-composite samples shall be collected once during the two-week period of hourly sensor data collection from all storm drain outfalls with visible flow that directly discharge into a lagoon. A time composite sample consists of a sample collected every 15 minutes at the same location (at 0 min., 15 min. and 30 min.). These three samples are then composited into one sample to take to the lab for analysis.

A5. LAGOON AND TRIBUTARY WATER QUALITY MONITORING FOR TWO-WEEK PERIODS.

The Monitoring Program Workplans shall include at a minimum the constituents, sampling locations, and frequency and duration of sampling as indicated below for the pollutants impairing a water quality limited segment. Site-specific changes to this sampling specification may be proposed to the San Diego Water Board along with the scientific rationale for the changes. Any proposed changes may not be implemented until incorporated into this Order by amendment.

i. Constituents
Field measurements of water temperature, pH, conductivity, and dissolved oxygen shall be collected when water quality samples listed below are collected.

Waters impaired due to Indicator Bacteria (Loma Alta Slough, Buena Vista Lagoon, Agua Hedionda Lagoon, San Elijo Lagoon)

- Fecal coliform
- Total coliform
- *Enterococcus*
- Tributary flow rate

Waters impaired due to Sediment/Siltation (Buena Vista Lagoon, Agua Hedionda Lagoon, Agua Hedionda Creek, San Elijo Lagoon, Los Penasquitos Lagoon)

- Turbidity
- Total Suspended Solids
- Tributary flow rate

Waters impaired due to TDS (Agua Hedionda Creek)
- Total dissolved solids
- Tributary flow rate

Waters impaired due to Eutrophic Conditions/Nutrients (Santa Margarita Lagoon, Loma Alta Slough, Buena Vista Lagoon, San Elijo Lagoon, Famosa Slough and Channel)
- Ammonia as N
- Total kjeldahl nitrogen
- Nitrite as N
- Nitrate as N
- Total nitrogen
- Ortho phosphate as P
- Total phosphorus
- Chlorophyll *a*
- Biochemical oxygen demand (BOD_5)
- Tributary flow rate

ii. Location
Lagoons:
A minimum of one sample site in each segment or portion of a segment shall be selected. The sampling site shall represent ambient water conditions and shall not be influenced by storm drain flow or other effluent discharges.

Tributaries:
A minimum of one sample site shall be selected in the tributary to the water quality limited segment, upstream of the tidal prism. The sampling site shall represent ambient water conditions and shall not be influenced by storm drain flow or other effluent discharges.

iii. Frequency/Duration
Time composite samples will consist of one sample collected every 15 minutes at the same location (at 0 min., 15 min., and 30 min.). These three samples are then composited into one sample to take to the lab for analysis.

Lagoons:
For tidally influenced lagoons, at a minimum, time composite samples shall be collected twice daily for the two two-week periods corresponding to the two-week periods of hourly sensor data collection. One sample shall be collected during high tide, the other sample during low tide.

Tidally influenced lagoons include Santa Margarita Lagoon, Loma Alta Slough, Agua Hedionda Lagoon, San Elijo Lagoon, Los Penasquitos Lagoon, and Famosa Slough and Channel. The mouth opening can

be maintained by dredging and still be considered a tidally influenced lagoon.
For non-tidally influenced lagoons, at a minimum, time composite samples shall be collected once daily for two two-week periods.

Tributaries:
For tributaries (and non-tidal lagoons), at a minimum, time composite samples shall be collected once daily for two two-week periods corresponding to the two-week periods of hourly sensor data collection.

A6. RAINFALL DATA REPRESENTATIVE OF THE WATERSHED
The Monitoring Program Workplans shall include precipitation monitoring and describe at a minimum the rainfall sampling device to be used, location of the gage, and frequency and duration of sampling as indicated below for the watersheds with impaired water quality limited segments. If an established and ongoing rainfall gage can be identified that is representative of the watershed, then the data from that gage may be used in place of a newly established gage specific to this project. If the rain monitoring equipment becomes inoperative, it must be repaired or replaced within 7 days. The San Diego Water Board must be notified within 24 hours of the failure of any of the rain monitoring equipment. If an established gage is used, the Workplan must specify who is responsible for maintaining and collecting data from this gage. The gage shall collect the following information:

i. Constituents
Rainfall measured in 1/100th inches per hour.

ii. Location
The rainfall gage shall be placed in a location that is representative of each watershed with an impaired waterbody.

iii. Frequency/Duration
The rainfall gage shall be operational to collect measurements continuously during every rainfall event commencing with the first storm after October 1, 2007, until the cessation of the monitoring program described in the workplans.

A7. LAGOON SEDIMENT SAMPLE
The Monitoring Program Workplans shall include at a minimum the constituents, sampling locations, and frequency and duration of sediment sampling as indicated below for the pollutants impairing a water quality limited segment. Site-specific changes to this sampling specification may be proposed to the San Diego Water Board along with the scientific rationale for the changes. Any proposed changes may not be implemented until incorporated into this Order by amendment.

i. Constituents
All lagoons impaired for nutrient/eutrophication and/or sedimentation/siltation:

Grain size distribution

ii. Location
A minimum of one sample site in each lagoon segment or portion of a segment shall be selected.

iii. Frequency/Duration
- A minimum of one sample shall be collected using surficial sampling tubes during each two-week period of hourly sensor data collection.
- A minimum of one sample shall be collected within 72 hours after the beginning of each storm event monitored for pollutagraph data described in Section 3.

A8. SPECIAL STUDIES
The Monitoring Program Workplans shall include, at a minimum, the following one-time surveys of waters impaired for eutrophic conditions/nutrients:
- Macrophyte and periphyton (estimation of biomass)
- Sediment oxygen demand
- Nutrient flux from sediments

A9. QUALITY ASSURANCE PROJECT PLAN AND IMPLEMENTATION OF MONITORING PROGRAM
The Dischargers shall submit an adequate Quality Assurance Project Plan (QAPP) for field and laboratory operations by **September 1, 2007**, as described below. If, within 30 days after submittal of the QAPP, no comments have been received from the San Diego Water Board, the Dischargers shall implement the QAPP and Workplans.

a. The QAPP for field operations shall include, at a minimum, the following:
   - Quality assurance objectives;
   - Sample container preparation, labeling and storage;
   - Chain-of-custody tracking;
   - Field setup;
   - Sampler equipment check and setup;
   - Sample collection;
   - Use of field blanks to assess field contamination;
   - Use of field duplicate samples;
   - Transportation to the laboratory;
   - Training of field personnel; and
   - Evaluation and enhancement if needed of the QA/QC plan.

b. The QAPP for laboratory operations shall include, at a minimum, the following:
   - Quality assurance objectives;
   - Organization of laboratory personnel, their education, experience, and duties;
   - Sample procedures;

- Sample custody;
- Calibration procedures and frequency;
- Analytical procedures;
- Data reduction, validation, and reporting;
- Internal quality control procedures;
- Performance and system audits;
- Preventive maintenance;
- Assessment of accuracy and precision;
- Correction actions; and a
- Quality assurance report.

Furthermore, the QAPP shall meet the standards as set forth in the Quality Assurance Project Plan for the State of California's Surface Water Ambient Monitoring Program (SWAMP). The SWAMP QAPP can be found on the World Wide Web at: *http://www.swrcb.ca.gov/swamp/index.html*.

A10. DATA REPORTS
Data Reports containing monitoring results from implementation of the Monitoring Program Workplan shall be submitted within 90 days after each distinct period of data collection has been completed. Data reports shall consist of electronic copies of laboratory results in either WORD or PDF format, and data compilations in Microsoft Excel spreadsheet format.

A11. CHANGES TO ORDER
The Dischargers may propose changes or alternatives to the directives in this Order if a valid rationale for the changes is shown. The Dischargers shall implement proposed changes upon amendment of this Order by the San Diego Water Board.

B. PROVISIONS

1. Duty to Comply - The Discharger(s) shall obtain all permits and access agreements needed to implement the Directives of this Order. The Discharger(s) shall properly manage, treat, and/or dispose of contaminated water samples in accordance with applicable federal, state, and local laws and regulations.

2. Request to Provide Information - The Discharger(s) may present characterization data, preliminary interpretations and conclusions as they become available, rather than waiting until a report is prepared. This type of on-going reporting can facilitate a consensus being reached between the Discharger(s) and the San Diego Water Board and may result in overall reduction of the time necessary to meet data needs.

3. Waste Constituent Analysis - All analyses shall be conducted at a laboratory certified for such analyses by the State Department of Health Services. Specific methods of analysis must be identified. If the Discharger(s) proposes to use methods or test procedures other than those included in the most current version of 40 CFR 136, *Guidelines Establishing Test Procedures for the Analysis of Pollutants;*

Procedures for Detection and Quantification, the exact methodology must be submitted for review by the San Diego Water Board prior to use. The director of the laboratory whose name appears on the certification shall supervise all analytical work in his/her laboratory and shall sign all reports submitted to the San Diego Water Board.

4. *Signatory Requirements* - [40 CFR 122.41(k)(1) and 40 CFR 122.22] All applications, reports, or information submitted to the San Diego Water Board shall be signed and certified.

a. All reports required by this Order shall be signed as follows:

(1) Responsible Corporate Officer(s) - For the purposes of this provision, a responsible corporate officer means: (i) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy - or decision-making functions for the corporation, or (ii) the manager of one or more manufacturing, production, or operating facilities, if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.
(2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or
(3) For a municipality, State, Federal or other public agency: by either a principal executive office or ranking elected official. For purposes of this section, a principal executive officer of a Federal agency includes: (a) the chief executive officer of the agency; or (b) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of U.S. EPA).

b. All reports required by this Order and other information requested by the San Diego Water Board shall be signed by a person described in paragraph a. of this reporting requirement, or by a duly authorized representative of that person. A person is a duly authorized representative only if:

(1) The authorization is made in writing by a person described in paragraph a. of this report requirement;

(2) The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.); and

(3) The written authorization is submitted to the San Diego Water Board.

c. *Changes to Authorization* - If an authorization under paragraph (b) of this provision is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph (b) of this provision must be submitted to the San Diego Water Board prior to or together with any reports or information to be signed by an authorized representative.

d. *Certification Statement* - Any person signing a document under paragraph a. or b. of this provision shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

5. All reports/workplans required under this Order shall be submitted to:

Executive Officer
Attn: Water Quality Standards Unit
California Regional Water Quality Control Board
San Diego Region
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4340

6. *Inspection and Entry* - [40 CFR 122.41(i)] [California Water Code section 13267 and 13383]
The discharger shall allow the San Diego Water Board, or an authorized San Diego Water Board representative, or an authorized representative of the U.S. EPA (including an authorized contractor acting as a representative of the San Diego Water Board or U.S. EPA), upon presentation of credentials and other documents as may be required by law, to:

a. Enter upon the discharger's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this Order;
b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this Order;
c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Order; and
d. Sample or monitoring at reasonable times, for the purposes of assuring compliance with this Order or as otherwise authorized by the

Clean Water Act or California Water Code, any substances or parameters at any location.

Ordered by:

John H. Robertus

EXECUTIVE OFFICER

Date Issued:

Attachment 1. Responsible Dischargers Within the Watershed of a Water Quality Limited Segment.

Water Quality Limited Segments	HUC	Municipalities and Military Facilities	Counties, State Agencies, and Other Facilities
Santa Margarita Lagoon	902.1	Camp Pendleton Fallbrook Naval Weapons Station Murrieta Temecula	1. San Diego County 2. Riverside County Flood Control and Water Conservation District 3. Caltrans 4. North County Transit District
Loma Alta Slough and Ocean Shoreline	904.1	Oceanside Vista	1. San Diego County 2. Caltrans
Buena Vista Lagoon and Ocean Shoreline	904.2	Carlsbad Oceanside Vista San Marcos	1. San Diego County 2. Caltrans
Agua Hedionda Lagoon and lower Agua Hedionda Creek	904.3	Carlsbad Oceanside San Marcos Vista	1. San Diego County 2. Caltrans
San Elijo Lagoon and Ocean Shoreline	904.6	Encinitas Escondido San Marcos Solana Beach	1. San Diego County 2. Caltrans 3. City of Escondido Hale Avenue Resource Recovery Facility
Los Penasquitos	906.1	Del Mar Poway San Diego	1. San Diego County 2. Caltrans
Famosa Slough and Channel	907.1	San Diego	1. Caltrans

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD, SAN DIEGO REGION

ADDENDUM NO. 1 TO INVESTIGATION ORDER NO. R9-2006-0076

OWNERS AND OPERATORS OF MUNICIPAL SEPARATE STORM SEWER SYSTEMS, CALIFORNIA DEPARTMENT OF TRANSPORTATION, HALE AVENUE RESOURCE RECOVERY FACILITY, AND NORTH COUNTY TRANSIT DISTRICT RESPONSIBLE FOR THE DISCHARGE OF BACTERIA, NUTRIENTS, SEDIMENT, AND TOTAL DISSOLVED SOLIDS INTO IMPAIRED LAGOONS, ADJACENT BEACHES, AND AGUA HEDIONDA CREEK

The California Regional Water Quality Control Board, San Diego Region (hereinafter, San Diego Water Board) finds that:

1. Postponing by one month the due date for submitting the Workplans required by Directive A1 is reasonable, provided that the Responsible Dischargers are prepared to initiate the field activities in their Workplans by October 1, 2007.

2. Information provided by the City of San Marcos (the City) verifies that the City is not located within the Buena Vista Lagoon Watershed. Accordingly, the City is not responsible for filing Monitoring Program Reports for the Buena Vista Lagoon as required by Investigation Order No. R9-2006-0076.

IT IS HEREBY ORDERED, pursuant to sections 13267 and 13383 of the Water Code that:

1. Directive A1 (Monitoring Program Workplans) of Investigative Order No. R9-2006-076 is revised follows: The due date of **August 1, 2007**, as stated in the first paragraph, for the development and submission of a Monitoring Program Workplan to the San Diego Water Board by the Dischargers is changed to **September 1, 2007**.

2. The table in Attachment 1 is revised as follows: The City of San Marcos is deleted from the Buena Vista Lagoon and Ocean Shoreline section of the table as a municipality within this watershed. The revised table is shown below in Attachment 1, Revised.

John H Robertus

JOHN. H. ROBERTUS
Executive Officer

Date Issued: November 1, 2006

ATTACHMENT 1, Revised

Responsible Dischargers within the Watershed of a Water Quality Limited Segment.

Water Quality Limited Segments	HUC	Municipalities and Military Facilities	Counties, State Agencies, and Other Facilities
Santa Margarita Lagoon	902.1	Camp Pendleton Fallbrook Naval Weapons Station Murrieta Temecula	1. San Diego County 2. Riverside County Flood Control and Water Conservation District 3. Caltrans 4. North County Transit District
Loma Alta Slough and Ocean Shoreline	904.1	Oceanside Vista	1. San Diego County 2. Caltrans
Buena Vista Lagoon and Ocean Shoreline	904.2	Carlsbad Oceanside Vista	1. San Diego County 2. Caltrans
Agua Hedionda Lagoon and lower Agua Hedionda Creek	904.3	Carlsbad Oceanside San Marcos Vista	1. San Diego County 2. Caltrans
San Elijo Lagoon and Ocean Shoreline	904.6	Encinitas Escondido San Marcos Solana Beach	1. San Diego County 2. Caltrans 3. City of Escondido Hale Avenue Resource Recovery Facility
Los Penasquitos	906.1	Del Mar Poway San Diego	1. San Diego County 2. Caltrans
Famosa Slough and Channel	907.1	San Diego	1. Caltrans

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD, SAN DIEGO REGION

ADDENDUM NO. 2 TO INVESTIGATION ORDER NO. R9-2006-0076

OWNERS AND OPERATORS OF MUNICIPAL SEPARATE STORM SEWER SYSTEMS, CALIFORNIA DEPARTMENT OF TRANSPORTATION, HALE AVENUE RESOURCE RECOVERY FACILITY, RESPONSIBLE FOR THE DISCHARGE OF BACTERIA, NUTRIENTS, SEDIMENT, AND TOTAL DISSOLVED SOLIDS INTO IMPAIRED LAGOONS, ADJACENT BEACHES, AND AGUA HEDIONDA CREEK

The California Regional Water Quality Control Board, San Diego Region (hereinafter, San Diego Water Board) finds that:

1. **Persons Responsible for the Discharge**: The North County Transit District permanently ceased its dewatering discharge into the Santa Margarita Lagoon on March 1, 2007, and should no longer be responsible for filing the Monitoring Program Reports required by Order R9-2006-0076 (Order).

2. **Monitoring Program Workplan**: The responsible dischargers have filed with the San Diego Water Board the Monitoring Program Workplan required by directive A1 of the Order. The workplan, written by the Southern California Coastal Water Research Project, titled "*San Diego Coastal Lagoons TMDL Monitoring Workplan*" (Attachment 2) was timely received by the San Diego Water Board on June 18, 2007. The workplan addresses all seven impaired lagoons. Pursuant to directive A11, the responsible dischargers proposed changes and alternatives to the monitoring requirements in directives A1 through A8 of the Order, and provided a valid rationale for these changes in the workplan. The workplan is adequate to guide the collection of monitoring data needed to characterize dry weather flow and storm flow influenced water quality in the segments listed in Table 1 of the Order to complete development of TMDLs, and load and wasteload allocations and reductions. The workplan study questions a through h3 listed in directive A1 were revised in the monitoring workplan.

3. **Data Report Submittal:** The responsible dischargers requested that directive A10 be changed to require quarterly filing of data reports on January 1st, April 1st, July 1st, and October 1st, rather than within 90 days of each distinct

period of data collection. This request provides more specificity regarding when data reports are due. In addition, fewer data submittals will take less time to enter into the models to be used for TMDL development.

IT IS HEREBY ORDERED, pursuant to sections 13267 and 13383 of the Water Code that:

1. The North County Transit District is no longer responsible for filing the Monitoring Program Reports required by Order No. R9-2006-0076 and Addendum No. 1. The table in Attachment 1, Revised, to Addendum No. 1 is revised a second time as follows: The North County Transit District is deleted from the Santa Margarita Lagoon section of the table as a Responsible Discharger within this watershed. The revised table is shown in Attachment 1, Second Revision, to this Addendum No. 2.

2. The study questions in the Monitoring Program Workplan titled "*San Diego Coastal Lagoons TMDL Monitoring Workplan*", dated June 18, 2007, (Attachment 2) supersede the study questions a through h3 in directive A1.

3. The monitoring requirements in the Monitoring Program Workplan supersede directives A2 through A8.

4. The Responsible Dischargers identified in Attachment 1, Second Revision, shall file with the San Diego Water Board quarterly data reports, one for each lagoon watershed, due on January 1st, April 1st, July 1st, and October 1st containing monitoring results collected from 90 to 120 days (or sooner) prior to the reporting due date. At a minimum, data reports shall consist of electronic copies of laboratory results, including quality assurance/quality control data, in either WORD or PDF format and data compilations in EXCEL spreadsheet format. The reports must identify the analytical methods used, detection limits obtained for each reported constituent, and a map showing the location of monitoring stations. This directive supersedes directive A10 of Order No. R9-2006-0076.

John H. Robertus

JOHN. H. ROBERTUS
Executive Officer

Date Issued: June 21, 2007

Attachment 1, Second Revision

Responsible Dischargers within the Watershed of a Water Quality Limited Segment.

Water Quality Limited Segments	HUC	Municipalities and Military Facilities	Counties, State Agencies, and Other Facilities
Santa Margarita Lagoon	902.1	Camp Pendleton Fallbrook Naval Weapons Station Murrieta Temecula	1. San Diego County 2. Riverside County Flood Control and Water Conservation District 3. Caltrans
Loma Alta Slough and Ocean Shoreline	904.1	Oceanside Vista	1. San Diego County 2. Caltrans
Buena Vista Lagoon and Ocean Shoreline	904.2	Carlsbad Oceanside Vista	1. San Diego County 2. Caltrans
Agua Hedionda Lagoon and lower Agua Hedionda Creek	904.3	Carlsbad Oceanside San Marcos Vista	1. San Diego County 2. Caltrans
San Elijo Lagoon and Ocean Shoreline	904.6	Encinitas Escondido San Marcos Solana Beach	1. San Diego County 2. Caltrans 3. City of Escondido Hale Avenue Resource Recovery Facility
Los Penasquitos	906.1	Del Mar Poway San Diego	1. San Diego County 2. Caltrans
Famosa Slough and Channel	907.1	San Diego	1. Caltrans

ATTACHMENT 2. FOR INVESTIGATION ORDER NO. R9-2006-0076.

See "Workplan for San Diego Lagoons TMDL Monitoring – Final 6-18-2007. pdf".

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD, SAN DIEGO REGION

ADDENDUM NO. 3 TO INVESTIGATION ORDER NO. R9-2006-0076

OWNERS AND OPERATORS OF MUNICIPAL SEPARATE STORM SEWER SYSTEMS, CALIFORNIA DEPARTMENT OF TRANSPORTATION, HALE AVENUE RESOURCE RECOVERY FACILITY, RESPONSIBLE FOR THE DISCHARGE OF BACTERIA, NUTRIENTS, SEDIMENT, AND TOTAL DISSOLVED SOLIDS INTO IMPAIRED LAGOONS, ADJACENT BEACHES, AND AGUA HEDIONDA CREEK

The California Regional Water Quality Control Board, San Diego Region (hereinafter, San Diego Water Board) finds that:

1. **Need for Land Elevation Data at Ocean Inlets:** Data are needed to develop Total Maximum Daily Loads (TMDLs) and their associated load and wasteload allocations and reductions for the water quality limited water body segments identified in Table 1 of Investigation Order No. R9-2006-0076 for each impairing pollutant. The San Diego Water Board intends to develop TMDLs, allocations, and reductions through modeling studies of the water quality limited lagoons and their watersheds. Land elevations across the ocean inlets to the lagoons are needed to configure accurate boundary conditions between the lagoons and the ocean in the lagoon models.

2. **Regulatory Authority and Necessity:** Water Code Section 13267 authorizes the San Diego Water Board to require the submission of monitoring reports from any person discharging pollutants into waters of the State. Water Code Section 13383 authorizes the San Diego Water Board to establish monitoring and reporting requirements for discharges regulated under the National Pollutant Discharge Elimination System. Reporting of land elevation data will ensure accurate boundary configuration of the ocean inlets in the models of the lagoons as described in finding 1. The modeling studies are part of an overall water quality investigation to assess the conditions of pollution in the lagoons and develop TMDLs for the lagoons. These actions will result in the restoration and protection of water quality necessary to support the designated beneficial uses of these waterbodies. The cost to produce a bathymetry survey of all of Famosa Slough was approximately $3,700. Surveying a cross-section of land elevations at an ocean inlet should cost significantly less, since it is a survey of a single, two dimensional cross-section, as opposed to a three dimensional survey of an entire lagoon. The associated costs of surveying cross-sections of the ocean inlets of

the lagoons bear a reasonable relationship to the need for the actions, specifically the protection of water quality and beneficial uses.

3. **California Environmental Quality Act**: This action is an order to enforce the laws and regulations administered by the San Diego Water Board. As such, this action is categorically exempt from the provisions of the California Environmental Quality Act pursuant to section 15308 of the Public Resources Code.

IT IS HEREBY ORDERED, pursuant to sections 13267 and 13383 of the Water Code that:

C. Ocean Inlet Land Elevation Data

C1. Elevation Data Requirements

The dischargers identified in Attachment 1, Second Revision, to Addendum No. 2 to Investigation Order No. R9-2006-0076 shall submit a cross-section showing the land elevations of the ocean inlet to each lagoon identified in Attachment 1, Second Revision. The cross-sections of the ocean inlets (except for Los Penasquitos Lagoon and Buena Vista Lagoon) shall be surveyed immediately prior to the start of the first index monitoring period described in the Monitoring Program Workplan titled *"San Diego Coastal Lagoons TMDL Monitoring Workplan"* dated June 18, 2007 (Attachment 2 to Addendum No. 2 to Investigation Order No. R9-2006-0076). The number of points to be surveyed along the cross-section shall be adequate to describe the width, depth, and shape of the inlet and its banks. The cross-section shall be surveyed at the location along the length of the inlet where the bottom of the inlet is at its highest elevation. If a beach berm has closed the inlet, the cross-section shall be surveyed at the location where the beach berm is at its highest elevation.

If the width, depth, or shape of the inlet and its banks changes significantly[1] prior to the start of any subsequent index monitoring period, the cross-section of the inlet shall be resurveyed before the subsequent index monitoring period commences. The cross-section shall be resurveyed at the same location along the length of the inlet that was previously surveyed.

Surveys of the ocean inlet at Los Penasquitos Lagoon shall be conducted in the same manner as above. However, the initial survey shall be conducted within three weeks of the beginning of the continuous monitoring period (October 1 – March 31), rather than immediately prior to the first index monitoring period. Subsequent surveys shall be conducted during the continuous monitoring period following each storm event that results in a significant change to the width, depth, or shape of the inlet and its banks. Since Buena Vista Lagoon is never open to tidal exchange, the ocean inlet for this lagoon does not need to be surveyed.

[1] Significant changes include opening of the ocean inlet due to storm events, opening of the ocean inlet by mechanical means, and other clearly visible alterations of the ocean inlet's width, depth, or shape, as determined by best professional judgment.

C2. Elevation Data Submittal
The cross-sections of the ocean inlets shall be submitted as part of the corresponding data reports required by directive 4 of Addendum No. 2 to Investigation Order No. R9-2006-0076.

C3. Contractor/Consultant Qualifications
All survey submittals shall be signed by and stamped with the seal of a California professional land surveyor. The surveys shall be conducted according to the standards of practice of professional land surveyors in California.

John H. Robertus

JOHN. H. ROBERTUS
Executive Officer

Date Issued: October 5, 2007

Chemistry Results Summary

Station ID	Date	Time	General Chemistry		
			Conductivity (mS/cm)	pH (pH Units)	TSS
			MRL= 0.001	MRL= 0.2	MRL= 5
Storm Event 1- Carroll Canyon Creek					
LPC-W1-CCC-PG1-TSS-1	11/30/2007	1235	0.291	7.5	488
LPC-W1-CCC-PG1-TSS-2	12/1/2007	1336	0.284	7.5	340
LPC-W1-CCC-PG1-TSS-3	12/1/2007	1435	0.244	7.5	716
LPC-W1-CCC-PG1-TSS-4	12/1/2007	1535	0.268	7.5	596
LPC-W1-CCC-PG1-TSS-5	12/1/2007	1644	0.329	7.5	396
LPC-W1-CCC-PG1-TSS-6	12/1/2007	1740	0.406	7.6	144
LPC-W1-CCC-PG1-TSS-7	12/1/2007	1835	0.469	7.6	116
LPC-W1-CCC-PG1-TSS-9	12/1/2007	2030	0.557	7.5	60
LPC-W1-CCC-PG1-TSS-10	12/1/2007	2130	0.326	7.6	568
LPC-W1-CCC-PG1-TSS-11	12/1/2007	2240	0.3	7.5	760
Storm Event 2- Carroll Canyon Creek					
LPL-W2-CCC-PG2-TSS-1	12/7/2007	0530			222
LPL-W2-CCC-PG2-TSS-3	12/7/2007	0710			130
LPL-W2-CCC-PG2-TSS-5	12/7/2007	0810			237
LPL-W2-CCC-PG2-TSS-6	12/7/2007	0840			558
LPL-W2-CCC-PG2-TSS-7	12/7/2007	0910			476
LPL-W2-CCC-PG2-TSS-8	12/7/2007	0940			404
LPL-W2-CCC-PG2-TSS-9	12/7/2007	1010			380
LPL-W2-CCC-PG2-TSS-10	12/7/2007	1040			312
LPL-W2-CCC-PG2-TSS-11	12/7/2007	1110			206
LPL-W2-CCC-PG2-TSS-12	12/7/2007	1140			224
LPL-W2-CCC-PG2-TSS-14	12/7/2007	1240			66
LPL-W2-CCC-PG2-TSS-19	12/7/2007	1531			29
Storm Event 3- Carroll Canyon Creek					
LPL-W3-CCC-PG3-TSS-3	2/3/2008	0710			5 U
LPL-W3-CCC-PG3-TSS-4	2/3/2008	0835			30.3
LPL-W3-CCC-PG3-TSS-6	2/3/2008	0905			7.7
LPL-W3-CCC-PG3-TSS-8	2/3/2008	1014			30
LPL-W3-CCC-PG3-TSS-11	2/3/2008	1121			148
LPL-W3-CCC-PG3-TSS-13	2/3/2008	1213			221
LPL-W3-CCC-PG3-TSS-15	2/3/2008	1307			241
LPL-W3-CCC-PG3-TSS-17	2/3/2008	1407			178
LPL-W3-CCC-PG3-TSS-19	2/3/2008	1507			124
LPL-W3-CCC-PG3-TSS-19 Dup	2/3/2008	1507			111
LPL-W3-CCC-PG3-TSS-21	2/3/2008	1607			100
LPL-W3-CCC-PG3-TSS-23	2/3/2008	1707			103
LPL-W3-CCC-PG3-TSS-32	2/3/2008	2137			31

Chemistry Results Summary

Station ID	Date	Time	General Chemistry		
			Conductivity (mS/cm)	pH (pH Units)	TSS
			MRL= 0.001	MRL= 0.2	MRL= 5
Storm Event 1-Segment 1					
LPL-SEG1-PG1-TSS-1	12/1/2007	0515	0.923	7.4	38
LPL-SEG1-PG1-TSS-2	12/1/2007	0530	1.043	7.5	109
LPL-SEG1-PG1-TSS-3	12/1/2007	0630	1.192	7.5	54
LPL-SEG1-PG1-TSS-4	12/1/2007	0730	1.215	7.4	24
LPL-SEG1-PG1-TSS-5	12/1/2007	0830	1.218	7.4	56
LPL-SEG1-PG1-TSS-6	12/1/2007	0930	1.226	7.5	27
LPL-SEG1-PG1-TSS-7	12/1/2007	1030	1.233	7.6	22
LPL-SEG1-PG1-TSS-8	12/1/2007	1130	1.262	7.5	19
LPL-SEG1-PG1-TSS-9	12/1/2007	1230	1.261	7.6	21.5
LPL-SEG1-PG1-TSS-10	12/1/2007	1330	1.281	7.6	18
Storm Event 2-Segment 1					
LPL-W2-SEG1-PG2-TSS-5	12/7/2007	0851			18
LPL-W2-SEG1-PG2-TSS-8	12/7/2007	1021			21.3
LPL-W2-SEG1-PG2-TSS-10	12/7/2007	1121			28.7
LPL-W2-SEG1-PG2-TSS-13	12/7/2007	1245			19.3
LPL-W2-SEG1-PG2-TSS-14	12/7/2007	1345			13.7
LPL-W2-SEG1-PG2-TSS-16	12/7/2007	1545			15.3
LPL-W2-SEG1-PG2-TSS-17	12/7/2007	1800			11.3
LPL-W2-SEG1-PG2-TSS-18	12/7/2007	2000			13
LPL-W2-SEG1-PG2-TSS-19	12/7/2007	2200			13.3
LPL-W2-SEG1-PG2-TSS-20	12/8/2007	0000			12.3
Storm Event 3-Segment 1					
LPL-W3-CML-SEG1-TSS-1	2/3/2008	0701			123.9
LPL-W3-CML-SEG1-TSS-4	2/3/2008	1001			44
LPL-W3-CML-SEG1-TSS-6	2/3/2008	1201			33.3
LPL-W3-CML-SEG1-TSS-7	2/3/2008	1301			32
LPL-W3-CML-SEG1-TSS-9	2/3/2008	1501			31.3
LPL-W3-CML-SEG1-TSS-11	2/3/2008	1701			62
LPL-W3-CML-SEG1-TSS-13	2/3/2008	1901			28.7
LPL-W3-CML-SEG1-TSS-16	2/3/2008	2115			15.3
LPL-W3-CML-SEG1-TSS-18	2/4/2008	0115			40
LPL-W3-CML-SEG1-TSS-18 Dup	2/4/2008	0115			2.7 J
LPL-W3-CML-SEG1-TSS-20	2/4/2008	0515			21.3
LPL-W3-CML-SEG1-TSS-23	2/4/2008	1115			32
LPL-W3-CML-SEG1-TSS-25	2/4/2008	1515			24.7

Chemistry Results Summary

Station ID	Date	Time	General Chemistry Conductivity (mS/cm) MRL= 0.001	pH (pH Units) MRL= 0.2	TSS MRL= 5
Storm Event 1- Carmel Creek					
LPL-W1-CML-PG1-TSS-1	11/30/2007	0940	0.572	7.4	91
LPL-W1-CML-PG1-TSS-2	11/30/2007	1040	0.254	7.4	180
LPL-W1-CML-PG1-TSS-3	11/30/2007	1140	0.225	7.4	56
LPL-W1-CML-PG1-TSS-6	11/30/2007	1440	0.267	7.4	83
LPL-W1-CML-PG1-TSS-7	11/30/2007	1540	0.295	7.3	38
LPL-W1-CML-PG1-TSS-12	11/30/2007	2040	0.757	7.5	15
LPL-W1-CML-PG1-TSS-15	11/30/2007	2340	0.278	7.3	32
LPL-W1-CML-PG1-TSS-17	12/1/2007	0140	0.546	7.4	19.5
LPL-W1-CML-PG1-TSS-20	12/1/2007	0440	0.934	7.5	16
LPL-W1-CML-PG1-TSS-25	12/1/2007	1320	1.494	7.6	14
Storm Event 2- Carmel Creek					
LPL-W2-CML-PG2-TSS-1	12/7/2007	0440			34
LPL-W2-CML-PG2-TSS-2	12/7/2007	0540			11
LPL-W2-CML-PG2-TSS-3	12/7/2007	0640			8.5
LPL-W2-CML-PG2-TSS-6	12/7/2007	0806			15.5
LPL-W2-CML-PG2-TSS-7	12/7/2007	0836			15.5
LPL-W2-CML-PG2-TSS-8	12/7/2007	0906			11.1
LPL-W2-CML-PG2-TSS-10	12/7/2007	1006			11
LPL-W2-CML-PG2-TSS-11	12/7/2007	1106			12.3
LPL-W2-CML-PG2-TSS-13	12/7/2007	1136			16
LPL-W2-CML-PG2-TSS-14	12/7/2007	1306			13
LPL-W2-CML-PG2-TSS-16	12/7/2007	1540			14
LPL-W2-CML-PG2-TSS-19	12/7/2007	2102			38.3
Storm Event 3- Carmel Creek					
LPL-W3-CML-PG3-TSS-3	2/3/2008	0748			0.7 J
LPL-W3-CML-PG3-TSS-4	2/3/2008	0818			4.3 J
LPL-W3-CML-PG3-TSS-5	2/3/2008	0848			16
LPL-W3-CML-PG3-TSS-6	2/3/2008	0918			30
LPL-W3-CML-PG3-TSS-8	2/3/2008	1018			9.5
LPL-W3-CML-PG3-TSS-11	2/3/2008	1148			7.3
LPL-W3-CML-PG3-TSS-13	2/3/2008	1240			8.7
LPL-W3-CML-PG3-TSS-15	2/3/2008	1340			10.7
LPL-W3-CML-PG3-TSS-18	2/3/2008	1510			14
LPL-W3-CML-PG3-TSS-21	2/3/2008	1640			7
LPL-W3-CML-PG3-TSS-25	2/3/2008	1840			3.7 J
LPL-W3-CML-PG3-TSS-25 Dup	2/3/2008	1840			3.7 J
LPL-W3-CML-PG3-TSS-28	2/3/2008	2010			4.7 J

Chemistry Results Summary

Station ID	Date	Time	General Chemistry		
			Conductivity (mS/cm)	pH (pH Units)	TSS
			MRL= 0.001	MRL= 0.2	MRL= 5
Storm Event 1- Los Penasquitos Creek					
LPL-W1-LPC-PG1-TSS-1	11/30/2007	1114	1.665	7.7	53
LPL-W1-LPC-PG1-TSS-4	11/30/2007	1414	1.688	7.8	35
LPL-W1-LPC-PG1-TSS-8	11/30/2007	1814	1.815	7.7	140
LPL-W1-LPC-PG1-TSS-9	11/30/2007	1914	1.753	7.7	170
LPL-W1-LPC-PG1-TSS-11	11/30/2007	2114	1.388	7.6	68
LPL-W1-LPC-PG1-TSS-12	11/30/2007	2214	1.22	7.6	60
LPL-W1-LPC-PG1-TSS-15	12/1/2007	0114	0.878	7.5	40
LPL-W1-LPC-PG1-TSS-18	12/1/2007	0414	0.842	7.4	23.3
LPL-W1-LPC-PG1-TSS-20	12/1/2007	0614	0.762	7.6	78
LPL-W1-LPC-PG1-TSS-24	12/1/2007	1014	0.69	7.6	30
Storm Event 2- Los Peñasquitos Creek					
LPL-W2-LPC-PG2-TSS-4	12/7/2007	0752			3.7 J
LPL-W2-LPC-PG2-TSS-12	12/7/2007	1152			5.3
LPL-W2-LPC-PG2-TSS-15	12/7/2007	1322			13.7
LPL-W2-LPC-PG2-TSS-18	12/7/2007	1501			22.3
LPL-W2-LPC-PG2-TSS-19	12/7/2007	1601			26.3
LPL-W2-LPC-PG2-TSS-20	12/7/2007	1701			23.3
LPL-W2-LPC-PG2-TSS-21	12/7/2007	1801			17
LPL-W2-LPC-PG2-TSS-22	12/7/2007	1901			15.7
LPL-W2-LPC-PG2-TSS-25	12/7/2007	2201			5.7
LPL-W2-LPC-PG2-TSS-28	12/8/2007	0101			4.3 J
LPL-W2-LPC-PG2-TSS-30	12/8/2007	0301			3.7 J
LPL-W2-LPC-PG2-TSS-35	12/8/2007	0801			2.7 J
Storm Event 3- Los Peñasquitos Creek					
LPL-W3-LPC-PG3-TSS-5	2/3/2008	0813			2 J
LPL-W3-LPC-PG3-TSS-7	2/3/2008	1013			1.5 J
LPL-W3-LPC-PG3-TSS-9	2/3/2008	1213			5 U
LPL-W3-LPC-PG3-TSS-11	2/3/2008	1413			1 J
LPL-W3-LPC-PG3-TSS-13	2/3/2008	1613			6.7
LPL-W3-LPC-PG3-TSS-14	2/3/2008	1713			12.7
LPL-W3-LPC-PG3-TSS-16	2/3/2008	1913			17.3
LPL-W3-LPC-PG3-TSS-18	2/3/2008	2113			12.7
LPL-W3-LPC-PG3-TSS-20	2/3/2008	2227			23.3
LPL-W3-LPC-PG3-TSS-20 Dup	2/3/2008	0027			2 J
LPL-W3-LPC-PG3-TSS-21	2/4/2008	0627			7.3
LPL-W3-LPC-PG3-TSS-24	2/4/2008	1216			3 J
LPL-W3-LPC-PG3-TSS-26	2/4/2008	2227			4 J

Chemistry Results Summary

Station ID	Date	Time	General Chemistry		
			Conductivity (mS/cm)	pH (pH Units)	TSS
			MRL= 0.001	MRL= 0.2	MRL= 5
Storm Event 1- Ocean Inlet					
LPL-W1-OI-PG1-TSS-1	11/30/2007	1003	32.2	8	65.5
LPL-W1-OI-PG1-TSS-2	11/30/2007	1203	35.1	8.1	11
LPL-W1-OI-PG1-TSS-4	11/30/2007	1603	8.47	7.7	751
LPL-W1-OI-PG1-TSS-5	11/30/2007	1803	5.38	7.5	107
LPL-W1-OI-PG1-TSS-7	11/30/2007	2203	4.66	7.5	71
LPL-W1-OI-PG1-TSS-8	12/1/2007	0003	4.35	7.5	81
LPL-W1-OI-PG1-TSS-9	12/1/2007	0203	2.85	7.4	209
LPL-W1-OI-PG1-TSS-10	12/1/2007	0403	1.847	7.5	98
LPL-W1-OI-PG1-TSS-11	12/1/2007	0603	1.458	7.5	67
LPL-W1-OI-PG1-TSS-12	12/1/2007	0803	1.162	7.4	53
LPL-W1-OI-PG1-TSS-13	12/1/2007	1003	1.159	7.5	298
LPL-W1-OI-PG1-TSS-14	12/1/2007	1203	1.236	7.6	106
LPL-W1-OI-PG1-TSS-15	12/1/2007	1403	1.228	7.5	39
Storm Event 2- Ocean Inlet					
LPL-W2-OI-PG2-TSS-2	12/7/2007	0840			16.7
LPL-W2-OI-PG2-TSS-5	12/7/2007	1010			5.3
LPL-W2-OI-PG2-TSS-7	12/7/2007	1110			6.3
LPL-W2-OI-PG2-TSS-9	12/7/2007	1240			11.7
LPL-W2-OI-PG2-TSS-13	12/7/2007	1640			159.7
LPL-W2-OI-PG2-TSS-14	12/7/2007	1845			697.3
LPL-W2-OI-PG2-TSS-16	12/7/2007	2245			90
LPL-W2-OI-PG2-TSS-18	12/8/2007	0245			9
LPL-W2-OI-PG2-TSS-19	12/8/2007	0445			14
LPL-W2-OI-PG2-TSS-21	12/8/2007	0845			27
Storm Event 3- Ocean Inlet					
LPL-W3-OI-PG3-TSS-3	2/3/2008	0936			5.5
LPL-W3-OI-PG3-TSS-5	2/3/2008	1136			7.5
LPL-W3-OI-PG3-TSS-7	2/3/2008	1336			7.5
LPL-W3-OI-PG3-TSS-9	2/3/2008	1536			7.5
LPL-W3-OI-PG3-TSS-11	2/3/2008	1736			11.3
LPL-W3-OI-PG3-TSS-13	2/3/2008	1936			22
LPL-W3-OI-PG3-TSS-15	2/3/2008	2135			21
LPL-W3-OI-PG3-TSS-17	2/4/2008	0135			30
LPL-W3-OI-PG3-TSS-19	2/4/2008	0535			8
LPL-W3-OI-PG3-TSS-20	2/4/2008	0735			16.5
LPL-W3-OI-PG3-TSS-20 Dup	2/4/2008	0735			9
LPL-W3-OI-PG3-TSS-22	2/4/2008	1135			6
LPL-W3-OI-PG3-TSS-24	2/4/2008	1535			6

Particle Size Results

Storm Event	Site	Component Percentages			
		Gravel	Sand	Silt	Clay
Storm 1	Carmel Creek	0.00	10.90	70.53	18.57
	Los Peñasquitos Creek	0.00	11.65	74.01	14.34
	Carroll Canyon Creek	0.00	8.31	72.37	19.32
	Lagoon Segment	0.00	8.26	69.51	22.23
	Ocean Inlet	0.00	41.34	47.47	11.20
Storm 2	Carmel Creek	0.00	42.28	44.00	13.63
	Los Peñasquitos Creek	0.00	42.36	48.91	8.73
	Carroll Canyon Creek	0.00	25.75	39.46	34.80

Core Lab
RESERVOIR OPTIMIZATION

Petroleum Services Division
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Weston Solutions, Inc.
2433 Impala Dr.
Carlsbad, CA 92008
Attn: Dave Renfrew

December 19, 2007

Subject: Transmittal of Particle-size Analysis Results
Project Name: Los Penasquitos Lagoon
Core Lab File No.: 57111-107793EN

Dear Mr. Renfrew,

Five water samples from your Los Penasquitos Lagoon project were submitted to our Bakersfield laboratory for particle-size distribution determinations of the contained solids. The particle-size distribution of the sediment in each of the samples was determined using laser diffraction techniques modified from ASTM D4464. A Coulter LS200 laser particle-size analyzer was utilized in the analysis.

Water samples were loaded into the LS200 sample chamber and then circulated through the system for about two minutes during which time the generated diffraction patterns were recorded by an array of detectors. All of the submitted water from each sample was utilized in the analysis.

The results of the particle-size distribution determination are presented tabulated and graphically in the accompanying report. We are pleased to have been of service to you and trust we will be called upon again in the future.

Very truly yours,

Jeffry L. Smith

Jeffry L. Smith
Laboratory Supervisor - Rock Properties

JLS: nw
1 original rpt., 2 cc rpt: Addressee

Core Lab

Comp. : Weston Solutions
Well : Los Penasquitos Lagoon

C.L. File # : 57111-107393EN

Sieve and Laser Particle Size Analysis

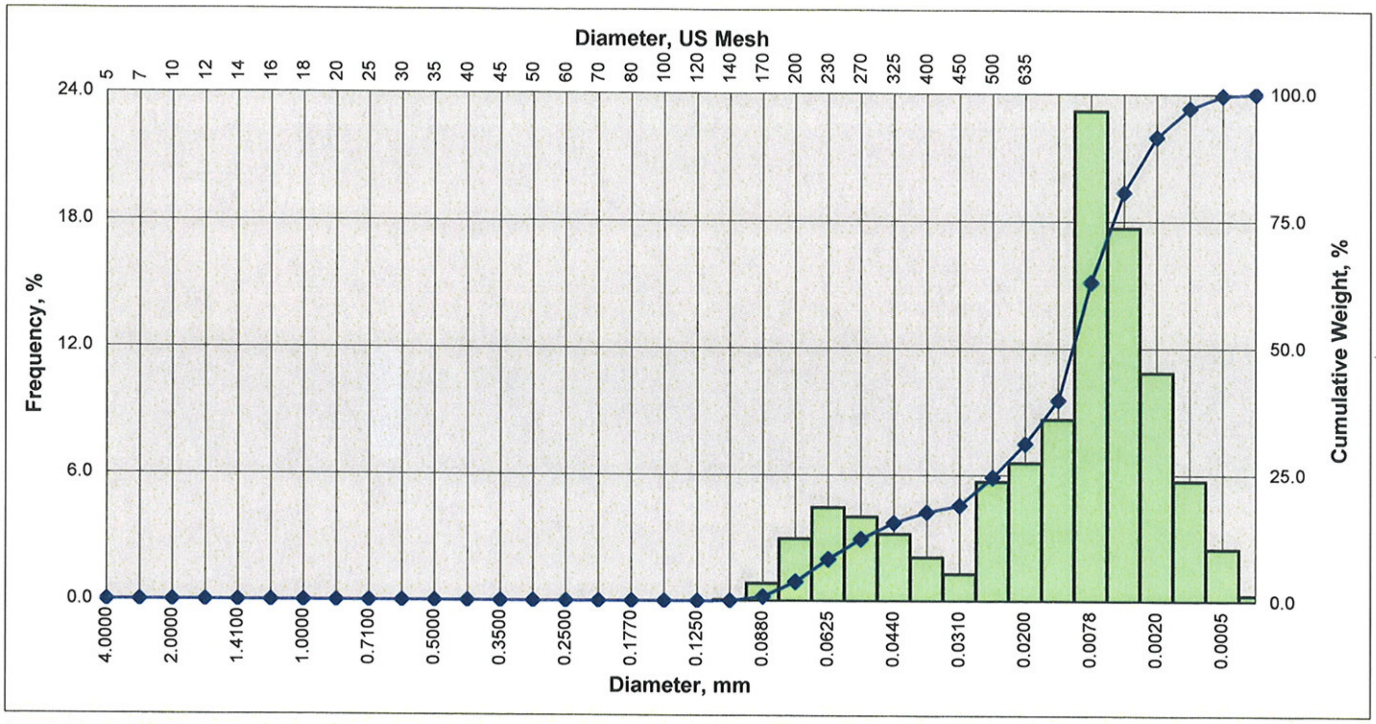
Sample Depth	Component Percentages								Percentiles										Sorting Statistics (Folk)				
	Gravel	Sand					Fines		Particle Diameter (mm)										Median	Mean	Sorting	Skew.	Kurt.
		vcgr	cgr	mgr	fgr	vfgr	silt	clay	5	10	16	25	40	50	75	84	90	95	mm	mm	ϕ		
CCC 11/30/07 22:40	0.00	0.00	0.00	0.00	0.00	8.31	72.37	19.32	0.0706 gran	0.0586 clay	0.0425 clay	0.0245 clay	0.0155 clay	0.0117 clay	0.0050 clay	0.0033 clay	0.0023 clay	0.0014 clay	0.012 silt	0.012 silt	1.779 Poor	0.035 near sym.	1.014 mesokurtic
LPC 12/01/07 10:14	0.00	0.00	0.79	2.62	3.11	5.13	74.01	14.34	0.1795 vfgr	0.0887 silt	0.0459 silt	0.0321 silt	0.0160 silt	0.0123 silt	0.0062 silt	0.0043 clay	0.0030 clay	0.0018 clay	0.012 silt	0.013 silt	1.870 Poor	-0.131 coarse	1.149 lepokurtic
CML 12/01/07 13:20	0.00	0.00	0.00	0.00	0.50	10.40	70.53	18.57	0.0910 vfgr	0.0678 silt	0.0357 silt	0.0244 silt	0.0149 silt	0.0110 silt	0.0050 silt	0.0035 clay	0.0025 clay	0.0016 clay	0.011 silt	0.011 silt	1.730 Poor	-0.023 near sym.	1.056 mesokurtic
OI 12/01/07 14:03	0.00	0.03	1.74	8.90	21.20	9.47	47.47	11.20	0.3077 vfgr	0.2547 silt	0.2153 silt	0.1636 silt	0.0725 silt	0.0285 silt	0.0082 silt	0.0052 clay	0.0036 clay	0.0022 clay	0.029 silt	0.032 silt	2.419 v. Poor	-0.026 near sym.	0.674 platykurtic
SEG1 12/01/07 13:30	0.00	0.00	0.00	0.00	0.42	7.84	69.51	22.23	0.0866 vfgr	0.0435 silt	0.0306 silt	0.0208 silt	0.0117 silt	0.0088 silt	0.0043 silt	0.0030 clay	0.0022 clay	0.0014 clay	0.009 silt	0.009 silt	1.738 Poor	-0.091 near sym.	1.077 mesokurtic

** Particle-size distribution pattern precludes calculation of these statistical parameters

Comp. : Weston Solutions
Well : Los Penasquitos Lagoon

CL File No. : 57111-107393EN
Sample ID : CCC
Date/Time : 11-30-07 / 22:40

Sieve and Laser Particle Size Analysis



	Particle Size Distribution					
	Diameter				Weight %	
	[US Mesh]	[in.]	[mm]	[ϕ]	[Incl.]	[Cum.]
Granule	5	0.1575	4.0000	-2.00	0.00	0.00
	7	0.1114	2.8300	-1.50	0.00	0.00
	10	0.0787	2.0000	-1.00	0.00	0.00
V Crse Sand	12	0.0661	1.6800	-0.75	0.00	0.00
	14	0.0555	1.4100	-0.50	0.00	0.00
	16	0.0469	1.1900	-0.25	0.00	0.00
	18	0.0394	1.0000	0.00	0.00	0.00
Coarse Sand	20	0.0331	0.8400	0.25	0.00	0.00
	25	0.0280	0.7100	0.50	0.00	0.00
	30	0.0232	0.5900	0.75	0.00	0.00
	35	0.0197	0.5000	1.00	0.00	0.00
Medium Sand	40	0.0165	0.4200	1.25	0.00	0.00
	45	0.0138	0.3500	1.50	0.00	0.00
	50	0.0118	0.3000	1.75	0.00	0.00
	60	0.0098	0.2500	2.00	0.00	0.00
Fine Sand	70	0.0083	0.2100	2.25	0.00	0.00
	80	0.0070	0.1770	2.50	0.00	0.00
	100	0.0059	0.1490	2.75	0.00	0.00
	120	0.0049	0.1250	3.00	0.00	0.00
V. Fine Sand	140	0.0041	0.1050	3.25	0.04	0.04
	170	0.0035	0.0880	3.50	0.85	0.90
	200	0.0029	0.0740	3.75	2.96	3.86
	230	0.0025	0.0625	4.00	4.45	8.31
Silt	270	0.0021	0.0530	4.25	4.01	12.32
	325	0.0017	0.0440	4.50	3.20	15.52
	400	0.0015	0.0370	4.75	2.08	17.60
	450	0.0012	0.0310	5.00	1.30	18.91
	500	0.0010	0.0250	5.25	5.68	24.59
	635	0.0008	0.0200	5.50	6.57	31.16
		0.0006	0.0156	6.00	8.64	39.80
		0.0003	0.0078	7.00	23.20	63.00
		0.0002	0.0039	8.00	17.68	80.68
Clay		0.00008	0.0020	9.00	10.84	91.52
		0.00004	0.0010	10.00	5.71	97.23
		0.00002	0.0005	11.00	2.48	99.71
		0.00001	0.0002	12.00	0.29	100.00

Sorting Statistics (Folk)				
Parameter		Trask	Inman	Folk
Median		Silt sized		
	(in)	0.0005	0.0005	0.0005
	(mm)	0.0117	0.0117	0.0117
Mean		Silt sized		
	(in)	0.0006	0.0005	0.0005
	(mm)	0.0147	0.0118	0.0118
Sorting		Poor		
		2.210	0.279	1.779
Skewness		Near symmetrical		
		0.950	0.126	0.035
Kurtosis		Mesokurtic		
		0.173	0.535	1.014

Component Percentages				
Gravel	Sand	Silt	Clay	Silt + Clay
0.00	8.31	72.37	19.32	91.69

Percentile [Weight, %]	Particle Diameter [in.]	[mm]	[phi]
5	0.0028	0.0706	3.8250
10	0.0023	0.0586	4.0937
16	0.0017	0.0425	4.5569
25	0.0010	0.0245	5.3521
40	0.0006	0.0155	6.0144
50	0.0005	0.0117	6.4230
75	0.0002	0.0050	7.6406
84	0.0001	0.0033	8.2443
90	0.0001	0.0023	8.7893
95	0.0001	0.0014	9.4852

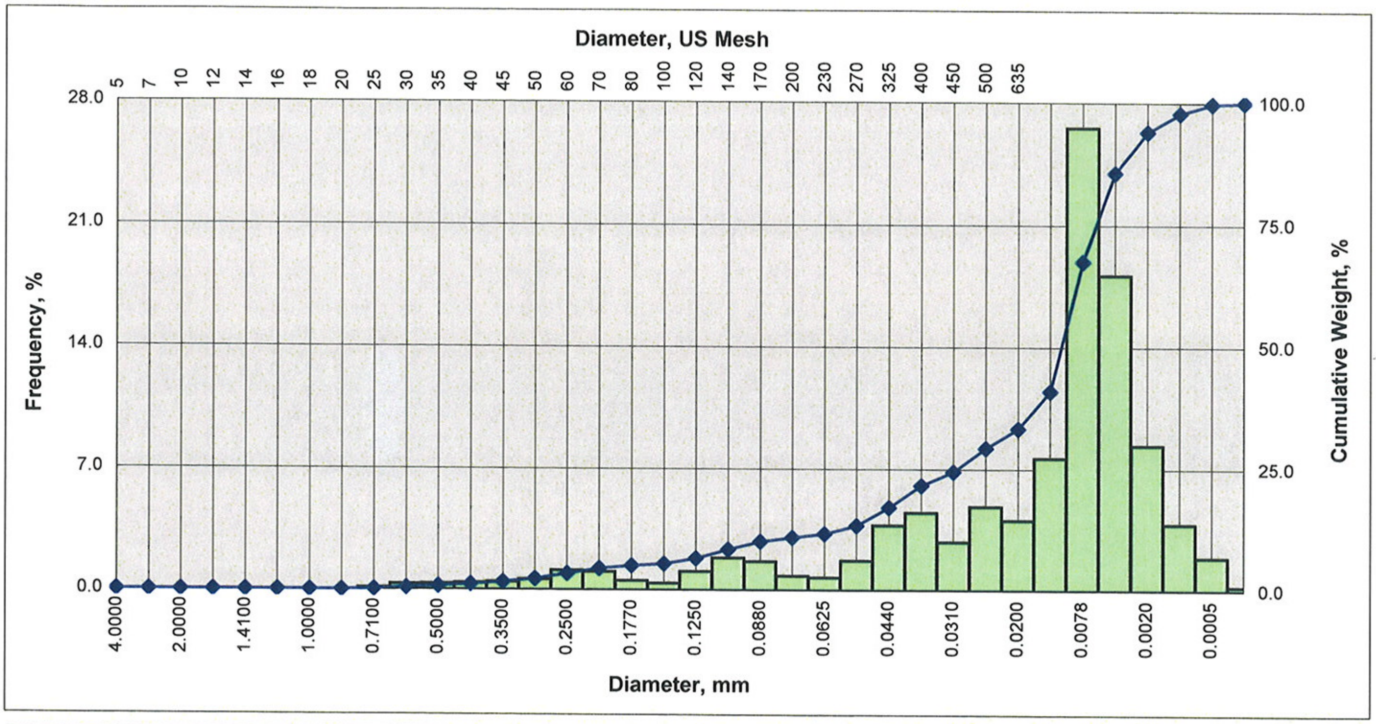
**Particle-size distribution precludes calculation of these statistical parameters.

Core Lab

Comp. : Weston Solutions
Well : Los Penasquitos Lagoon

CL File No. : 57111-107393EN
Sample ID : LPC
Date/Time : 12-01-07 / 10:14

Sieve and Laser Particle Size Analysis



Particle Size Distribution	Diameter [US Mesh]	Diameter [in.]	Diameter [mm]	Diameter [ϕ]	Weight % [Incl.]	Weight % [Cum.]
Granule	5	0.1575	4.0000	-2.00	0.00	0.00
	7	0.1114	2.8300	-1.50	0.00	0.00
	10	0.0787	2.0000	-1.00	0.00	0.00
V Crse Sand	12	0.0661	1.6800	-0.75	0.00	0.00
	14	0.0555	1.4100	-0.50	0.00	0.00
	16	0.0469	1.1900	-0.25	0.00	0.00
	18	0.0394	1.0000	0.00	0.00	0.00
Coarse Sand	20	0.0331	0.8400	0.25	0.01	0.01
	25	0.0280	0.7100	0.50	0.10	0.11
	30	0.0232	0.5900	0.75	0.33	0.44
	35	0.0197	0.5000	1.00	0.36	0.79
Medium Sand	40	0.0165	0.4200	1.25	0.41	1.20
	45	0.0138	0.3500	1.50	0.46	1.66
	50	0.0118	0.3000	1.75	0.61	2.26
	60	0.0098	0.2500	2.00	1.15	3.41
Fine Sand	70	0.0083	0.2100	2.25	1.07	4.48
	80	0.0070	0.1770	2.50	0.55	5.03
	100	0.0059	0.1490	2.75	0.41	5.44
	120	0.0049	0.1250	3.00	1.08	6.52
V. Fine Sand	140	0.0041	0.1050	3.25	1.86	8.38
	170	0.0035	0.0880	3.50	1.67	10.05
	200	0.0029	0.0740	3.75	0.84	10.89
	230	0.0025	0.0625	4.00	0.76	11.65
Silt	270	0.0021	0.0530	4.25	1.72	13.37
	325	0.0017	0.0440	4.50	3.77	17.13
	400	0.0015	0.0370	4.75	4.49	21.62
	450	0.0012	0.0310	5.00	2.80	24.43
	500	0.0010	0.0250	5.25	4.84	29.27
	635	0.0008	0.0200	5.50	4.05	33.32
		0.0006	0.0156	6.00	7.63	40.95
		0.0003	0.0078	7.00	26.57	67.53
		0.0002	0.0039	8.00	18.13	85.66
Clay		0.00008	0.0020	9.00	8.36	94.02
		0.00004	0.0010	10.00	3.84	97.86
		0.00002	0.0005	11.00	1.90	99.76
		0.00001	0.0002	12.00	0.24	100.00

Sorting Statistics (Folk)

Parameter		Trask	Inman	Folk
Median		Silt sized		
	(in)	0.0005	0.0005	0.0005
	(mm)	0.0123	0.0123	0.0123
Mean		Silt sized		
	(in)	0.0008	0.0006	0.0005
	(mm)	0.0191	0.0140	0.0134
Sorting		Poor		
		2.284	0.304	1.870
Skewness		Coarse skewed		
		1.141	-0.306	-0.131
Kurtosis		Lepokurtic		
		0.151	0.946	1.149

Component Percentages

Gravel	Sand	Silt	Clay	Silt + Clay
0.00	11.65	74.01	14.34	88.35

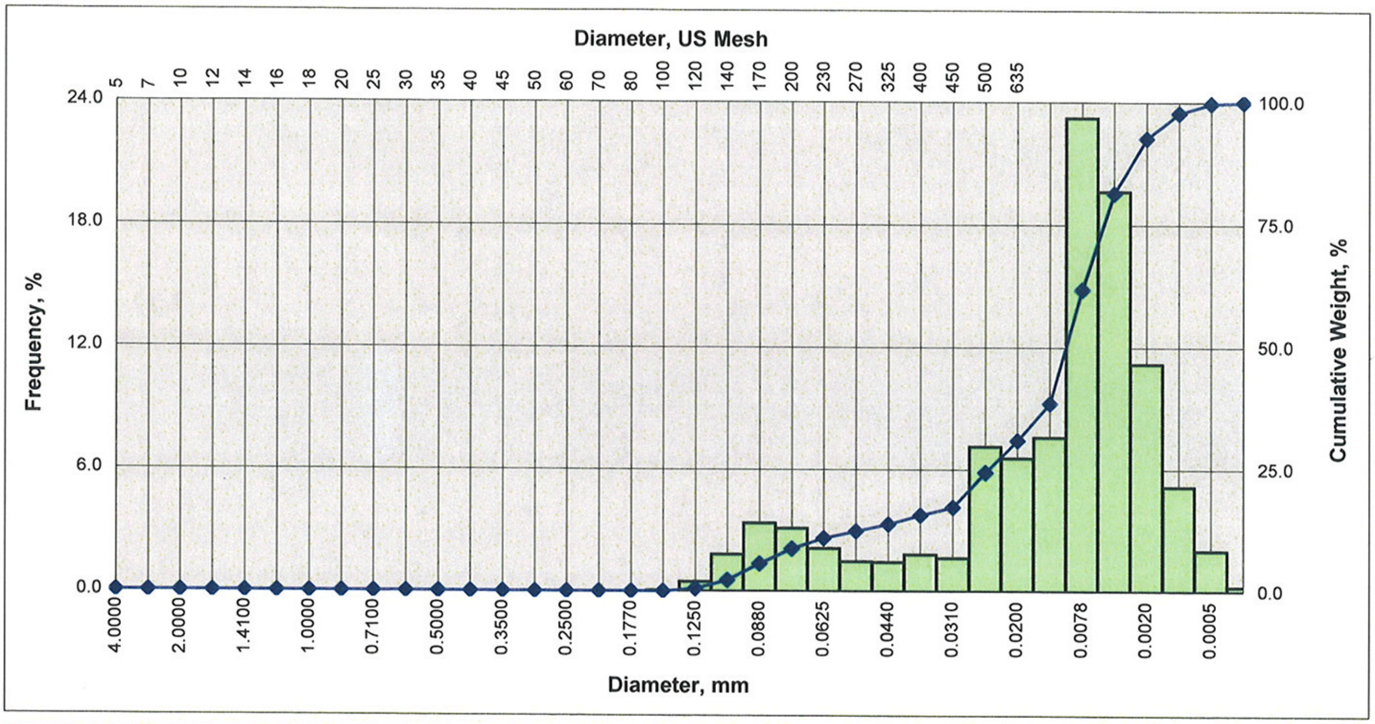
Percentile [Weight, %]	Particle Diameter [in.]	Particle Diameter [mm]	Particle Diameter [phi]
5	0.0071	0.1795	2.4780
10	0.0035	0.0887	3.4953
16	0.0018	0.0459	4.4455
25	0.0013	0.0321	4.9612
40	0.0006	0.0160	5.9703
50	0.0005	0.0123	6.3428
75	0.0002	0.0062	7.3441
84	0.0002	0.0043	7.8773
90	0.0001	0.0030	8.4027
95	0.0001	0.0018	9.1579

**Particle-size distribution precludes calculation of these statistical parameters.

Comp. : Weston Solutions
Well : Los Penasquitos Lagoon

CL File No. : 57111-107393EN
Sample ID : CML
Date/Time : 12-01-07 / 13:20

Sieve and Laser Particle Size Analysis



Particle Size Distribution						
	Diameter				Weight %	
	[US Mesh]	[in.]	[mm]	[ϕ]	[Incl.]	[Cum.]
Granule	5	0.1575	4.0000	-2.00	0.00	0.00
	7	0.1114	2.8300	-1.50	0.00	0.00
	10	0.0787	2.0000	-1.00	0.00	0.00
V Crse Sand	12	0.0661	1.6800	-0.75	0.00	0.00
	14	0.0555	1.4100	-0.50	0.00	0.00
	16	0.0469	1.1900	-0.25	0.00	0.00
	18	0.0394	1.0000	0.00	0.00	0.00
Coarse Sand	20	0.0331	0.8400	0.25	0.00	0.00
	25	0.0280	0.7100	0.50	0.00	0.00
	30	0.0232	0.5900	0.75	0.00	0.00
	35	0.0197	0.5000	1.00	0.00	0.00
Medium Sand	40	0.0165	0.4200	1.25	0.00	0.00
	45	0.0138	0.3500	1.50	0.00	0.00
	50	0.0118	0.3000	1.75	0.00	0.00
	60	0.0098	0.2500	2.00	0.00	0.00
Fine Sand	70	0.0083	0.2100	2.25	0.00	0.00
	80	0.0070	0.1770	2.50	0.00	0.00
	100	0.0059	0.1490	2.75	0.03	0.03
	120	0.0049	0.1250	3.00	0.47	0.50
V. Fine Sand	140	0.0041	0.1050	3.25	1.82	2.32
	170	0.0035	0.0880	3.50	3.36	5.68
	200	0.0029	0.0740	3.75	3.10	8.78
	230	0.0025	0.0625	4.00	2.11	10.90
Silt	270	0.0021	0.0530	4.25	1.47	12.37
	325	0.0017	0.0440	4.50	1.44	13.81
	400	0.0015	0.0370	4.75	1.82	15.63
	450	0.0012	0.0310	5.00	1.64	17.27
	500	0.0010	0.0250	5.25	7.13	24.40
	635	0.0008	0.0200	5.50	6.56	30.97
		0.0006	0.0156	6.00	7.59	38.56
		0.0003	0.0078	7.00	23.24	61.79
		0.0002	0.0039	8.00	19.63	81.43
Clay		0.00008	0.0020	9.00	11.19	92.61
		0.00004	0.0010	10.00	5.15	97.76
		0.00002	0.0005	11.00	2.01	99.77
		0.00001	0.0002	12.00	0.23	100.00

Sorting Statistics (Folk)			
Parameter	Trask	Inman	Folk
Median	Silt sized		
(in)	0.0004	0.0004	0.0004
(mm)	0.0110	0.0110	0.0110
Mean	Silt sized		
(in)	0.0006	0.0004	0.0004
(mm)	0.0147	0.0111	0.0111
Sorting	Poor		
	2.200	0.311	1.730
Skewness	Near symmetrical		
	1.007	-0.067	-0.023
Kurtosis	Mesokurtic		
	0.148	0.742	1.056

Component Percentages				
Gravel	Sand	Silt	Clay	Silt + Clay
0.00	10.90	70.53	18.57	89.10

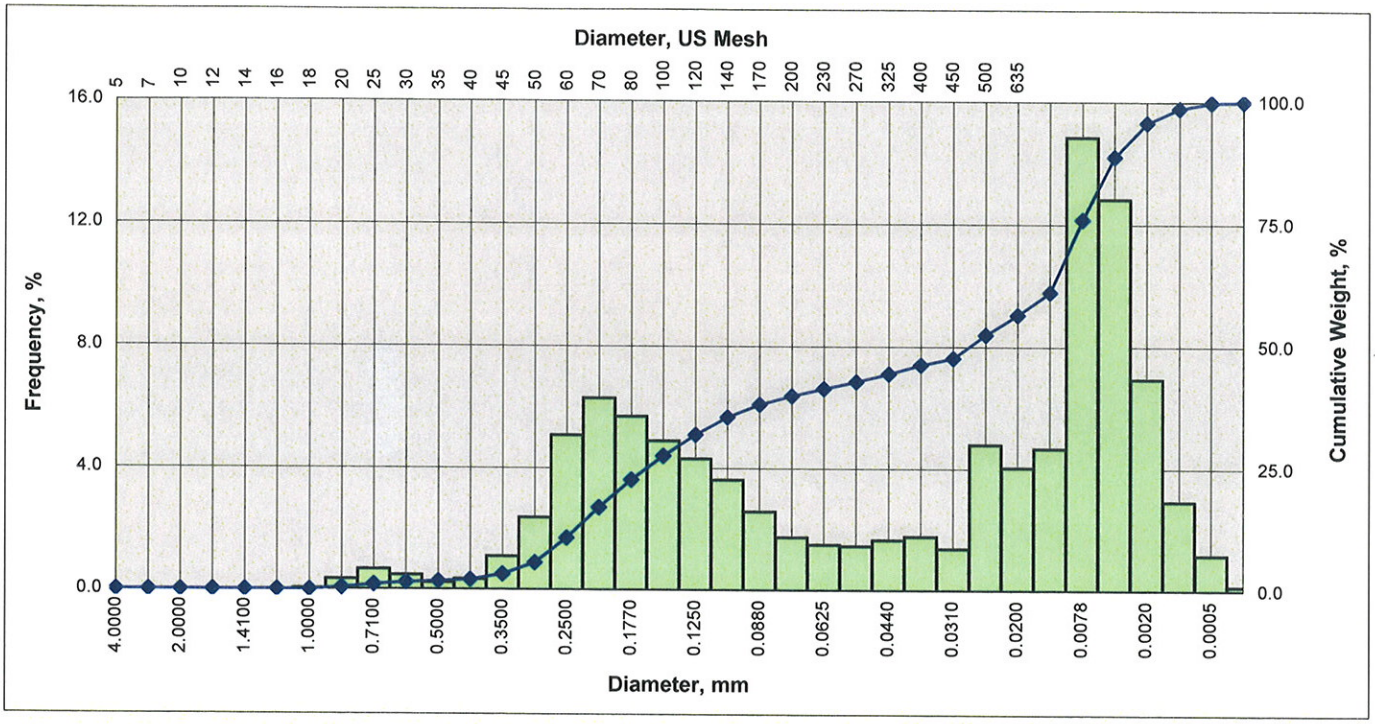
Percentile [Weight, %]	Particle Diameter [in.]	[mm]	[phi]
5	0.0036	0.0910	3.4582
10	0.0027	0.0678	3.8826
16	0.0014	0.0357	4.8076
25	0.0010	0.0244	5.3554
40	0.0006	0.0149	6.0716
50	0.0004	0.0110	6.5028
75	0.0002	0.0050	7.6310
84	0.0001	0.0035	8.1738
90	0.0001	0.0025	8.6724
95	0.0001	0.0016	9.3205

**Particle-size distribution precludes calculation of these statistical parameters.

Comp. : Weston Solutions
Well : Los Penasquitos Lagoon

CL File No. : 57111-107393EN
Sample ID : OI
Date/Time : 12-01-07 / 14:03

Sieve and Laser Particle Size Analysis



Particle Size Distribution						
	Diameter				Weight %	
	[US Mesh]	[in.]	[mm]	[ϕ]	[Incl.]	[Cum.]
Granule	5	0.1575	4.0000	-2.00	0.00	0.00
	7	0.1114	2.8300	-1.50	0.00	0.00
	10	0.0787	2.0000	-1.00	0.00	0.00
V Crse Sand	12	0.0661	1.6800	-0.75	0.00	0.00
	14	0.0555	1.4100	-0.50	0.00	0.00
	16	0.0469	1.1900	-0.25	0.00	0.00
	18	0.0394	1.0000	0.00	0.03	0.03
Coarse Sand	20	0.0331	0.8400	0.25	0.34	0.37
	25	0.0280	0.7100	0.50	0.67	1.04
	30	0.0232	0.5900	0.75	0.48	1.52
	35	0.0197	0.5000	1.00	0.24	1.76
Medium Sand	40	0.0165	0.4200	1.25	0.34	2.11
	45	0.0138	0.3500	1.50	1.10	3.20
	50	0.0118	0.3000	1.75	2.38	5.59
	60	0.0098	0.2500	2.00	5.08	10.66
Fine Sand	70	0.0083	0.2100	2.25	6.29	16.96
	80	0.0070	0.1770	2.50	5.69	22.65
	100	0.0059	0.1490	2.75	4.90	27.55
	120	0.0049	0.1250	3.00	4.32	31.87
V. Fine Sand	140	0.0041	0.1050	3.25	3.63	35.49
	170	0.0035	0.0880	3.50	2.59	38.08
	200	0.0029	0.0740	3.75	1.74	39.82
	230	0.0025	0.0625	4.00	1.51	41.33
Silt	270	0.0021	0.0530	4.25	1.47	42.80
	325	0.0017	0.0440	4.50	1.66	44.46
	400	0.0015	0.0370	4.75	1.78	46.24
	450	0.0012	0.0310	5.00	1.38	47.63
	500	0.0010	0.0250	5.25	4.80	52.42
	635	0.0008	0.0200	5.50	4.04	56.46
		0.0006	0.0156	6.00	4.67	61.13
		0.0003	0.0078	7.00	14.85	75.98
		0.0002	0.0039	8.00	12.83	88.80
Clay		0.00008	0.0020	9.00	6.95	95.75
		0.00004	0.0010	10.00	2.93	98.68
		0.00002	0.0005	11.00	1.18	99.86
		0.00001	0.0002	12.00	0.14	100.00

Sorting Statistics (Folk)			
Parameter	Trask	Inman	Folk
Median	Silt sized		
(in)	0.0011	0.0011	0.0011
(mm)	0.0285	0.0285	0.0285
Mean	Silt sized		
(in)	0.0034	0.0013	0.0013
(mm)	0.0859	0.0335	0.0318
Sorting	V. Poor		
	4.479	0.156	2.419
Skewness	Near symmetrical		
	1.280	0.046	-0.026
Kurtosis	Platykurtic		
	0.309	0.325	0.674

Component Percentages				
Gravel	Sand	Silt	Clay	Silt + Clay
0.00	41.33	47.47	11.20	58.67

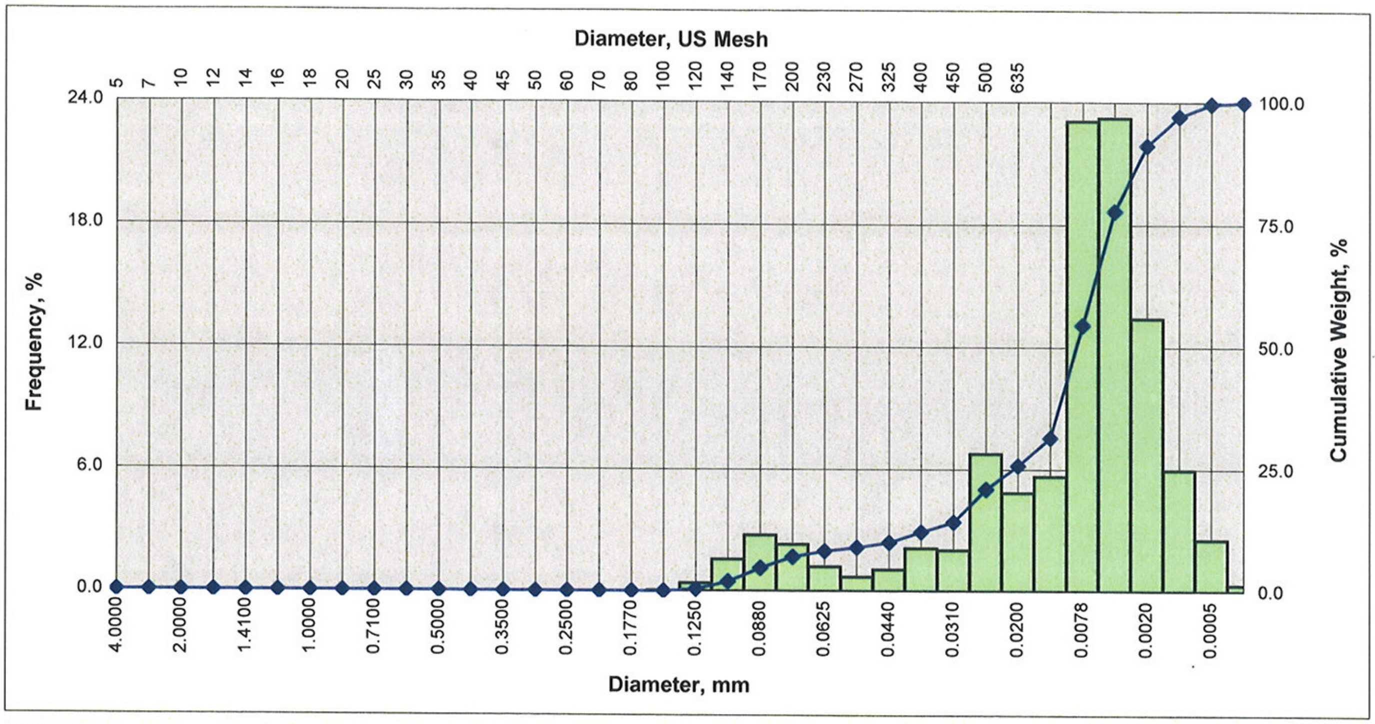
Percentile [Weight, %]	Particle Diameter [in.]	[mm]	[phi]
5	0.0121	0.3077	1.7003
10	0.0100	0.2547	1.9734
16	0.0085	0.2153	2.2154
25	0.0064	0.1636	2.6121
40	0.0029	0.0725	3.7849
50	0.0011	0.0285	5.1311
75	0.0003	0.0082	6.9382
84	0.0002	0.0052	7.5805
90	0.0001	0.0036	8.1249
95	0.0001	0.0022	8.8113

**Particle-size distribution precludes calculation of these statistical parameters.

Comp. : Weston Solutions
Well : Los Penasquitos Lagoon

57111-107393EN 57111-107305
Sample ID : SEG1
Date/Time : 12-01-07 / 13:30

Sieve and Laser Particle Size Analysis



Particle Size Distribution

	Diameter [US Mesh]	Diameter [in.]	Diameter [mm]	Diameter [ϕ]	Weight % [Incl.]	Weight % [Cum.]
Granule	5	0.1575	4.0000	-2.00	0.00	0.00
	7	0.1114	2.8300	-1.50	0.00	0.00
	10	0.0787	2.0000	-1.00	0.00	0.00
V Crse Sand	12	0.0661	1.6800	-0.75	0.00	0.00
	14	0.0555	1.4100	-0.50	0.00	0.00
	16	0.0469	1.1900	-0.25	0.00	0.00
	18	0.0394	1.0000	0.00	0.00	0.00
Coarse Sand	20	0.0331	0.8400	0.25	0.00	0.00
	25	0.0280	0.7100	0.50	0.00	0.00
	30	0.0232	0.5900	0.75	0.00	0.00
	35	0.0197	0.5000	1.00	0.00	0.00
Medium Sand	40	0.0165	0.4200	1.25	0.00	0.00
	45	0.0138	0.3500	1.50	0.00	0.00
	50	0.0118	0.3000	1.75	0.00	0.00
	60	0.0098	0.2500	2.00	0.00	0.00
Fine Sand	70	0.0083	0.2100	2.25	0.00	0.00
	80	0.0070	0.1770	2.50	0.00	0.00
	100	0.0059	0.1490	2.75	0.02	0.02
	120	0.0049	0.1250	3.00	0.40	0.42
V. Fine Sand	140	0.0041	0.1050	3.25	1.57	1.99
	170	0.0035	0.0880	3.50	2.76	4.75
	200	0.0029	0.0740	3.75	2.31	7.06
	230	0.0025	0.0625	4.00	1.21	8.26
Silt	270	0.0021	0.0530	4.25	0.71	8.97
	325	0.0017	0.0440	4.50	1.07	10.04
	400	0.0015	0.0370	4.75	2.11	12.15
	450	0.0012	0.0310	5.00	2.03	14.18
	500	0.0010	0.0250	5.25	6.77	20.95
	635	0.0008	0.0200	5.50	4.85	25.80
		0.0006	0.0156	6.00	5.65	31.45
		0.0003	0.0078	7.00	23.08	54.53
		0.0002	0.0039	8.00	23.24	77.77
Clay		0.00008	0.0020	9.00	13.41	91.18
		0.00004	0.0010	10.00	5.96	97.14
		0.00002	0.0005	11.00	2.55	99.69
		0.00001	0.0002	12.00	0.31	100.00

Sorting Statistics (Folk)

Parameter		Trask	Inman	Folk
Median		Silt sized		
	(in)	0.0003	0.0003	0.0003
	(mm)	0.0088	0.0088	0.0088
Mean		Silt sized		
	(in)	0.0005	0.0004	0.0004
	(mm)	0.0125	0.0096	0.0093
Sorting		Poor		
		2.199	0.315	1.738
Skewness		Near symmetrical		
		1.073	-0.187	-0.091
Kurtosis		Mesokurtic		
		0.199	0.793	1.077

Component Percentages

Gravel	Sand	Silt	Clay	Silt + Clay
0.00	8.26	69.51	22.23	91.74

Percentile [Weight, %]	Particle Diameter [in.]	Particle Diameter [mm]	Particle Diameter [phi]
5	0.0034	0.0866	3.5292
10	0.0017	0.0435	4.5232
16	0.0012	0.0306	5.0322
25	0.0008	0.0208	5.5892
40	0.0005	0.0117	6.4235
50	0.0003	0.0088	6.8278
75	0.0002	0.0043	7.8632
84	0.0001	0.0030	8.3649
90	0.0001	0.0022	8.8410
95	0.0001	0.0014	9.5042

**Particle-size distribution precludes calculation of these statistical parameters.

WESTON SOLUTIONS

- [x] 2433 Impala Drive • Carlsbad, CA 92008 • (760) 931-8081, FAX 931-1580
- [ ] 98 Main St., Ste. #428 • Tiburon, CA 94920 • (415) 435-1847, FAX 435-0479
- [ ] 1440 Broadway, Ste. 908 • Oakland, CA 94612 • (510) 808-0302, FAX 891-9710
- [ ] 152 Sunset View Lane • Sequim, WA 98382 • (360) 582-1758, FAX 582-1679
- [ ] 4729 NE View Drive • Port Gamble, WA 98364 • (360) 297-6903, FAX 297-6905

107793

CHAIN OF CUSTODY

15022

DATE 12/5/07 PAGE 1 OF 1

PROJECT NAME / SURVEY / PROJECT NUMBER: LOS PENASQUITOS LAGOON

PROJECT MANAGER: DAVE RENFREW

COMPANY: WESTON SOLUTIONS

ADDRESS: SEE ABOVE

PHONE/FAX: " "

SAMPLE I.D.	DATE	TIME	MATRIX	INITIALS	NUMBER & TYPE OF CONTAINERS	ANALYSIS/TEST REQUESTED: LASER PARTICLE SIZE					PRESERVED HOW/ COMMENTS	SAMPLE TEMP. UPON RECEIPT (FOR WESTON USE ONLY)	WESTON LAB ID (FOR WESTON USE ONLY)
LPL-WI-LPC-COMP1-PS-1	12/1/07	10:14	H_2O	DM	1-L Bottle	X					ICE		
LPL-WI-CML-COMP1-PS-1	12/1/07	13:20				X							
LPL-WI-SEG1-COMP1-PS-1	12/1/07	13:30				X							
LPL-WI-CCC-COMP1-PS-1	11/30/07	22:40				X							
LPL-WI-OI-COMP1-PS-1	12/1/07	14:03				X							

SPECIAL INSTRUCTIONS/COMMENTS:

SAMPLED BY: D. MCCOY, B. EVANS, S. CROPPER, B. MARDIAN

SHIPPING:

Shipping VIA: FEDEX OVERNIGHT Airbill No:

SAMPLE CONDITION UPON RECEIPT (FOR WESTON USE ONLY):

	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY
Signature	[signature]	Jo Smith [signature]				
Firm	WESTON	[illegible]				
Date/Time	12/5/07 12:00	12/6/07 15:00				

WHITE – return to originator • YELLOW – lab • PINK – retained by originator

Core Lab
RESERVOIR OPTIMIZATION

Petroleum Services Division
3437 Landco Dr.
Bakersfield, California 93308
Tel: 661-325-5657
Fax: 661-325-5808
www.corelab.com

Weston Solutions, Inc.
2433 Impala Dr.
Carlsbad, CA 92008
Attn: Dave Renfrew

December 19, 2007

Subject: Transmittal of Particle-size Analysis Results
Project Name: Los Penasquitos Lagoon
Core Lab File No.: 57111-107817EN

Dear Mr. Renfrew,

Three additional water samples from your Los Penasquitos Lagoon project were submitted to our Bakersfield laboratory for particle-size distribution determinations of the contained solids. The particle-size distribution of the sediment in each of the samples was determined using laser diffraction techniques modified from ASTM D4464. A Coulter LS200 laser particle-size analyzer was utilized in the analysis.

Water samples were loaded into the LS200 sample chamber and then circulated through the system for about two minutes during which time the generated diffraction patterns were recorded by an array of detectors. All of the submitted water from each sample was utilized in the analysis.

The results of the particle-size distribution determination are presented tabulated and graphically in the accompanying report. We are pleased to have been of service to you and trust we will be called upon again in the future.

Very truly yours,

Jeffry L. Smith

Jeffry L. Smith
Laboratory Supervisor - Rock Properties

JLS: nw
1 original rpt., 2 cc rpt: Addressee

Core Lab

Comp. : Weston Solutions
Well : Los Penasquitos Lagoon

C.L. File # : 57111-107817EN

Sieve and Laser Particle Size Analysis

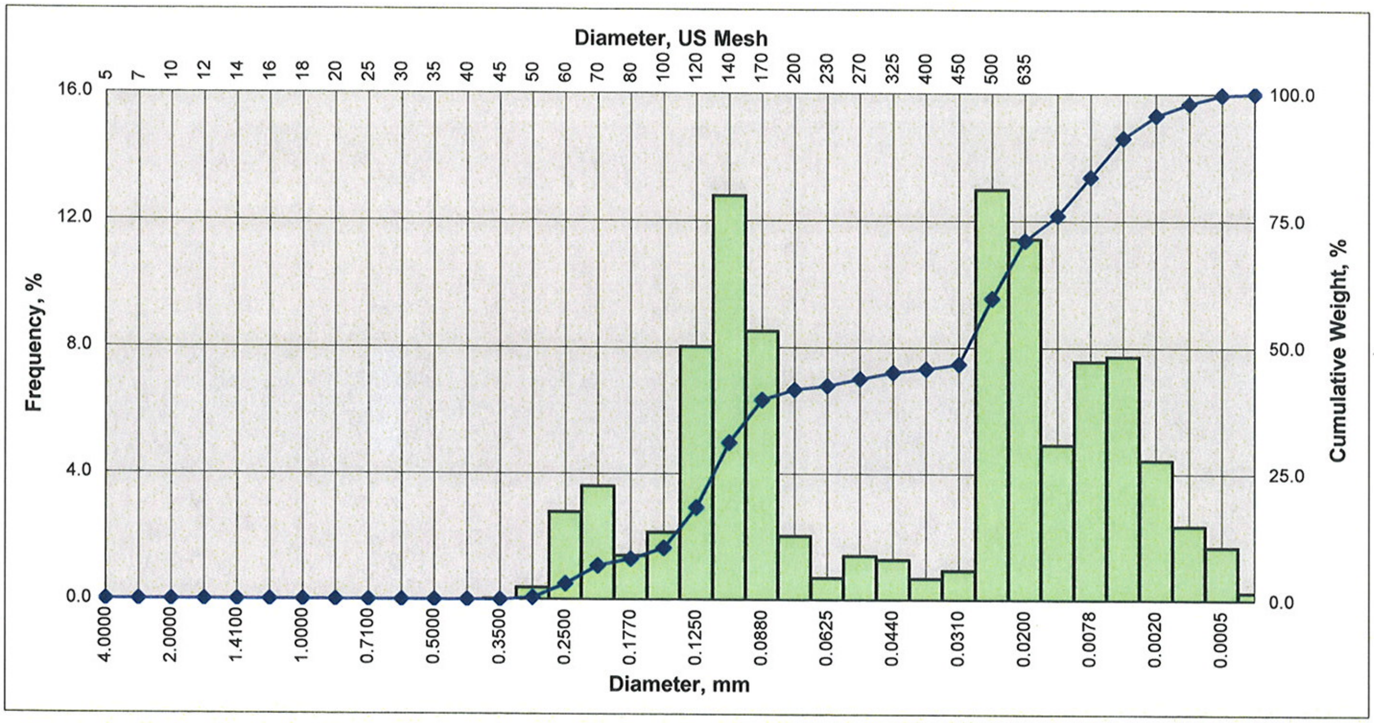
Sample Depth	Component Percentages								Percentiles										Sorting Statistics (Folk)				
	Gravel	Sand					Fines		Particle Diameter (mm)										Median	Mean	Sorting	Skew.	Kurt.
		vcgr	cgr	mgr	fgr	vfgr	silt	clay	5	10	16	25	40	50	75	84	90	95	mm	mm	ϕ		
LPC 12/08/07 08:45	0.00	0.00	0.00	3.18	15.16	24.02	48.91	8.73	0.2322 fgr	0.1464 fgr	0.1288 fgr	0.1139 fgr	0.0866 vfgr	0.0297 vfgr	0.0171 silt	0.0075 silt	0.0045 silt	0.0023 clay	0.030 silt	0.031 silt	2.032 v. Poor	0.037 near sym.	0.994 mesokurtic
CCC 12/07/07 15:31	0.00	0.00	0.00	0.14	8.65	16.96	39.46	34.80	0.1719 fgr	0.0930 fgr	0.0773 fgr	0.0639 fgr	0.0134 vfgr	0.0079 vfgr	0.0026 silt	0.0017 silt	0.0012 silt	0.0008 clay	0.008 silt	0.010 silt	2.557 v. Poor	-0.168 coarse	0.688 platykurtic
CMLCK 12/07/07 21:02	0.00	0.00	0.00	6.65	21.08	14.65	44.00	13.63	0.2690 fgr	0.2183 fgr	0.1820 fgr	0.1458 fgr	0.0669 vfgr	0.0422 vfgr	0.0074 silt	0.0045 silt	0.0030 silt	0.0017 clay	0.042 silt	0.033 silt	2.442 v. Poor	0.240 fine	0.699 platykurtic

** Particle-size distribution pattern precludes calculation of these statistical parameters

Comp. : Weston Solutions
Well : Los Penasquitos Lagoon

CL File No. : 57111-107817EN
Sample ID : LPC
Date / Time : 12-08-07 / 08:45

Sieve and Laser Particle Size Analysis



Particle Size Distribution

	Diameter [US Mesh]	[in.]	[mm]	[ϕ]	Weight % [Incl.]	Weight % [Cum.]
Granule	5	0.1575	4.0000	-2.00	0.00	0.00
	7	0.1114	2.8300	-1.50	0.00	0.00
	10	0.0787	2.0000	-1.00	0.00	0.00
V Crse Sand	12	0.0661	1.6800	-0.75	0.00	0.00
	14	0.0555	1.4100	-0.50	0.00	0.00
	16	0.0469	1.1900	-0.25	0.00	0.00
	18	0.0394	1.0000	0.00	0.00	0.00
Coarse Sand	20	0.0331	0.8400	0.25	0.00	0.00
	25	0.0280	0.7100	0.50	0.00	0.00
	30	0.0232	0.5900	0.75	0.00	0.00
	35	0.0197	0.5000	1.00	0.00	0.00
Medium Sand	40	0.0165	0.4200	1.25	0.00	0.00
	45	0.0138	0.3500	1.50	0.01	0.01
	50	0.0118	0.3000	1.75	0.39	0.40
	60	0.0098	0.2500	2.00	2.78	3.18
Fine Sand	70	0.0083	0.2100	2.25	3.59	6.77
	80	0.0070	0.1770	2.50	1.40	8.18
	100	0.0059	0.1490	2.75	2.15	10.32
	120	0.0049	0.1250	3.00	8.01	18.34
V. Fine Sand	140	0.0041	0.1050	3.25	12.78	31.11
	170	0.0035	0.0880	3.50	8.51	39.62
	200	0.0029	0.0740	3.75	2.03	41.65
	230	0.0025	0.0625	4.00	0.71	42.36
Silt	270	0.0021	0.0530	4.25	1.40	43.76
	325	0.0017	0.0440	4.50	1.28	45.04
	400	0.0015	0.0370	4.75	0.69	45.73
	450	0.0012	0.0310	5.00	0.94	46.68
	500	0.0010	0.0250	5.25	12.98	59.66
	635	0.0008	0.0200	5.50	11.42	71.08
		0.0006	0.0156	6.00	4.93	76.00
		0.0003	0.0078	7.00	7.56	83.57
		0.0002	0.0039	8.00	7.71	91.27
Clay		0.00008	0.0020	9.00	4.43	95.71
		0.00004	0.0010	10.00	2.35	98.06
		0.00002	0.0005	11.00	1.69	99.75
		0.00001	0.0002	12.00	0.25	100.00

Sorting Statistics (Folk)

Parameter		Trask	Inman	Folk
Median		Silt sized		
	(in)	0.0012	0.0012	0.0012
	(mm)	0.0297	0.0297	0.0297
Mean		Silt sized		
	(in)	0.0026	0.0012	0.0012
	(mm)	0.0655	0.0311	0.0306
Sorting		V. Poor		
		2.585	0.242	2.032
Skewness		Near symmetrical		
		1.484	0.174	0.037
Kurtosis		Mesokurtic		
		0.341	0.622	0.994

Component Percentages

Gravel	Sand	Silt	Clay	Silt + Clay
0.00	42.36	48.91	8.73	57.64

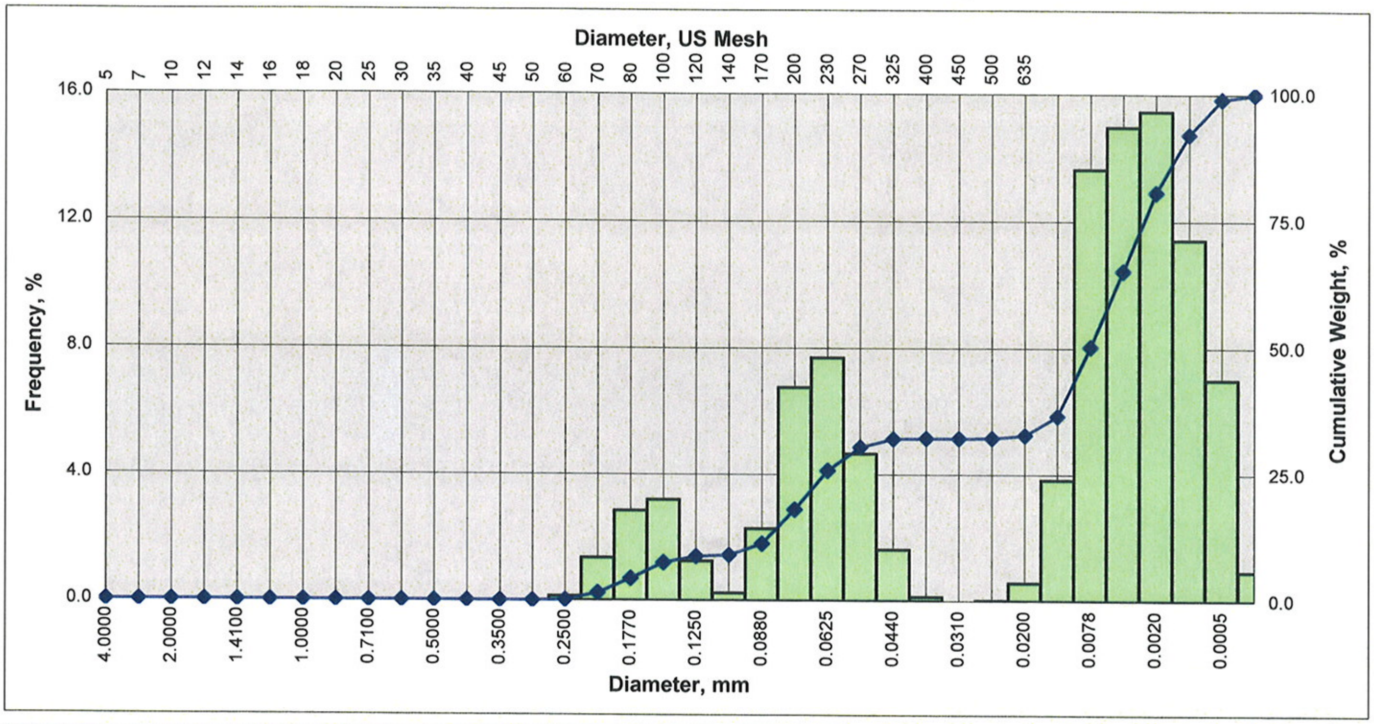
Percentile [Weight, %]	Particle Diameter [in.]	[mm]	[phi]
5	0.0091	0.2322	2.1064
10	0.0058	0.1464	2.7724
16	0.0051	0.1288	2.9570
25	0.0045	0.1139	3.1337
40	0.0034	0.0866	3.5287
50	0.0012	0.0297	5.0729
75	0.0007	0.0171	5.8737
84	0.0003	0.0075	7.0548
90	0.0002	0.0045	7.8110
95	0.0001	0.0023	8.7530

**Particle-size distribution precludes calculation of these statistical parameters.

Comp. : Weston Solutions
Well : Los Penasquitos Lagoon

CL File No. : 57111-107817EN
Sample ID : CCC
Date / Time : 12-07-07 / 15:31

Sieve and Laser Particle Size Analysis



Particle Size Distribution						
	Diameter				Weight %	
	[US Mesh]	[in.]	[mm]	[φ]	[Incl.]	[Cum.]
Granule	5	0.1575	4.0000	-2.00	0.00	0.00
	7	0.1114	2.8300	-1.50	0.00	0.00
	10	0.0787	2.0000	-1.00	0.00	0.00
V Crse Sand	12	0.0661	1.6800	-0.75	0.00	0.00
	14	0.0555	1.4100	-0.50	0.00	0.00
	16	0.0469	1.1900	-0.25	0.00	0.00
	18	0.0394	1.0000	0.00	0.00	0.00
Coarse Sand	20	0.0331	0.8400	0.25	0.00	0.00
	25	0.0280	0.7100	0.50	0.00	0.00
	30	0.0232	0.5900	0.75	0.00	0.00
	35	0.0197	0.5000	1.00	0.00	0.00
Medium Sand	40	0.0165	0.4200	1.25	0.00	0.00
	45	0.0138	0.3500	1.50	0.00	0.00
	50	0.0118	0.3000	1.75	0.00	0.00
	60	0.0098	0.2500	2.00	0.13	0.14
Fine Sand	70	0.0083	0.2100	2.25	1.35	1.49
	80	0.0070	0.1770	2.50	2.85	4.33
	100	0.0059	0.1490	2.75	3.20	7.53
	120	0.0049	0.1250	3.00	1.26	8.79
V. Fine Sand	140	0.0041	0.1050	3.25	0.24	9.03
	170	0.0035	0.0880	3.50	2.28	11.31
	200	0.0029	0.0740	3.75	6.75	18.06
	230	0.0025	0.0625	4.00	7.69	25.75
Silt	270	0.0021	0.0530	4.25	4.66	30.41
	325	0.0017	0.0440	4.50	1.63	32.04
	400	0.0015	0.0370	4.75	0.14	32.18
	450	0.0012	0.0310	5.00	0.00	32.18
	500	0.0010	0.0250	5.25	0.02	32.20
	635	0.0008	0.0200	5.50	0.58	32.78
		0.0006	0.0156	6.00	3.83	36.61
		0.0003	0.0078	7.00	13.63	50.24
		0.0002	0.0039	8.00	14.97	65.20
Clay		0.00008	0.0020	9.00	15.46	80.66
		0.00004	0.0010	10.00	11.41	92.07
		0.00002	0.0005	11.00	6.99	99.07
		0.00001	0.0002	12.00	0.93	100.00

Sorting Statistics (Folk)			
Parameter	Trask	Inman	Folk
Median	Silt sized		
(in)	0.0003	0.0003	0.0003
(mm)	0.0079	0.0079	0.0079
Mean	Silt sized		
(in)	0.0013	0.0004	0.0004
(mm)	0.0332	0.0114	0.0101
Sorting	V. Poor		
	4.960	0.147	2.557
Skewness	Coarse skewed		
	1.630	-0.204	-0.168
Kurtosis	Platykurtic		
	0.334	0.404	0.688

Component Percentages				
Gravel	Sand	Silt	Clay	Silt + Clay
0.00	25.75	39.46	34.80	74.25

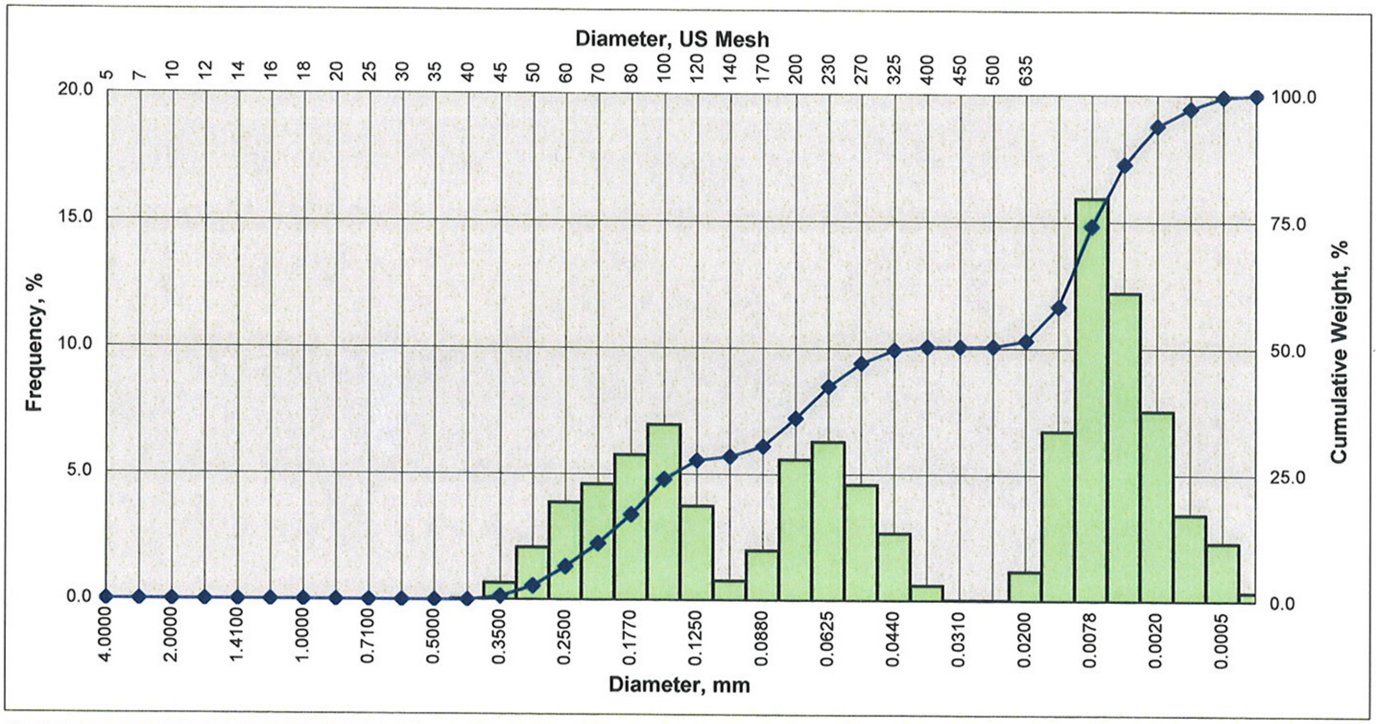
Percentile [Weight, %]	Particle Diameter [in.]	[mm]	[phi]
5	0.0068	0.1719	2.5401
10	0.0037	0.0930	3.4269
16	0.0030	0.0773	3.6943
25	0.0025	0.0639	3.9680
40	0.0005	0.0134	6.2216
50	0.0003	0.0079	6.9835
75	0.0001	0.0026	8.5887
84	0.0001	0.0017	9.2195
90	0.0000	0.0012	9.7531
95	0.0000	0.0008	10.2993

**Particle-size distribution precludes calculation of these statistical parameters.

Comp. : Weston Solutions
Well : Los Penasquitos Lagoon

CL File No. : 57111-107817EN
Sample ID : CMLCK
Date / Time : 12-07-07 / 21:02

Sieve and Laser Particle Size Analysis



Particle Size Distribution						
	Diameter				Weight %	
	[US Mesh]	[in.]	[mm]	[ϕ]	[Incl.]	[Cum.]
Granule	5	0.1575	4.0000	-2.00	0.00	0.00
	7	0.1114	2.8300	-1.50	0.00	0.00
	10	0.0787	2.0000	-1.00	0.00	0.00
V Crse Sand	12	0.0661	1.6800	-0.75	0.00	0.00
	14	0.0555	1.4100	-0.50	0.00	0.00
	16	0.0469	1.1900	-0.25	0.00	0.00
	18	0.0394	1.0000	0.00	0.00	0.00
Coarse Sand	20	0.0331	0.8400	0.25	0.00	0.00
	25	0.0280	0.7100	0.50	0.00	0.00
	30	0.0232	0.5900	0.75	0.00	0.00
	35	0.0197	0.5000	1.00	0.00	0.00
Medium Sand	40	0.0165	0.4200	1.25	0.03	0.03
	45	0.0138	0.3500	1.50	0.67	0.70
	50	0.0118	0.3000	1.75	2.08	2.78
	60	0.0098	0.2500	2.00	3.87	6.65
Fine Sand	70	0.0083	0.2100	2.25	4.61	11.25
	80	0.0070	0.1770	2.50	5.77	17.02
	100	0.0059	0.1490	2.75	6.97	23.98
	120	0.0049	0.1250	3.00	3.74	27.72
V. Fine Sand	140	0.0041	0.1050	3.25	0.79	28.51
	170	0.0035	0.0880	3.50	1.99	30.49
	200	0.0029	0.0740	3.75	5.59	36.08
	230	0.0025	0.0625	4.00	6.30	42.38
Silt	270	0.0021	0.0530	4.25	4.59	46.97
	325	0.0017	0.0440	4.50	2.68	49.65
	400	0.0015	0.0370	4.75	0.62	50.26
	450	0.0012	0.0310	5.00	0.03	50.30
	500	0.0010	0.0250	5.25	0.04	50.34
	635	0.0008	0.0200	5.50	1.18	51.51
		0.0006	0.0156	6.00	6.72	58.24
		0.0003	0.0078	7.00	15.93	74.17
		0.0002	0.0039	8.00	12.21	86.37
Clay		0.00008	0.0020	9.00	7.53	93.90
		0.00004	0.0010	10.00	3.43	97.34
		0.00002	0.0005	11.00	2.31	99.65
		0.00001	0.0002	12.00	0.35	100.00

Sorting Statistics (Folk)				
Parameter		Trask	Inman	Folk
Median		Silt sized		
	(in)	0.0017	0.0017	0.0017
	(mm)	0.0422	0.0422	0.0422
Mean		Silt sized		
	(in)	0.0030	0.0011	0.0013
	(mm)	0.0766	0.0287	0.0326
Sorting		V. Poor		
		4.426	0.157	2.442
Skewness		Finely skewed		
		0.781	0.370	0.240
Kurtosis		Platykurtic		
		0.321	0.373	0.699

Component Percentages				
Gravel	Sand	Silt	Clay	Silt + Clay
0.00	42.38	44.00	13.63	57.62

Percentile [Weight, %]	Particle Diameter [in.]	[mm]	[phi]
5	0.0106	0.2690	1.8941
10	0.0086	0.2183	2.1959
16	0.0072	0.1820	2.4582
25	0.0057	0.1458	2.7779
40	0.0026	0.0669	3.9029
50	0.0017	0.0422	4.5668
75	0.0003	0.0074	7.0701
84	0.0002	0.0045	7.7916
90	0.0001	0.0030	8.3757
95	0.0001	0.0017	9.2144

**Particle-size distribution precludes calculation of these statistical parameters.

Core Labs

107817

CHAIN OF CUSTODY

15229

WESTON SOLUTIONS

- [x] 2433 Impala Drive • Carlsbad, CA 92008 • (760) 931-8081, FAX 931-1580
- [ ] 98 Main St., Ste. #428 • Tiburon, CA 94920 • (415) 435-1847, FAX 435-0479
- [ ] 1440 Broadway, Ste. 908 • Oakland, CA 94612 • (510) 808-0302, FAX 891-9710
- [ ] 152 Sunset View Lane • Sequim, WA 98382 • (360) 582-1758, FAX 582-1679
- [ ] 4729 NE View Drive • Port Gamble, WA 98364 • (360) 297-6903, FAX 297-6905

DATE 12/11/07 PAGE 1 OF 1

PROJECT NAME / SURVEY / PROJECT NUMBER: Los Penasquitos Lagoon

PROJECT MANAGER: Dave Renfrew

COMPANY: Weston

ADDRESS: See above

PHONE/FAX: -"-

SAMPLE I.D.	DATE	TIME	MATRIX	INITIALS	NUMBER & TYPE OF CONTAINERS	ANALYSIS/TEST REQUESTED: Particle Size					PRESERVED HOW/ COMMENTS	SAMPLE TEMP. UPON RECEIPT (FOR WESTON USE ONLY)	WESTON LAB ID (FOR WESTON USE ONLY)
LPL-W2-CCC-comp2-partsz	12/7/07	1531	H2O	DR	1-L BOTTLE	X					Ice		
LPL-W2-CMLCK-~~partsz~~-comp2	↓	2102	↓	↓	↓	X					↓		
LPL-W2-LPC-partsz-comp2	12/8/07	0845	↓	↓	↓	X					↓		

SPECIAL INSTRUCTIONS/COMMENTS:

Composites made by Sara H.

SHIPPING: Core Labs FEDEX

Shipping VIA ~~CRC Pickup~~ Airbill No:

SAMPLE CONDITION UPON RECEIPT (FOR WESTON USE ONLY):

RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY
Signature: [signature]	Signature: [signature]	Signature	Signature	Signature	Signature
Firm: WESTON	Firm: Core Lab	Firm	Firm	Firm	Firm
Date/Time: 12-11-07 1:00pm	Date/Time: 12/12/07	Date/Time	Date/Time	Date/Time	Date/Time

WHITE – return to originator • YELLOW – lab • PINK – retained by originator

WESTON SOLUTIONS, INC.
2433 Impala Drive
Carlsbad, CA 92010
(760) 795-6900 / (760) 931-1580 FAX
www.westonsolutions.com

March 4, 2008

Dear Dave:

Please find enclosed the results for 26 grain size samples for your job Los Penasquitos Lagoon received on February 18, 2008. These samples were processed according to procedures described by Plumb, 1981. All analyses were performed consistent with our laboratory's quality assurance program, and all samples met the quality control criteria specified in the above methods and/or our internal SOPs.

We will dispose of the samples in 3 months unless you specify otherwise. Please let me know if you have any questions.

Sincerely,

Satomi Yonemasu

Satomi Yonemasu
Assistant Benthic Laboratory Manager

GRAIN SIZE ANALYSIS

Contract Number/Name:	Los Penasquitos Lagoon
Contact person:	Dave Renfrew
Date of analysis:	19Feb08
Date of report:	04Mar08
Analysis method:	Sieve/pipette (Plumb, 1981)
Sample Identification:	B080218.01
Client Sample Name:	SITE 5
Total sample weight:	18.530 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.242	1.306	1.306
1414.214	-0.5	0.141	0.761	2.067
1000.000	0.0	0.173	0.934	3.001
707.107	0.5	0.139	0.750	3.751
500.000	1.0	0.093	0.502	4.253
353.553	1.5	0.208	1.122	5.375
250.000	2.0	0.202	1.090	6.465
176.777	2.5	0.697	3.761	10.227
125.000	3.0	1.215	6.557	16.783
88.388	3.5	1.860	10.038	26.821
62.500	4.0	1.496	8.073	34.894
31.250	5.0	1.790	9.662	44.556
15.625	6.0	2.207	11.909	56.465
7.812	7.0	1.166	6.291	62.756
3.906	8.0	1.291	6.965	69.722
1.953	9.0	0.749	4.044	73.766
< 1.953	> 9.0	4.861	26.234	100.000

% < 4 phi = 65.106
% > 1 phi = 3.751
% gravel = 1.306
% sand = 33.588
% silt = 34.827
% clay = 30.278

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
5.457	22.76	6.733	9.40	3.793	0.336

5th percentile = 1.333
16th percentile = 2.940
50th percentile = 5.457
84th percentile = 10.526
95th percentile = .
*** 84th percentile extrapolated ***
*** 95th percentile not reached ***

Weston Solutions, Inc.
2433 Impala Dr.
Carlsbad, CA 92010

GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 19Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.02
Client Sample Name: SITE 4
Total sample weight: 21.840 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.019	0.087	0.087
1414.214	-0.5	0.047	0.215	0.302
1000.000	0.0	0.112	0.513	0.815
707.107	0.5	0.167	0.765	1.580
500.000	1.0	0.191	0.875	2.454
353.553	1.5	0.250	1.145	3.599
250.000	2.0	0.476	2.179	5.778
176.777	2.5	1.220	5.586	11.364
125.000	3.0	5.294	24.240	35.604
88.388	3.5	6.770	30.998	66.602
62.500	4.0	2.558	11.712	78.314
31.250	5.0	1.083	4.957	83.271
15.625	6.0	0.666	3.050	86.321
7.812	7.0	0.708	3.241	89.562
3.906	8.0	0.375	1.716	91.277
1.953	9.0	0.250	1.144	92.421
< 1.953	> 9.0	1.655	7.579	100.000

% < 4 phi = 21.686
% > 1 phi = 1.580
% gravel = 0.087
% sand = 78.227
% silt = 12.963
% clay = 8.723

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
3.232	106.42	3.917	66.18	1.322	0.518

5th percentile = 1.821
16th percentile = 2.596
50th percentile = 3.232
84th percentile = 5.239
95th percentile = .
*** 95th percentile not reached ***

Weston Solutions, Inc.
2433 Impala Dr.
Carlsbad, CA 92010

GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 19Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.03
Client Sample Name: SITE 3
Total sample weight: 31.546 grams

-------- Size ------ Microns	Phi	Weight grams	Percent	Cumulative Percent
2000.000	-1.0	0.000	0.000	0.000
1414.214	-0.5	0.000	0.000	0.000
1000.000	0.0	0.001	0.003	0.003
707.107	0.5	0.019	0.060	0.063
500.000	1.0	0.115	0.365	0.428
353.553	1.5	1.930	6.118	6.546
250.000	2.0	5.125	16.246	22.792
176.777	2.5	13.338	42.281	65.073
125.000	3.0	9.032	28.631	93.704
88.388	3.5	1.446	4.584	98.288
62.500	4.0	0.134	0.425	98.713
31.250	5.0	0.042	0.132	98.844
15.625	6.0	0.042	0.132	98.976
7.812	7.0	0.083	0.264	99.240
3.906	8.0	0.042	0.132	99.372
1.953	9.0	0.042	0.132	99.504
< 1.953	> 9.0	0.156	0.496	100.000

% < 4 phi = 1.287
% > 1 phi = 0.063
% gravel = 0.000
% sand = 98.713
% silt = 0.660
% clay = 0.628

Sample Statistics

Median phi	Median microns	Mean phi	Mean microns	Dispersion	Skewness
2.322	200.02	2.311	201.56	0.520	-0.021

5th percentile = 1.374
16th percentile = 1.791
50th percentile = 2.322
84th percentile = 2.831
95th percentile = 3.141

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GRAIN SIZE ANALYSIS

Contract Number/Name:	Los Penasquitos Lagoon
Contact person:	Dave Renfrew
Date of analysis:	19Feb08
Date of report:	04Mar08
Analysis method:	Sieve/pipette (Plumb, 1981)
Sample Identification:	B080218.04
Client Sample Name:	SITE 2
Total sample weight:	31.478 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.000	0.000	0.000
1414.214	-0.5	0.000	0.000	0.000
1000.000	0.0	0.006	0.019	0.019
707.107	0.5	0.001	0.003	0.022
500.000	1.0	0.034	0.108	0.130
353.553	1.5	0.554	1.760	1.890
250.000	2.0	6.221	19.763	21.653
176.777	2.5	15.560	49.431	71.084
125.000	3.0	7.922	25.167	96.251
88.388	3.5	0.817	2.595	98.846
62.500	4.0	0.082	0.260	99.107
31.250	5.0	0.042	0.132	99.239
15.625	6.0	0.042	0.132	99.371
7.812	7.0	0.042	0.132	99.503
3.906	8.0	0.042	0.132	99.636
1.953	9.0	0.042	0.132	99.768
< 1.953	> 9.0	0.073	0.232	100.000

% < 4 phi = 0.893
% > 1 phi = 0.022
% gravel = 0.000
% sand = 99.107
% silt = 0.529
% clay = 0.364

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
2.287	204.94	2.307	202.11	0.450	0.045

5th percentile = 1.579
16th percentile = 1.857
50th percentile = 2.287
84th percentile = 2.757
95th percentile = 2.975

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GRAIN SIZE ANALYSIS

Contract Number/Name:	Los Penasquitos Lagoon
Contact person:	Dave Renfrew
Date of analysis:	19Feb08
Date of report:	04Mar08
Analysis method:	Sieve/pipette (Plumb, 1981)
Sample Identification:	B080218.05
Client Sample Name:	SITE 1
Total sample weight:	29.496 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.000	0.000	0.000
1414.214	-0.5	0.000	0.000	0.000
1000.000	0.0	0.023	0.078	0.078
707.107	0.5	0.086	0.292	0.370
500.000	1.0	0.261	0.885	1.254
353.553	1.5	3.326	11.276	12.530
250.000	2.0	5.611	19.023	31.553
176.777	2.5	10.799	36.611	68.165
125.000	3.0	7.212	24.451	92.615
88.388	3.5	1.229	4.167	96.782
62.500	4.0	0.210	0.712	97.494
31.250	5.0	0.167	0.565	98.058
15.625	6.0	0.042	0.141	98.200
7.812	7.0	0.042	0.141	98.341
3.906	8.0	0.083	0.282	98.623
1.953	9.0	0.042	0.141	98.764
< 1.953	> 9.0	0.365	1.236	100.000

% < 4 phi = 2.506
% > 1 phi = 0.370
% gravel = 0.000
% sand = 97.494
% silt = 1.129
% clay = 1.377

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
2.252	209.94	2.208	216.51	0.616	-0.072

5th percentile = 1.166
16th percentile = 1.591
50th percentile = 2.252
84th percentile = 2.824
95th percentile = 3.286

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GRAIN SIZE ANALYSIS

Contract Number/Name:	Los Penasquitos Lagoon
Contact person:	Dave Renfrew
Date of analysis:	19Feb08
Date of report:	04Mar08
Analysis method:	Sieve/pipette (Plumb, 1981)
Sample Identification:	B080218.06
Client Sample Name:	SITE 13
Total sample weight:	31.225 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.020	0.064	0.064
1414.214	-0.5	0.014	0.045	0.109
1000.000	0.0	0.040	0.128	0.237
707.107	0.5	0.056	0.179	0.416
500.000	1.0	0.147	0.471	0.887
353.553	1.5	0.739	2.367	3.254
250.000	2.0	4.171	13.358	16.612
176.777	2.5	11.481	36.769	53.381
125.000	3.0	11.479	36.763	90.143
88.388	3.5	2.259	7.235	97.378
62.500	4.0	0.246	0.788	98.166
31.250	5.0	0.083	0.267	98.433
15.625	6.0	0.083	0.267	98.699
7.812	7.0	0.042	0.133	98.833
3.906	8.0	0.167	0.533	99.366
1.953	9.0	0.125	0.400	99.766
< 1.953	> 9.0	0.073	0.234	100.000

% < 4 phi = 1.834
% > 1 phi = 0.416
% gravel = 0.064
% sand = 98.102
% silt = 1.200
% clay = 0.634

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
2.454	182.50	2.447	183.42	0.470	-0.015

5th percentile = 1.565
16th percentile = 1.977
50th percentile = 2.454
84th percentile = 2.916
95th percentile = 3.336

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GRAIN SIZE ANALYSIS

Contract Number/Name:	Los Penasquitos Lagoon
Contact person:	Dave Renfrew
Date of analysis:	19Feb08
Date of report:	04Mar08
Analysis method:	Sieve/pipette (Plumb, 1981)
Sample Identification:	B080218.07
Client Sample Name:	SITE 14
Total sample weight:	30.847 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.000	0.000	0.000
1414.214	-0.5	0.006	0.019	0.019
1000.000	0.0	0.006	0.019	0.039
707.107	0.5	0.031	0.100	0.139
500.000	1.0	0.106	0.344	0.483
353.553	1.5	1.475	4.782	5.265
250.000	2.0	5.248	17.013	22.278
176.777	2.5	14.194	46.015	68.293
125.000	3.0	8.192	26.557	94.850
88.388	3.5	1.137	3.686	98.536
62.500	4.0	0.087	0.282	98.818
31.250	5.0	0.042	0.135	98.953
15.625	6.0	0.042	0.135	99.088
7.812	7.0	0.042	0.135	99.223
3.906	8.0	0.042	0.135	99.358
1.953	9.0	0.042	0.135	99.493
< 1.953	> 9.0	0.156	0.507	100.000

% < 4 phi = 1.182
% > 1 phi = 0.139
% gravel = 0.000
% sand = 98.818
% silt = 0.540
% clay = 0.642

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
2.301	202.89	2.306	202.28	0.490	0.009

5th percentile = 1.472
16th percentile = 1.815
50th percentile = 2.301
84th percentile = 2.796
95th percentile = 3.020

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GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 19Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.08
Client Sample Name: SITE 15
Total sample weight: 11.706 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.067	0.572	0.572
1414.214	-0.5	0.006	0.051	0.624
1000.000	0.0	0.015	0.128	0.752
707.107	0.5	0.021	0.179	0.931
500.000	1.0	0.030	0.256	1.187
353.553	1.5	0.050	0.427	1.615
250.000	2.0	0.100	0.854	2.469
176.777	2.5	0.234	1.999	4.468
125.000	3.0	0.519	4.434	8.902
88.388	3.5	0.875	7.475	16.377
62.500	4.0	0.791	6.757	23.134
31.250	5.0	1.783	15.233	38.367
15.625	6.0	2.080	17.772	56.138
7.812	7.0	1.189	10.155	66.293
3.906	8.0	0.509	4.352	70.646
1.953	9.0	0.849	7.254	77.899
< 1.953	> 9.0	2.587	22.101	100.000

% < 4 phi = 76.866
% > 1 phi = 0.931
% gravel = 0.572
% sand = 22.562
% silt = 47.512
% clay = 29.354

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
5.655	19.85	6.603	10.29	3.128	0.303

5th percentile = 2.560
16th percentile = 3.475
50th percentile = 5.655
84th percentile = 9.732
95th percentile = .
*** 84th percentile extrapolated ***
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name:	Los Penasquitos Lagoon
Contact person:	Dave Renfrew
Date of analysis:	19Feb08
Date of report:	04Mar08
Analysis method:	Sieve/pipette (Plumb, 1981)
Sample Identification:	B080218.09
Client Sample Name:	SITE 17
Total sample weight:	28.674 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.031	0.108	0.108
1414.214	-0.5	0.053	0.185	0.293
1000.000	0.0	0.178	0.621	0.914
707.107	0.5	0.557	1.943	2.856
500.000	1.0	0.995	3.470	6.326
353.553	1.5	4.433	15.460	21.786
250.000	2.0	1.610	5.615	27.401
176.777	2.5	2.266	7.903	35.304
125.000	3.0	4.571	15.941	51.245
88.388	3.5	6.360	22.180	73.425
62.500	4.0	4.014	13.999	87.424
31.250	5.0	1.316	4.590	92.014
15.625	6.0	0.425	1.481	93.495
7.812	7.0	0.340	1.184	94.679
3.906	8.0	0.170	0.592	95.271
1.953	9.0	0.170	0.592	95.864
< 1.953	> 9.0	1.186	4.136	100.000

% < 4 phi = 12.576
% > 1 phi = 2.856
% gravel = 0.108
% sand = 87.316
% silt = 7.847
% clay = 4.729

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
2.961	128.43	2.595	165.48	1.282	-0.285

5th percentile = 0.809
16th percentile = 1.313
50th percentile = 2.961
84th percentile = 3.878
95th percentile = 7.542

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GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 19Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.10
Client Sample Name: SITE 7
Total sample weight: 17.933 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.043	0.240	0.240
1414.214	-0.5	0.021	0.117	0.357
1000.000	0.0	0.055	0.307	0.664
707.107	0.5	0.065	0.362	1.026
500.000	1.0	0.074	0.413	1.439
353.553	1.5	0.144	0.803	2.242
250.000	2.0	0.263	1.467	3.708
176.777	2.5	0.387	2.158	5.866
125.000	3.0	0.576	3.212	9.078
88.388	3.5	0.849	4.734	13.813
62.500	4.0	0.769	4.288	18.101
31.250	5.0	1.571	8.760	26.861
15.625	6.0	2.335	13.021	39.882
7.812	7.0	1.953	10.890	50.772
3.906	8.0	1.571	8.760	59.532
1.953	9.0	0.807	4.498	64.030
< 1.953	> 9.0	6.450	35.970	100.000

% < 4 phi = 81.899
% > 1 phi = 1.026
% gravel = 0.240
% sand = 17.861
% silt = 41.431
% clay = 40.468

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
6.929	8.21	7.851	4.33	4.096	0.225

5th percentile = 2.299
16th percentile = 3.755
50th percentile = 6.929
84th percentile = 11.948
95th percentile = .
*** 84th percentile extrapolated ***
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 19Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.11
Client Sample Name: SITE 8
Total sample weight: 17.327 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.007	0.040	0.040
1414.214	-0.5	0.017	0.098	0.139
1000.000	0.0	0.014	0.081	0.219
707.107	0.5	0.034	0.196	0.416
500.000	1.0	0.051	0.294	0.710
353.553	1.5	0.059	0.341	1.050
250.000	2.0	0.074	0.427	1.477
176.777	2.5	0.128	0.739	2.216
125.000	3.0	0.286	1.651	3.867
88.388	3.5	0.670	3.867	7.733
62.500	4.0	0.876	5.056	12.789
31.250	5.0	1.826	10.536	23.325
15.625	6.0	2.632	15.191	38.516
7.812	7.0	1.698	9.801	48.317
3.906	8.0	1.401	8.086	56.402
1.953	9.0	1.486	8.576	64.978
< 1.953	> 9.0	6.068	35.022	100.000

% < 4 phi = 87.211
% > 1 phi = 0.416
% gravel = 0.040
% sand = 12.749
% silt = 43.613
% clay = 43.598

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
7.208	6.76	7.790	4.52	3.485	0.167

5th percentile = 3.147
16th percentile = 4.305
50th percentile = 7.208
84th percentile = 11.276
95th percentile = .
*** 84th percentile extrapolated ***
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 19Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.12
Client Sample Name: SITE 6
Total sample weight: 15.797 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.055	0.348	0.348
1414.214	-0.5	0.022	0.139	0.487
1000.000	0.0	0.018	0.114	0.601
707.107	0.5	0.015	0.095	0.696
500.000	1.0	0.025	0.158	0.855
353.553	1.5	0.103	0.652	1.507
250.000	2.0	0.113	0.715	2.222
176.777	2.5	0.394	2.494	4.716
125.000	3.0	0.830	5.254	9.970
88.388	3.5	1.144	7.242	17.212
62.500	4.0	0.769	4.868	22.080
31.250	5.0	1.359	8.600	30.680
15.625	6.0	2.462	15.587	46.267
7.812	7.0	1.104	6.987	53.255
3.906	8.0	1.443	9.137	62.392
1.953	9.0	1.104	6.987	69.380
< 1.953	> 9.0	4.837	30.620	100.000

% < 4 phi = 77.920
% > 1 phi = 0.696
% gravel = 0.348
% sand = 21.732
% silt = 40.312
% clay = 37.608

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
6.534	10.79	7.138	7.10	3.722	0.162

5th percentile = 2.527
16th percentile = 3.416
50th percentile = 6.534
84th percentile = 10.860
95th percentile = .
*** 84th percentile extrapolated ***
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 19Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.13
Client Sample Name: SITE 9
Total sample weight: 16.919 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.100	0.591	0.591
1414.214	-0.5	0.048	0.284	0.875
1000.000	0.0	0.051	0.301	1.176
707.107	0.5	0.064	0.378	1.554
500.000	1.0	0.086	0.508	2.063
353.553	1.5	0.127	0.751	2.813
250.000	2.0	0.206	1.218	4.031
176.777	2.5	0.440	2.601	6.632
125.000	3.0	1.253	7.406	14.037
88.388	3.5	1.748	10.331	24.369
62.500	4.0	1.421	8.399	32.767
31.250	5.0	1.528	9.033	41.801
15.625	6.0	2.590	15.307	57.107
7.812	7.0	1.316	7.779	64.886
3.906	8.0	0.849	5.019	69.905
1.953	9.0	0.934	5.520	75.425
< 1.953	> 9.0	4.158	24.575	100.000

% < 4 phi = 67.233
% > 1 phi = 1.554
% gravel = 0.591
% sand = 32.176
% silt = 37.137
% clay = 30.095

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
5.536	21.56	6.632	10.08	3.537	0.310

5th percentile = 2.186
16th percentile = 3.095
50th percentile = 5.536
84th percentile = 10.168
95th percentile = .
*** 84th percentile extrapolated ***
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 20Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.14
Client Sample Name: SITE 10
Total sample weight: 19.906 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.154	0.774	0.774
1414.214	-0.5	0.076	0.382	1.155
1000.000	0.0	0.073	0.367	1.522
707.107	0.5	0.093	0.467	1.989
500.000	1.0	0.087	0.437	2.426
353.553	1.5	0.223	1.120	3.547
250.000	2.0	0.183	0.919	4.466
176.777	2.5	0.604	3.034	7.500
125.000	3.0	1.499	7.530	15.030
88.388	3.5	2.381	11.961	26.992
62.500	4.0	2.011	10.102	37.094
31.250	5.0	3.539	17.779	54.873
15.625	6.0	2.165	10.876	65.749
7.812	7.0	1.374	6.902	72.651
3.906	8.0	0.833	4.183	76.834
1.953	9.0	0.874	4.392	81.227
< 1.953	> 9.0	3.737	18.773	100.000

% < 4 phi = 62.906
% > 1 phi = 1.989
% gravel = 0.774
% sand = 36.320
% silt = 39.741
% clay = 23.166

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
4.726	37.79	6.210	13.51	3.170	0.468

5th percentile = 2.088
16th percentile = 3.041
50th percentile = 4.726
84th percentile = 9.380
95th percentile = .
*** 84th percentile extrapolated ***
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 20Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.15
Client Sample Name: SITE 11
Total sample weight: 14.722 grams

-------- Size ------ Microns	Phi	Weight grams	Percent	Cumulative Percent
2000.000	-1.0	0.001	0.007	0.007
1414.214	-0.5	0.168	1.141	1.148
1000.000	0.0	0.260	1.766	2.914
707.107	0.5	0.179	1.216	4.130
500.000	1.0	0.112	0.761	4.891
353.553	1.5	0.083	0.564	5.454
250.000	2.0	0.082	0.557	6.011
176.777	2.5	0.099	0.672	6.684
125.000	3.0	0.199	1.352	8.036
88.388	3.5	0.378	2.568	10.603
62.500	4.0	0.597	4.055	14.658
31.250	5.0	1.374	9.333	23.991
15.625	6.0	3.331	22.625	46.617
7.812	7.0	1.790	12.161	58.778
3.906	8.0	1.332	9.050	67.828
1.953	9.0	0.874	5.939	73.767
< 1.953	> 9.0	3.862	26.233	100.000

% < 4 phi = 85.342
% > 1 phi = 4.130
% gravel = 0.007
% sand = 14.652
% silt = 53.170
% clay = 32.172

Sample Statistics

Median phi	Median microns	Mean phi	Mean microns	Dispersion	Skewness
6.278	12.88	7.158	7.00	3.014	0.292

5th percentile = 1.097
16th percentile = 4.144
50th percentile = 6.278
84th percentile = 10.172
95th percentile = .
*** 84th percentile extrapolated ***
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 20Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.16
Client Sample Name: SITE 12
Total sample weight: 24.322 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.000	0.000	0.000
1414.214	-0.5	0.001	0.004	0.004
1000.000	0.0	0.009	0.037	0.041
707.107	0.5	0.019	0.078	0.119
500.000	1.0	0.057	0.234	0.354
353.553	1.5	0.203	0.835	1.188
250.000	2.0	0.166	0.682	1.871
176.777	2.5	0.419	1.723	3.593
125.000	3.0	1.487	6.114	9.707
88.388	3.5	2.899	11.919	21.626
62.500	4.0	2.668	10.969	32.595
31.250	5.0	3.914	16.091	48.687
15.625	6.0	2.457	10.100	58.787
7.812	7.0	2.123	8.730	67.517
3.906	8.0	1.207	4.964	72.481
1.953	9.0	1.207	4.964	77.446
< 1.953	> 9.0	5.486	22.554	100.000

% < 4 phi = 67.405
% > 1 phi = 0.119
% gravel = 0.000
% sand = 32.595
% silt = 39.886
% clay = 27.519

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
5.130	28.56	6.594	10.35	3.330	0.440

5th percentile = 2.615
16th percentile = 3.264
50th percentile = 5.130
84th percentile = 9.924
95th percentile = .
*** 84th percentile extrapolated ***
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 20Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.17
Client Sample Name: SITE 19
Total sample weight: 11.107 grams

-------- Size ------ Microns	Phi	Weight grams	Percent	Cumulative Percent
2000.000	-1.0	0.025	0.225	0.225
1414.214	-0.5	0.067	0.603	0.828
1000.000	0.0	0.072	0.648	1.477
707.107	0.5	0.057	0.513	1.990
500.000	1.0	0.043	0.387	2.377
353.553	1.5	0.062	0.558	2.935
250.000	2.0	0.026	0.234	3.169
176.777	2.5	0.047	0.423	3.592
125.000	3.0	0.104	0.936	4.529
88.388	3.5	0.273	2.458	6.986
62.500	4.0	0.224	2.017	9.003
31.250	5.0	0.874	7.872	16.875
15.625	6.0	1.499	13.495	30.370
7.812	7.0	1.249	11.246	41.615
3.906	8.0	0.791	7.122	48.737
1.953	9.0	0.999	8.996	57.734
< 1.953	> 9.0	4.695	42.266	100.000

% < 4 phi = 90.997
% > 1 phi = 1.990
% gravel = 0.225
% sand = 8.778
% silt = 39.734
% clay = 51.263

Sample Statistics

Median phi	Median microns	Mean phi	Mean microns	Dispersion	Skewness
8.140	3.54	8.404	2.95	3.515	0.075

5th percentile = 3.096
16th percentile = 4.889
50th percentile = 8.140
84th percentile = 11.920
95th percentile = .
*** 84th percentile extrapolated ***
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name:	Los Penasquitos Lagoon
Contact person:	Dave Renfrew
Date of analysis:	20Feb08
Date of report:	04Mar08
Analysis method:	Sieve/pipette (Plumb, 1981)
Sample Identification:	B080218.18
Client Sample Name:	SITE 20
Total sample weight:	19.634 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	1.116	5.684	5.684
1414.214	-0.5	0.089	0.453	6.137
1000.000	0.0	0.076	0.387	6.525
707.107	0.5	0.051	0.260	6.784
500.000	1.0	0.062	0.316	7.100
353.553	1.5	0.100	0.509	7.609
250.000	2.0	0.379	1.930	9.540
176.777	2.5	1.396	7.110	16.650
125.000	3.0	2.778	14.149	30.799
88.388	3.5	2.953	15.041	45.840
62.500	4.0	1.817	9.255	55.094
31.250	5.0	1.790	9.119	64.213
15.625	6.0	1.374	6.998	71.211
7.812	7.0	0.916	4.665	75.877
3.906	8.0	0.916	4.665	80.542
1.953	9.0	0.416	2.121	82.663
< 1.953	> 9.0	3.404	17.337	100.000

% < 4 phi = 44.906
% > 1 phi = 6.784
% gravel = 5.684
% sand = 49.410
% silt = 25.448
% clay = 19.458

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
3.725	75.64	5.835	17.52	3.381	0.624

5th percentile = .
16th percentile = 2.454
50th percentile = 3.725
84th percentile = 9.216
95th percentile = .
*** 5th percentile not obtainable ***
*** 84th percentile extrapolated ***
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name:	Los Penasquitos Lagoon
Contact person:	Dave Renfrew
Date of analysis:	20Feb08
Date of report:	04Mar08
Analysis method:	Sieve/pipette (Plumb, 1981)
Sample Identification:	B080218.19
Client Sample Name:	SITE 21
Total sample weight:	.29.748 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.576	1.936	1.936
1414.214	-0.5	0.983	3.304	5.241
1000.000	0.0	2.485	8.354	13.594
707.107	0.5	5.504	18.502	32.097
500.000	1.0	7.581	25.484	57.581
353.553	1.5	5.570	18.724	76.305
250.000	2.0	0.441	1.482	77.787
176.777	2.5	0.194	0.652	78.440
125.000	3.0	0.322	1.082	79.522
88.388	3.5	0.638	2.145	81.667
62.500	4.0	0.426	1.432	83.099
31.250	5.0	0.458	1.540	84.638
15.625	6.0	0.874	2.939	87.578
7.812	7.0	0.749	2.519	90.097
3.906	8.0	0.333	1.120	91.217
1.953	9.0	0.666	2.239	93.456
< 1.953	> 9.0	1.947	6.544	100.000

% < 4 phi = 16.901
% > 1 phi = 32.097
% gravel = 1.936
% sand = 81.162
% silt = 8.118
% clay = 8.783

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
0.851	554.30	2.325	199.55	2.260	0.652

5th percentile = -0.536
16th percentile = 0.065
50th percentile = 0.851
84th percentile = 4.585
95th percentile = .
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 20Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.20
Client Sample Name: SITE 22
Total sample weight: 28.555 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.744	2.605	2.605
1414.214	-0.5	1.213	4.248	6.853
1000.000	0.0	3.439	12.043	18.897
707.107	0.5	6.678	23.386	42.283
500.000	1.0	5.808	20.340	62.622
353.553	1.5	4.452	15.591	78.213
250.000	2.0	0.250	0.875	79.089
176.777	2.5	0.101	0.354	79.442
125.000	3.0	0.073	0.256	79.698
88.388	3.5	0.066	0.231	79.929
62.500	4.0	0.045	0.158	80.087
31.250	5.0	0.467	1.635	81.722
15.625	6.0	0.042	0.149	81.871
7.812	7.0	0.509	1.784	83.655
3.906	8.0	0.764	2.676	86.331
1.953	9.0	0.297	1.041	87.372
< 1.953	> 9.0	3.606	12.628	100.000

% < 4 phi = 19.913
% > 1 phi = 42.283
% gravel = 2.605
% sand = 77.481
% silt = 6.244
% clay = 13.669

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
0.690	619.98	3.504	88.12	3.625	0.777

5th percentile = -0.718
16th percentile = -0.120
50th percentile = 0.690
84th percentile = 7.129
95th percentile = .
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name:	Los Penasquitos Lagoon
Contact person:	Dave Renfrew
Date of analysis:	20Feb08
Date of report:	04Mar08
Analysis method:	Sieve/pipette (Plumb, 1981)
Sample Identification:	B080218.21
Client Sample Name:	SITE 23
Total sample weight:	22.355 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.495	2.214	2.214
1414.214	-0.5	0.995	4.451	6.665
1000.000	0.0	1.672	7.479	14.144
707.107	0.5	2 078	9.295	23.440
500.000	1.0	2.446	10.941	34.381
353.553	1.5	2.578	11.532	45.913
250.000	2.0	2.322	10.387	56.300
176.777	2.5	1.315	5.882	62.182
125.000	3.0	0.793	3.547	65.729
88.388	3.5	0.408	1.825	67.554
62.500	4.0	0.251	1.123	68.677
31.250	5.0	0.509	2.279	70.956
15.625	6.0	1.274	5.697	76.653
7.812	7.0	1.146	5.128	81.781
3.906	8.0	1.061	4.748	86.528
1.953	9.0	0.297	1.329	87.858
< 1.953	> 9.0	2.714	12.142	100.000

% < 4 phi = 31.323
% > 1 phi = 23.440
% gravel = 2.214
% sand = 66.463
% silt = 17.852
% clay = 13.472

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
1.697	308.48	3.784	72.61	3.684	0.567

5th percentile = -0.687
16th percentile = 0.100
50th percentile = 1.697
84th percentile = 7.467
95th percentile = .
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name:	Los Penasquitos Lagoon
Contact person:	Dave Renfrew
Date of analysis:	20Feb08
Date of report:	04Mar08
Analysis method:	Sieve/pipette (Plumb, 1981)
Sample Identification:	B080218.22
Client Sample Name:	SITE 18
Total sample weight:	30.820 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.274	0.889	0.889
1414.214	-0.5	0.958	3.108	3.997
1000.000	0.0	2.179	7.070	11.067
707.107	0.5	4.316	14.004	25.071
500.000	1.0	6.173	20.029	45.100
353.553	1.5	13.352	43.322	88.422
250.000	2.0	1.765	5.727	94.149
176.777	2.5	0.491	1.593	95.742
125.000	3.0	0.165	0.535	96.277
88.388	3.5	0.137	0.445	96.722
62.500	4.0	0.079	0.256	96.978
31.250	5.0	0.255	0.827	97.805
15.625	6.0	0.042	0.138	97.943
7.812	7.0	0.085	0.276	98.218
3.906	8.0	0.042	0.138	98.356
1.953	9.0	0.085	0.276	98.631
< 1.953	> 9.0	0.422	1.369	100.000

% < 4 phi = 3.022
% > 1 phi = 25.071
% gravel = 0.889
% sand = 96.089
% silt = 1.378
% clay = 1.644

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
1.057	480.78	0.813	569.38	0.636	-0.383

5th percentile = -0.429
16th percentile = 0.176
50th percentile = 1.057
84th percentile = 1.449
95th percentile = 2.267

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GRAIN SIZE ANALYSIS

Contract Number/Name:	Los Penasquitos Lagoon
Contact person:	Dave Renfrew
Date of analysis:	20Feb08
Date of report:	04Mar08
Analysis method:	Sieve/pipette (Plumb, 1981)
Sample Identification:	B080218.23
Client Sample Name:	SITE 24
Total sample weight:	16.254 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.031	0.191	0.191
1414.214	-0.5	0.014	0.086	0.277
1000.000	0.0	0.024	0.148	0.425
707.107	0.5	0.040	0.246	0.671
500.000	1.0	0.082	0.504	1.175
353.553	1.5	0.352	2.166	3.341
250.000	2.0	0.756	4.651	7.992
176.777	2.5	0.617	3.796	11.788
125.000	3.0	0.471	2.898	14.686
88.388	3.5	0.367	2.258	16.943
62.500	4.0	0.554	3.408	20.352
31.250	5.0	1.953	12.015	32.367
15.625	6.0	4.246	26.120	58.486
7.812	7.0	4.203	25.858	84.345
3.906	8.0	0.679	4.179	88.524
1.953	9.0	0.382	2.351	90.875
< 1.953	> 9.0	1.483	9.125	100.000

% < 4 phi = 79.648
% > 1 phi = 0.671
% gravel = 0.191
% sand = 20.161
% silt = 68.172
% clay = 11.476

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
5.675	19.57	5.139	28.38	1.848	-0.290

5th percentile = 1.678
16th percentile = 3.291
50th percentile = 5.675
84th percentile = 6.987
95th percentile = .
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 21Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.24
Client Sample Name: SITE 27
Total sample weight: 23.183 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.063	0.272	0.272
1414.214	-0.5	0.059	0.254	0.526
1000.000	0.0	0.057	0.246	0.772
707.107	0.5	0.102	0.440	1.212
500.000	1.0	0.275	1.186	2.398
353.553	1.5	3.725	16.067	18.466
250.000	2.0	2.998	12.932	31.397
176.777	2.5	3.643	15.714	47.111
125.000	3.0	3.194	13.777	60.888
88.388	3.5	1.930	8.325	69.213
62.500	4.0	1.154	4.978	74.191
31.250	5.0	1.613	6.959	81.150
15.625	6.0	1.274	5.494	86.643
7.812	7.0	0.807	3.479	90.123
3.906	8.0	0.552	2.381	92.503
1.953	9.0	0.382	1.648	94.152
< 1.953	> 9.0	1.356	5.848	100.000

% < 4 phi = 25.809
% > 1 phi = 1.212
% gravel = 0.272
% sand = 73.919
% silt = 18.313
% clay = 7.497

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
2.605	164.39	3.471	90.18	2.048	0.423

5th percentile = 1.081
16th percentile = 1.423
50th percentile = 2.605
84th percentile = 5.519
95th percentile = .
*** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 21Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.25
Client Sample Name: SITE 25
Total sample weight: 29.265 grams

-------- Size ------		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.070	0.239	0.239
1414.214	-0.5	0.038	0.130	0.369
1000.000	0.0	0.039	0.133	0.502
707.107	0.5	0.121	0.413	0.916
500.000	1.0	1.045	3.571	4.487
353.553	1.5	12.033	41.118	45.604
250.000	2.0	7.178	24.528	70.132
176.777	2.5	4.212	14.393	84.525
125.000	3.0	1.949	6.660	91.184
88.388	3.5	0.834	2.850	94.034
62.500	4.0	0.390	1.333	95.367
31.250	5.0	0.594	2.031	97.398
15.625	6.0	0.085	0.290	97.688
7.812	7.0	0.085	0.290	97.978
3.906	8.0	0.085	0.290	98.268
1.953	9.0	0.042	0.145	98.413
< 1.953	> 9.0	0.464	1.587	100.000

% < 4 phi = 4.633
% > 1 phi = 0.916
% gravel = 0.239
% sand = 95.128
% silt = 2.901
% clay = 1.732

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
1.590	332.26	1.811	285.01	0.671	0.330

5th percentile = 1.006
16th percentile = 1.140
50th percentile = 1.590
84th percentile = 2.482
95th percentile = 3.862

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GRAIN SIZE ANALYSIS

Contract Number/Name: Los Penasquitos Lagoon
Contact person: Dave Renfrew
Date of analysis: 21Feb08
Date of report: 04Mar08
Analysis method: Sieve/pipette (Plumb, 1981)
Sample Identification: B080218.26
Client Sample Name: SITE 26
Total sample weight: 12.800 grams

-------- Size ------ Microns	Phi	Weight grams	Percent	Cumulative Percent
2000.000	-1.0	0.000	0.000	0.000
1414.214	-0.5	0.006	0.047	0.047
1000.000	0.0	0.032	0.250	0.297
707.107	0.5	0.114	0.891	1.188
500.000	1.0	0.128	1.000	2.188
353.553	1.5	0.132	1.031	3.219
250.000	2.0	0.128	1.000	4.219
176.777	2.5	0.125	0.977	5.195
125.000	3.0	0.166	1.297	6.492
88.388	3.5	0.228	1.781	8.274
62.500	4.0	0.323	2.523	10.797
31.250	5.0	0.127	0.995	11.792
15.625	6.0	3.651	28.525	40.317
7.812	7.0	2.972	23.218	63.535
3.906	8.0	0.892	6.965	70.501
1.953	9.0	0.892	6.965	77.466
< 1.953	> 9.0	2.884	22.534	100.000

% < 4 phi = 89.203
% > 1 phi = 1.188
% gravel = 0.000
% sand = 10.797
% silt = 59.704
% clay = 29.499

Sample Statistics

Median phi	Median microns	Mean phi	Mean microns	Dispersion	Skewness
6.417	11.70	7.381	6.00	2.233	0.432

5th percentile = 2.400
16th percentile = 5.148
50th percentile = 6.417
84th percentile = 9.614
95th percentile = .
*** 84th percentile extrapolated ***
*** 95th percentile not reached ***

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CHAIN OF CUSTODY

15592

DATE 2/18/08 PAGE 1 OF 3

PROJECT NAME / SURVEY / PROJECT NUMBER: LOS PENASQUITOS LAGOON

PROJECT MANAGER: DAVE RENFREW

COMPANY: WESTON SOLUTIONS

ADDRESS: SEE ABOVE

PHONE/FAX: " "

SAMPLE I.D.	DATE	TIME	MATRIX	INITIALS	NUMBER & TYPE OF CONTAINERS	ANALYSIS/TEST REQUESTED: GRAIN SIZE					PRESERVED HOW/ COMMENTS	SAMPLE TEMP. UPON RECEIPT (FOR WESTON USE ONLY)	WESTON LAB ID (FOR WESTON USE ONLY)
SITE 5	2-11-08	11:45	SEDIMENT	DM	1-ZIPLOCK	X					ICE		
SITE 4		11:57				X							
SITE 3		12:13				X							
SITE 2		12:23				X							
SITE 1		13:05				X							
SITE 13		14:30				X							
SITE 14		14:45				X							
SITE 15		15:05				X							
SITE 17		15:25				X							
SITE 7		16:00				X							
SITE 8		16:25				X							
SITE 6		11:04				X							

SPECIAL INSTRUCTIONS/COMMENTS:
SAMPLED BY: DAN McCOY

SHIPPING:
Shipping VIA: Airbill No:

SAMPLE CONDITION UPON RECEIPT (FOR WESTON USE ONLY):

	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY
Signature	D. J. McCoy	[signature]				
Firm	WESTON	WESTON				
Date/Time	2/18/08 10:45	2/18/08 1045				

WHITE – return to originator • YELLOW – lab • PINK – retained by originator

WESTON SOLUTIONS.

☒ 2433 Impala Drive • Carlsbad, CA 92008 • (760) 931-8081, FAX 931-1580
☐ 98 Main St., Ste. #428 • Tiburon, CA 94920 • (415) 435-1847, FAX 435-0479
☐ 1440 Broadway, Ste. 908 • Oakland, CA 94612 • (510) 808-0302, FAX 891-9710
☐ 152 Sunset View Lane • Sequim, WA 98382 • (360) 582-1758, FAX 582-1679
☐ 4729 NE View Drive • Port Gamble, WA 98364 • (360) 297-6903, FAX 297-6905

CHAIN OF CUSTODY

15593

DATE 2/18/08 PAGE 2 OF 3

PROJECT NAME / SURVEY / PROJECT NUMBER: LOS PENASQUITOS LAGOON

PROJECT MANAGER: DAVE RENFREW

COMPANY: WESTON SOLUTIONS

ADDRESS: SEE ABOVE

PHONE/FAX: " "

SAMPLE I.D.	DATE	TIME	MATRIX	INITIALS	NUMBER & TYPE OF CONTAINERS	ANALYSIS/TEST REQUESTED: GRAIN SIZE					PRESERVED HOW/ COMMENTS	SAMPLE TEMP. UPON RECEIPT (FOR WESTON USE ONLY)	WESTON LAB ID (FOR WESTON USE ONLY)
SITE 9	2-13-08	11:00	SEDIMENT	DM	1-ZIPLOCK	X					ICE		
SITE 10	↓	11:20	↓	↓	↓	X					↓		
SITE 11		11:35				X							
SITE 12		11:50				X							
SITE 19		12:30				X							
SITE 20		14:05				X							
SITE 21		14:35				X							
SITE 22		14:50				X							
SITE 23		15:15				X							
SITE 18	↓	15:25	↓	↓	↓	X					↓		

SPECIAL INSTRUCTIONS/COMMENTS:

SAMPLED BY: DAN McCOY

SHIPPING:

Shipping VIA: Airbill No:

SAMPLE CONDITION UPON RECEIPT (FOR WESTON USE ONLY):

RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY
Signature [signature]	Signature [signature]	Signature	Signature	Signature	Signature
Firm WESTON	Firm WESTON	Firm	Firm	Firm	Firm
Date/Time 2/18/08 10:45	Date/Time 2/18/08 1045	Date/Time	Date/Time	Date/Time	Date/Time

WHITE – return to originator • YELLOW – lab • PINK – retained by originator

WESTON SOLUTIONS

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☐ 4729 NE View Drive • Port Gamble, WA 98364 • (360) 297-6903, FAX 297-6905

CHAIN OF CUSTODY

15588

DATE 2/18/08 PAGE 3 OF 3

PROJECT NAME / SURVEY / PROJECT NUMBER: LOS PENASQUITOS LAGOON

PROJECT MANAGER: DAVE RENFREW

COMPANY: WESTON SOLUTIONS

ADDRESS: SEE ABOVE ↗

PHONE/FAX:

SAMPLE I.D.	DATE	TIME	MATRIX	INITIALS	NUMBER & TYPE OF CONTAINERS	ANALYSIS/TEST REQUESTED: GRAIN SIZE					PRESERVED HOW/ COMMENTS	SAMPLE TEMP. UPON RECEIPT (FOR WESTON USE ONLY)	WESTON LAB ID (FOR WESTON USE ONLY)
SITE 24	2-15-08	11:16	SEDIMENT	DM	1-ZIPLOCK	X					ICE		
SITE 27	↓	11:27	↓	↓	↓	X					↓		
SITE 25	↓	11:58	↓	↓	↓	X					↓		
SITE 26	↓	12:33	↓	↓	↓	X					↓		

SPECIAL INSTRUCTIONS/COMMENTS:
SAMPLED BY: DAN McCOY

SHIPPING:
Shipping VIA: Airbill No:

SAMPLE CONDITION UPON RECEIPT (FOR WESTON USE ONLY):

	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY
Signature	D McCoy	[signature]				
Firm	WESTON	Weston				
Date/Time	2/18/08 10:45	2/18/08 1045				

WHITE – return to originator • YELLOW – lab • PINK – retained by originator

Quality Assurance/ Quality Control

Quality assurance and quality control (QA/QC) checks were performed on all laboratory analysis data. A 100% check of each laboratory deliverable was performed for consistency with the respective Chain of Custody forms. In addition, a minimum 10% check of the laboratory results and QC procedures was performed prior to data being integrated into Weston's internal database. If any problems were noticed, the laboratory was notified and appropriate changes were made to comply with the QAPP/COC.

November 30- December 1, 2007

All procedural blanks were Non-Detect.

All duplicate samples that were run with each sample batch for analysis of TSS, pH, Conductivity, and Turbidity met acceptance criteria for RPD.

Analysis of pH, conductivity, and Turbidity was performed outside of sample holding times as a secondary assessment due to data sonde errors during the first rainfall monitoring event.

December 7-8, 2007

All procedural blanks were Non-Detect.

All duplicate samples that were run with each sample batch for TSS analysis met acceptance criteria for RPD.

February 3-4, 2008

All procedural blanks were Non-Detect.

The Field Duplicate sample from Los Peñasquitos Creek and from the Ocean Inlet had RPD values that were outside of the acceptance limits. However, the RPD is not applicable because the results for the two replicates were lower than 10 times the MDL.

Field Equipment

Calibration of field instrumentation was conducted prior to use according to manufacturer's specifications. Quality assurance and quality control (QA/QC) for sampling processes included proper collection of the samples in order to minimize the possibility of contamination. All samples were collected in manufacturer supplied, laboratory cleaned, contaminant free bottles.

All sampling personnel were trained according to field sampling procedures listed in the QAPP. Chain-of-custody procedures were used for all samples throughout the collection, transport, and analytical process. Monthly maintenance and calibration was performed in the field for each of the deployed water quality sondes. A maintenance and calibration schedule is provided below.

Dates of Sonde Calibration and Maintenance

10/11/07- Sonde installation

10/30/07

11/20/07

12/04/07 – It was noted that several sondes had power errors between 11/20/07 and 12/04/07.

12/18/07

12/28/07

01/25/08

02/25/08

03/19/08

4/17/08 and 4/21/08- Sonde removal

Sonde Data

The continuous monitoring of water quality parameters is presented in the following appendix. For each location, the six parameters are shown in two graphs per month to show a greater amount of detail. There are also monthly statistical summaries for each location.

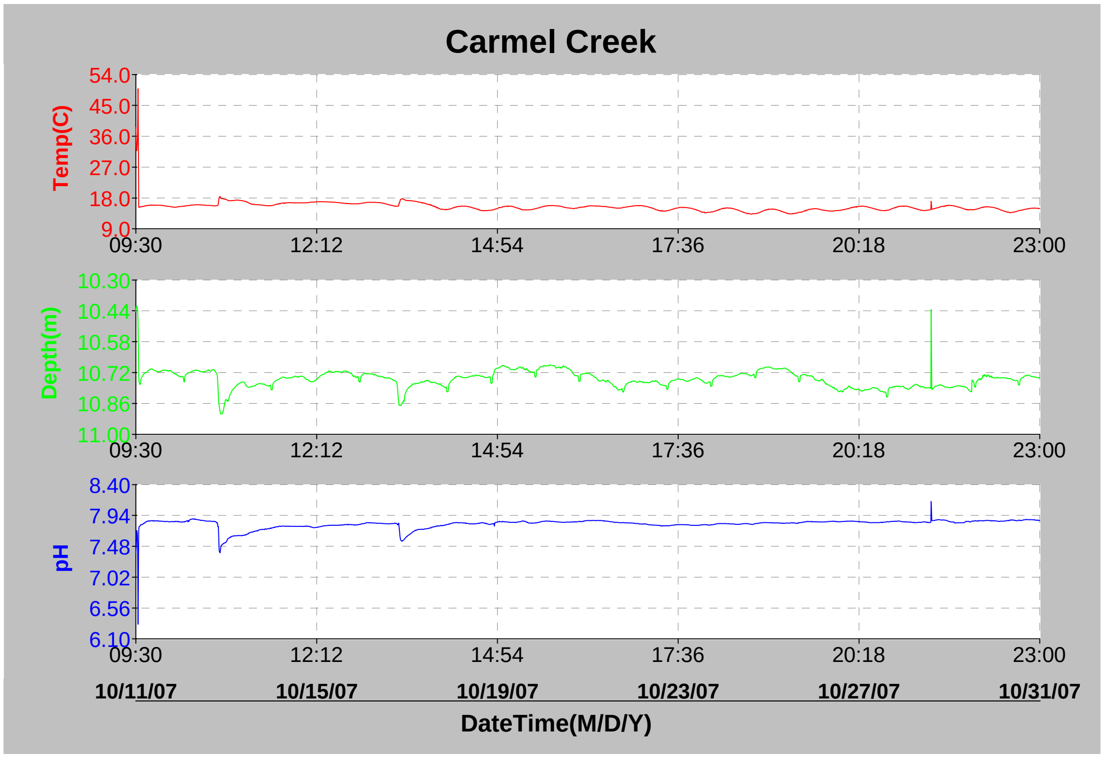
The following notes are related to inaccurate data or data gaps. The gaps in the data during the monitoring period when the data sondes were not recording data were omitted from the graphs and summaries. The data presented in the appendix represent all the data that was colleted. For instance, some graphs may only show a partial month due to a data gap. There are also some unusual spikes in the data associated with maintenance and calibration. These occurrences are noted below.

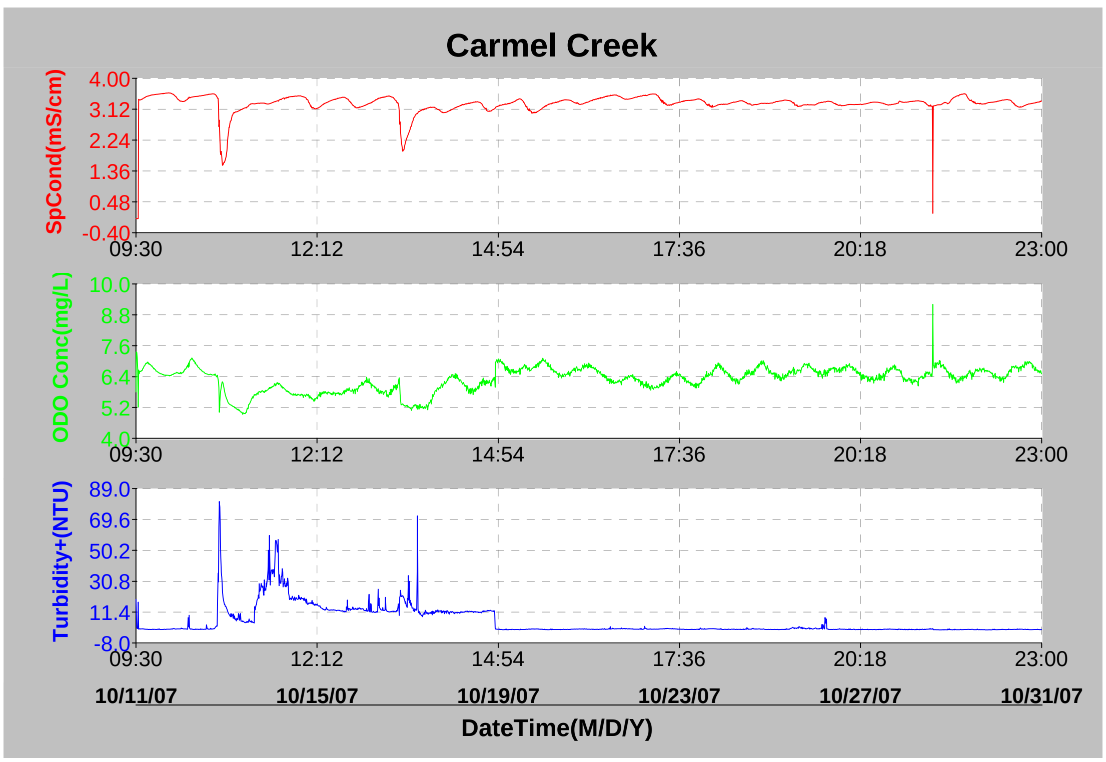
In some cases a correction factor was applied to each site to represent the total water level, as the sonde pressure sensor used to measure water level was located above the surface of the sediment. The data presented for the depths in this appendix were measured from the sensor to the surface of the water. Carmel Creek and Los Peñasquitos Creek MES locations initially read inaccurate water level measurements from October 11 through November 20, 2007. During this time, the Carmel Creek sonde read approximately 10.7 m in depth when the actual water depth was 0.7m while the Los Peñasquitos Creek sonde read 10.4m when the actual depth was approximately 10.4m. The Carmel Creek sonde was adjusted to the appropriate depth on 11/20/2007 at 11:30 while the Los Peñasquitos Creek was adjusted to the appropriate depth on 11/20/2007 at 15:00.

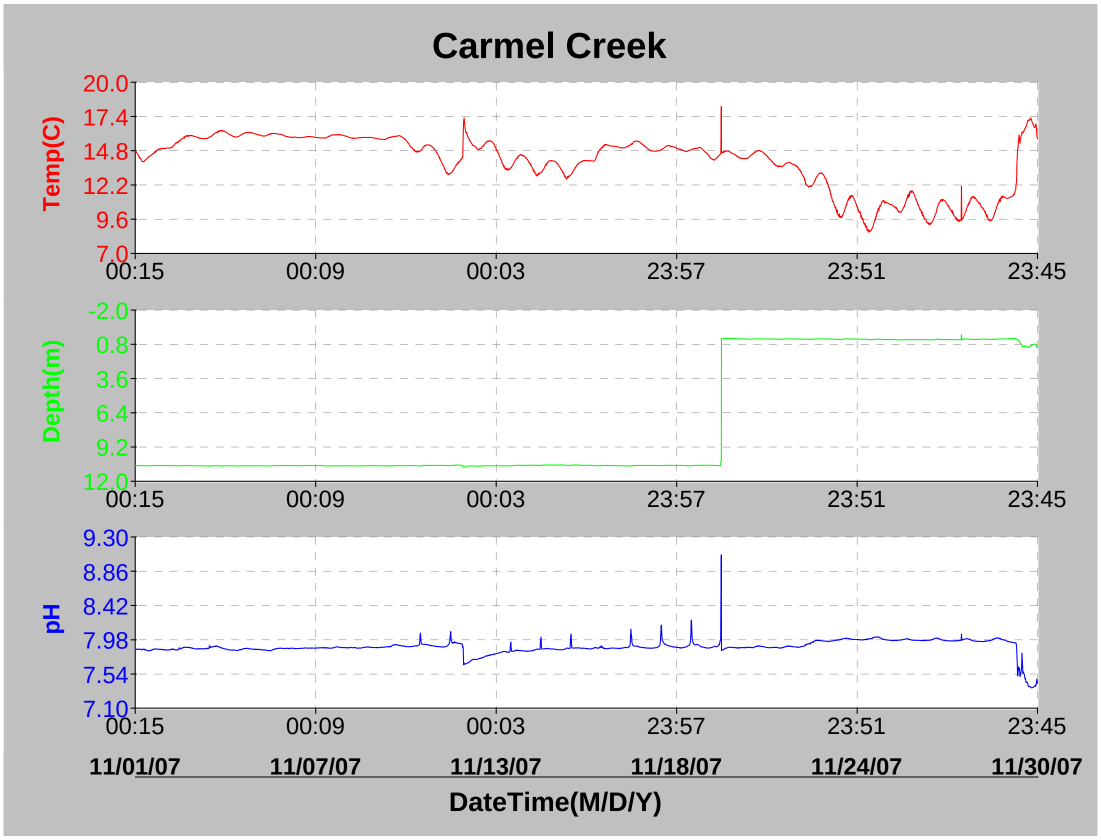
Turbidity can be a difficult parameter to accurately measure over extended periods of time, particularly using field-deployed sondes. Various scenarios, such as debris caught on the probe or small animals such as crabs residing inside sonde cage, and others, may result in artificially high turbidity readings. Scenarios such as these should be considered when examining turbidity values that appear to be extremely elevated during periods of dry weather.

Dates of Calibration and Maintenance
10/11/07
10/30/07
11/20/07
12/04/07
12/18/07
12/28/07
01/25/08
02/25/08
03/19/08

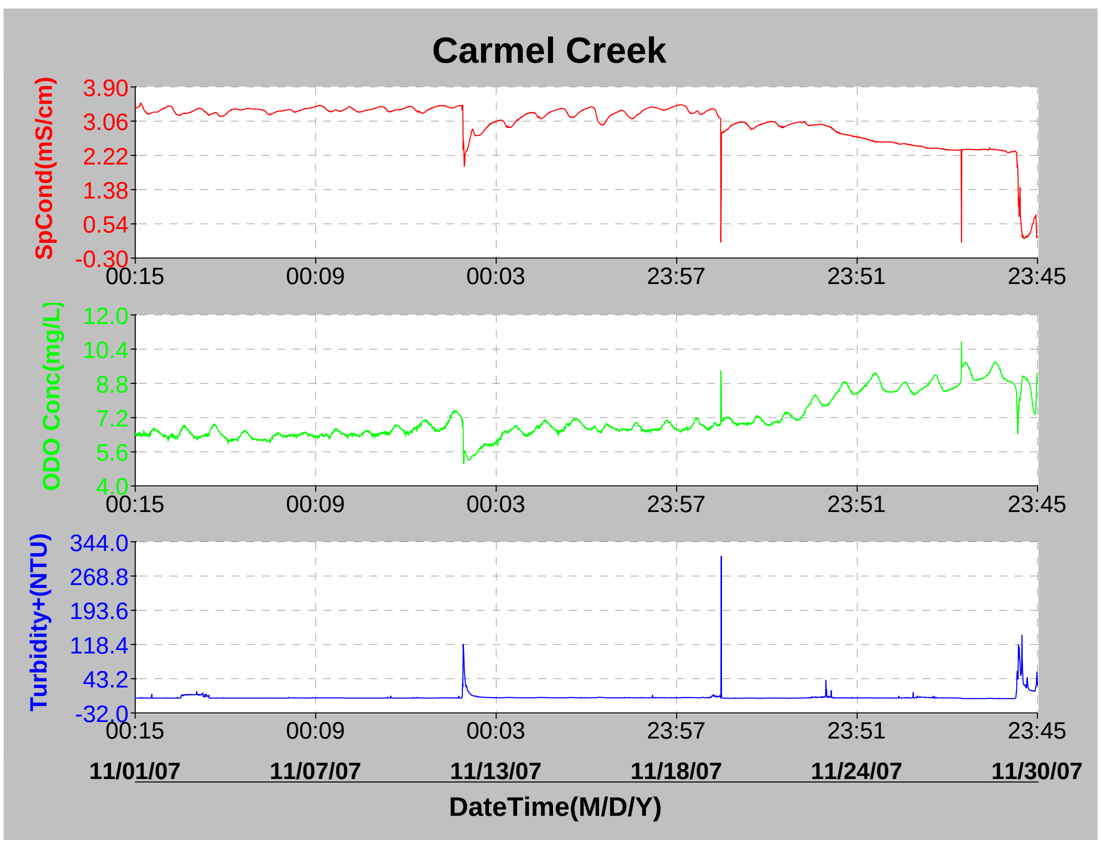
CARMEL CREEK


Carmel Creek
Temp(C)
54.0
45.0
36.0
27.0
18.0
9.0
Depth(m)
10.30
10.44
10.58
10.72
10.86
11.00
pH
8.40
7.94
7.48
7.02
6.56
6.10
09:30
12:12
14:54
17:36
20:18
23:00
10/11/07
10/15/07
10/19/07
10/23/07
10/27/07
10/31/07
DateTime(M/D/Y)

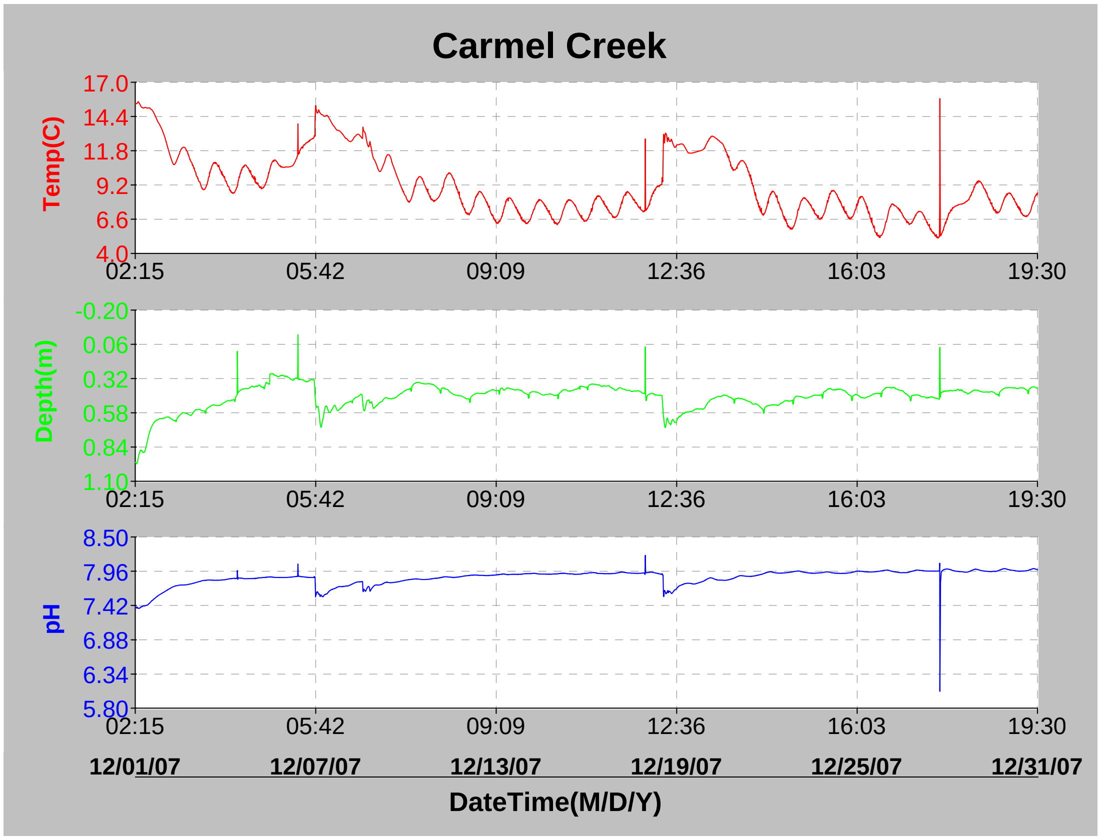

Carmel Creek
SpCond(mS/cm)
4.00
3.12
2.24
1.36
0.48
-0.40
ODO Conc(mg/L)
10.0
8.8
7.6
6.4
5.2
4.0
Turbidity+(NTU)
89.0
69.6
50.2
30.8
11.4
-8.0
09:30
12:12
14:54
17:36
20:18
23:00
10/11/07
10/15/07
10/19/07
10/23/07
10/27/07
10/31/07
DateTime(M/D/Y)

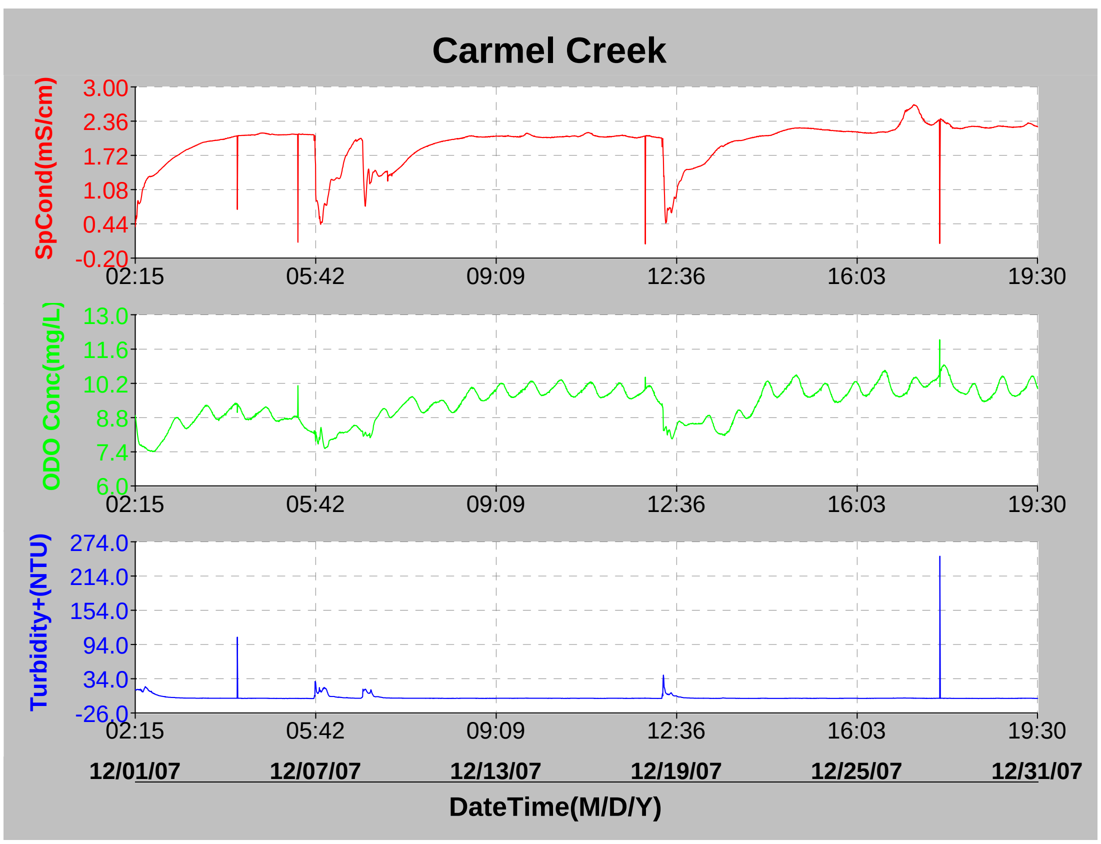


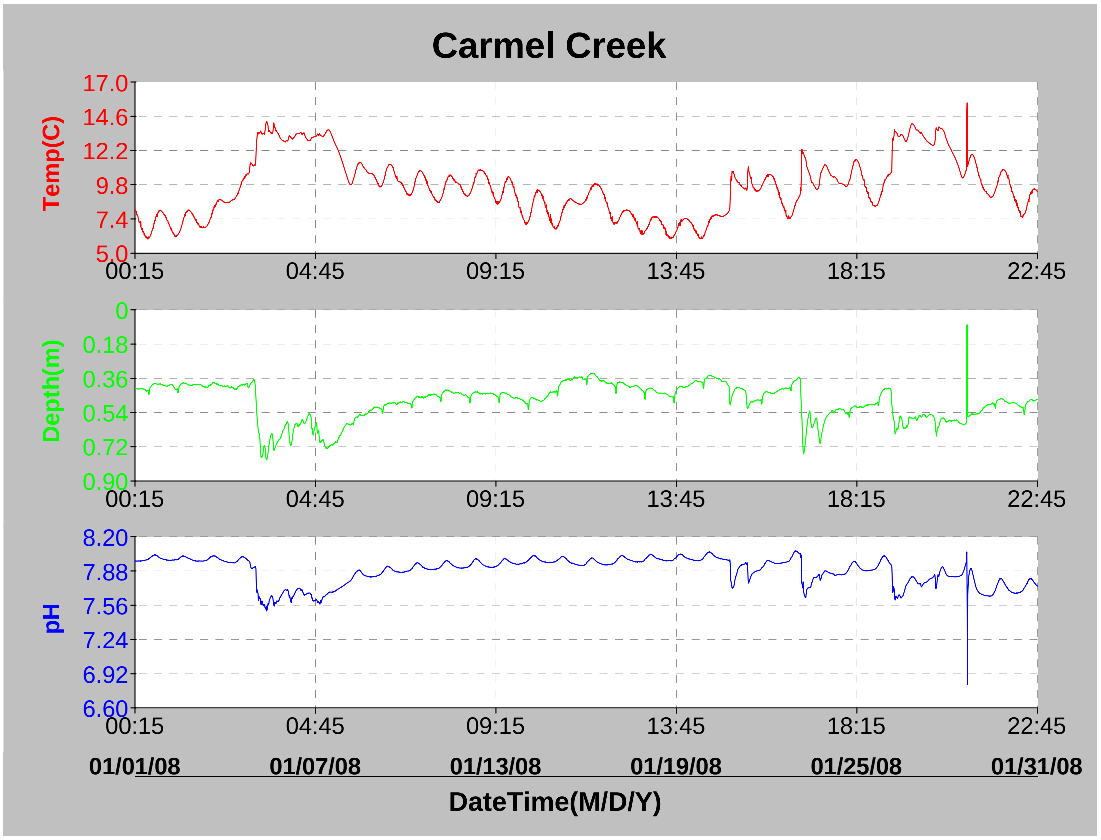
Carmel Creek
Temp(C)
20.0
17.4
14.8
12.2
9.6
7.0
Depth(m)
-2.0
0.8
3.6
6.4
9.2
12.0
pH
9.30
8.86
8.42
7.98
7.54
7.10
00:15
00:09
00:03
23:57
23:51
23:45
11/01/07
11/07/07
11/13/07
11/18/07
11/24/07
11/30/07
DateTime(M/D/Y)

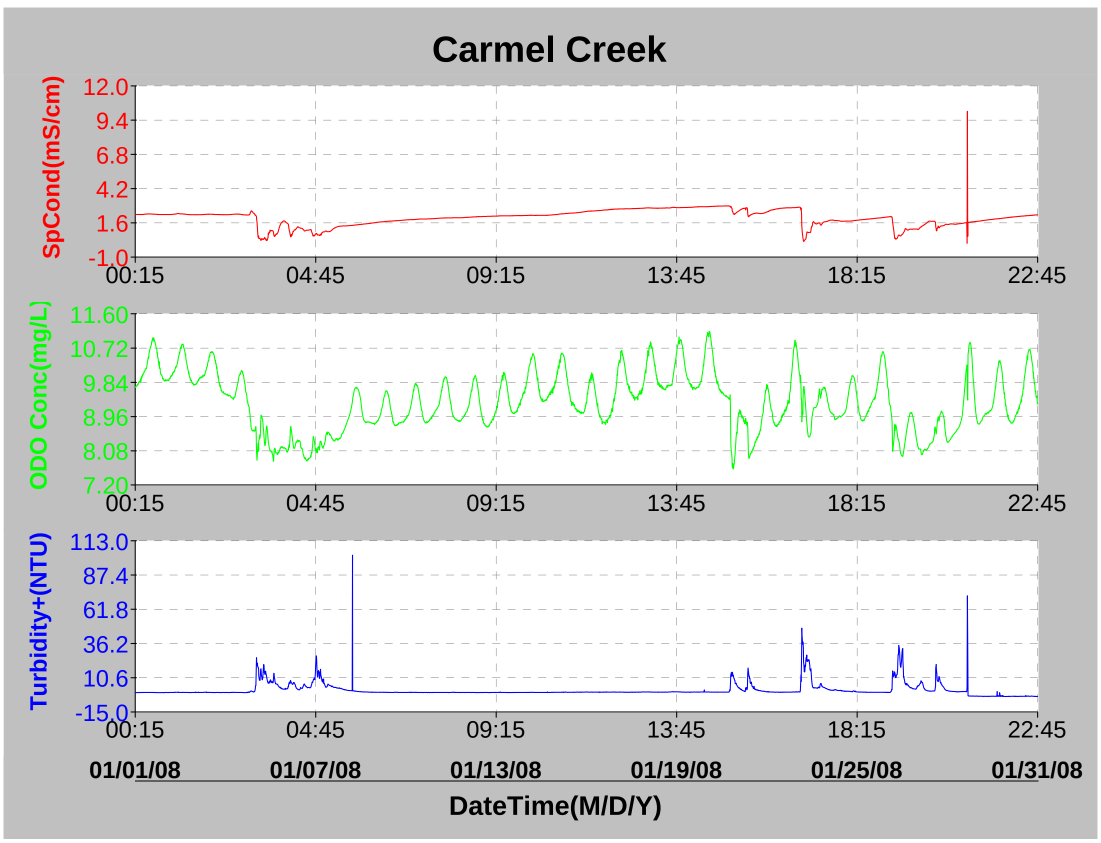


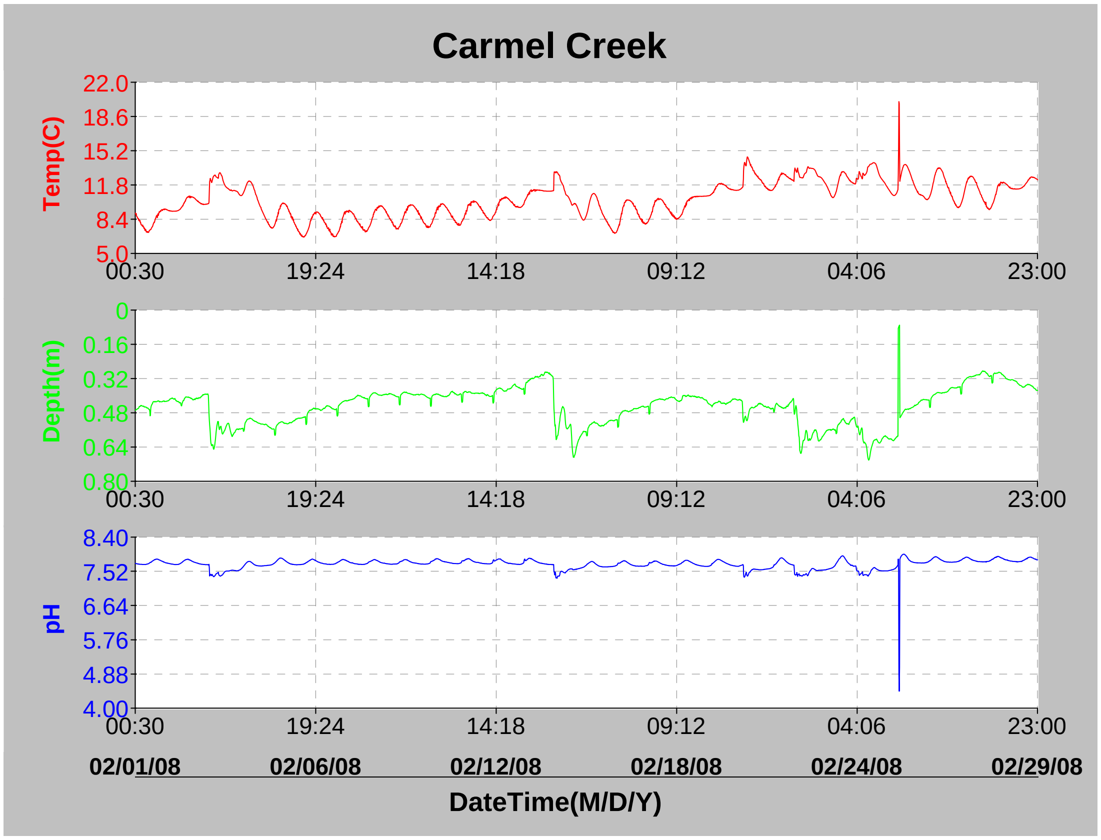
Carmel Creek
SpCond(mS/cm)
3.90
3.06
2.22
1.38
0.54
-0.30
ODO Conc(mg/L)
12.0
10.4
8.8
7.2
5.6
4.0
Turbidity+(NTU)
344.0
268.8
193.6
118.4
43.2
-32.0
00:15
00:09
00:03
23:57
23:51
23:45
11/01/07
11/07/07
11/13/07
11/18/07
11/24/07
11/30/07
DateTime(M/D/Y)


Carmel Creek
Temp(C)
17.0
14.4
11.8
9.2
6.6
4.0
Depth(m)
-0.20
0.06
0.32
0.58
0.84
1.10
pH
8.50
7.96
7.42
6.88
6.34
5.80
02:15
05:42
09:09
12:36
16:03
19:30
12/01/07
12/07/07
12/13/07
12/19/07
12/25/07
12/31/07
DateTime(M/D/Y)

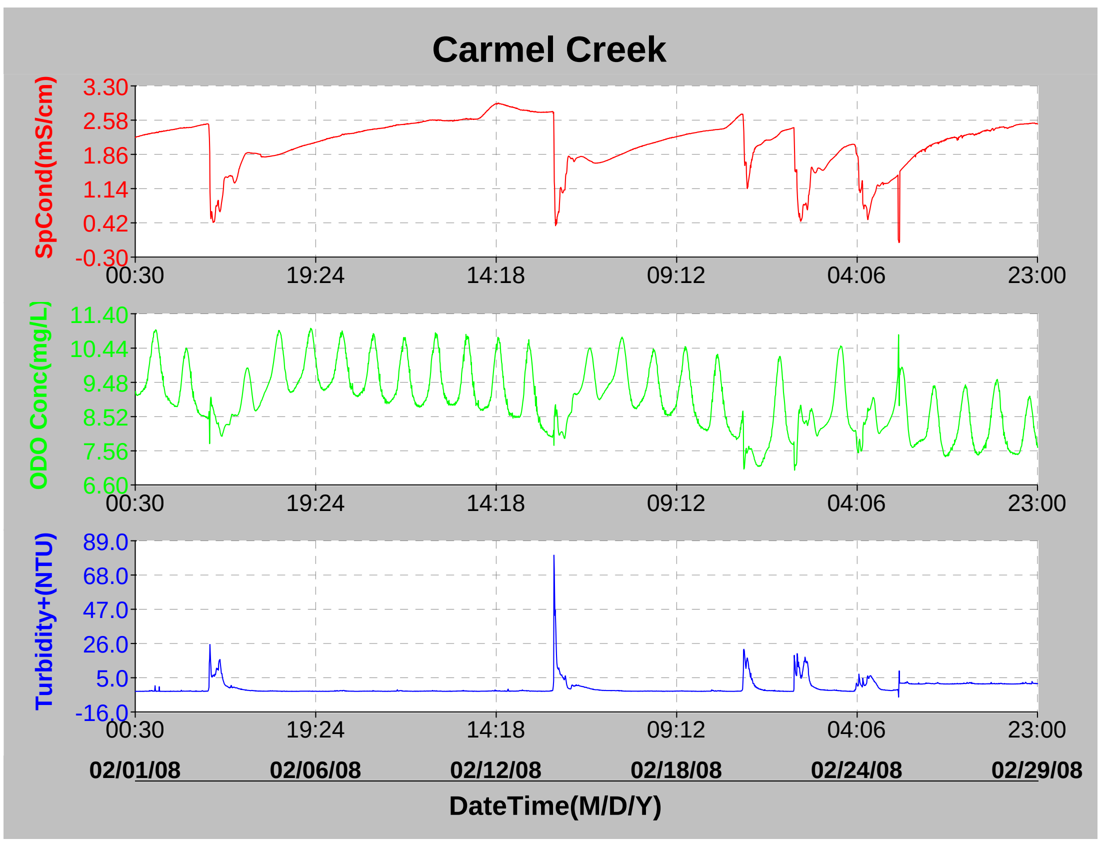

Carmel Creek
SpCond(mS/cm)
3.00
2.36
1.72
1.08
0.44
-0.20
ODO Conc(mg/L)
13.0
11.6
10.2
8.8
7.4
6.0
Turbidity+(NTU)
274.0
214.0
154.0
94.0
34.0
-26.0
02:15
05:42
09:09
12:36
16:03
19:30
12/01/07
12/07/07
12/13/07
12/19/07
12/25/07
12/31/07
DateTime(M/D/Y)


Carmel Creek
Temp(C)
17.0
14.6
12.2
9.8
7.4
5.0
Depth(m)
0
0.18
0.36
0.54
0.72
0.90
pH
8.20
7.88
7.56
7.24
6.92
6.60
00:15
04:45
09:15
13:45
18:15
22:45
01/01/08
01/07/08
01/13/08
01/19/08
01/25/08
01/31/08
DateTime(M/D/Y)

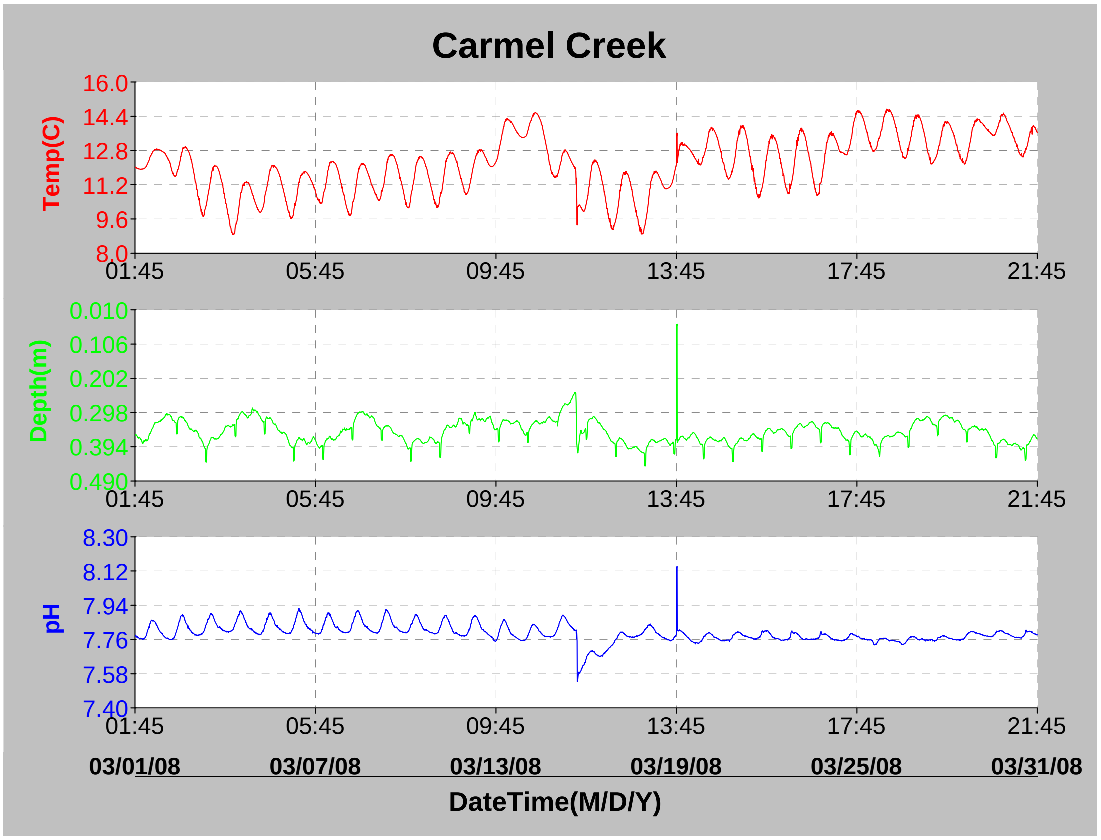

Carmel Creek
SpCond(mS/cm)
12.0
9.4
6.8
4.2
1.6
-1.0
ODO Conc(mg/L)
11.60
10.72
9.84
8.96
8.08
7.20
Turbidity+(NTU)
113.0
87.4
61.8
36.2
10.6
-15.0
00:15
04:45
09:15
13:45
18:15
22:45
01/01/08
01/07/08
01/13/08
01/19/08
01/25/08
01/31/08
DateTime(M/D/Y)

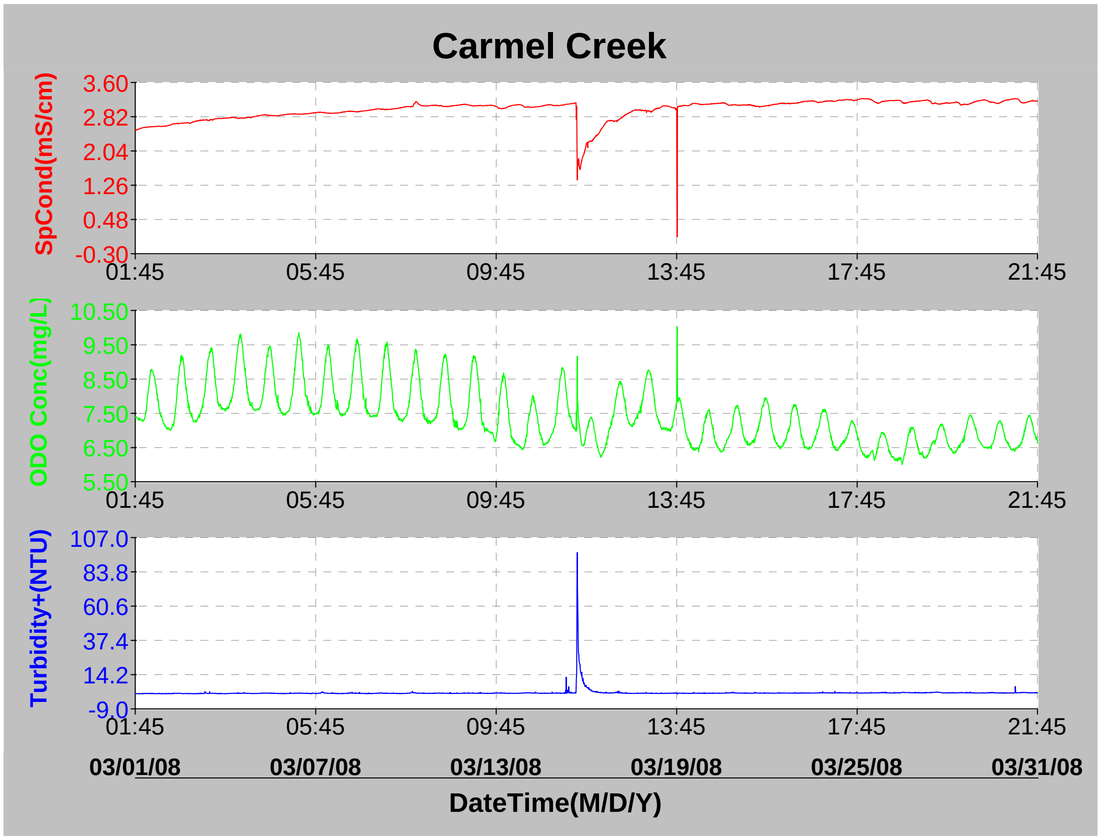


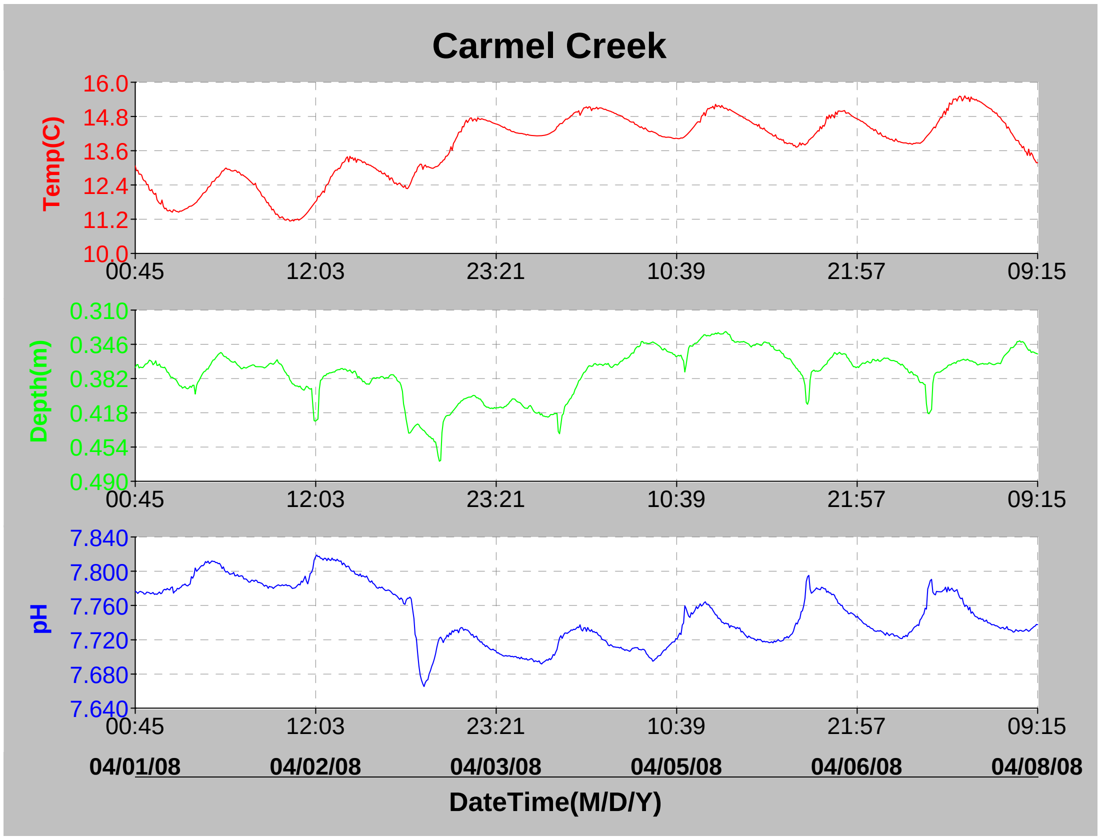
Carmel Creek
Temp(C)
22.0
18.6
15.2
11.8
8.4
5.0
Depth(m)
0
0.16
0.32
0.48
0.64
0.80
pH
8.40
7.52
6.64
5.76
4.88
4.00
00:30
19:24
14:18
09:12
04:06
23:00
02/01/08
02/06/08
02/12/08
02/18/08
02/24/08
02/29/08
DateTime(M/D/Y)

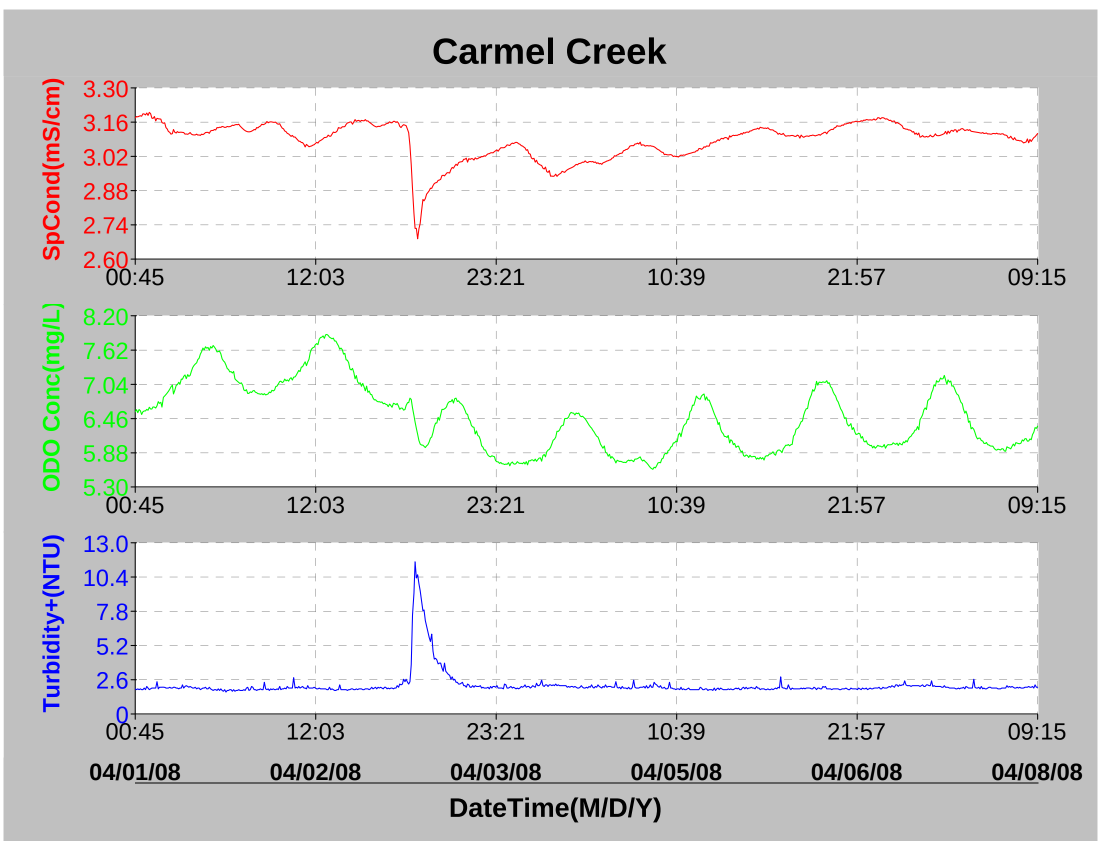


Carmel Creek
SpCond(mS/cm)
3.30
2.58
1.86
1.14
0.42
-0.30
ODO Conc(mg/L)
11.40
10.44
9.48
8.52
7.56
6.60
Turbidity+(NTU)
89.0
68.0
47.0
26.0
5.0
-16.0
00:30
19:24
14:18
09:12
04:06
23:00
02/01/08
02/06/08
02/12/08
02/18/08
02/24/08
02/29/08
DateTime(M/D/Y)

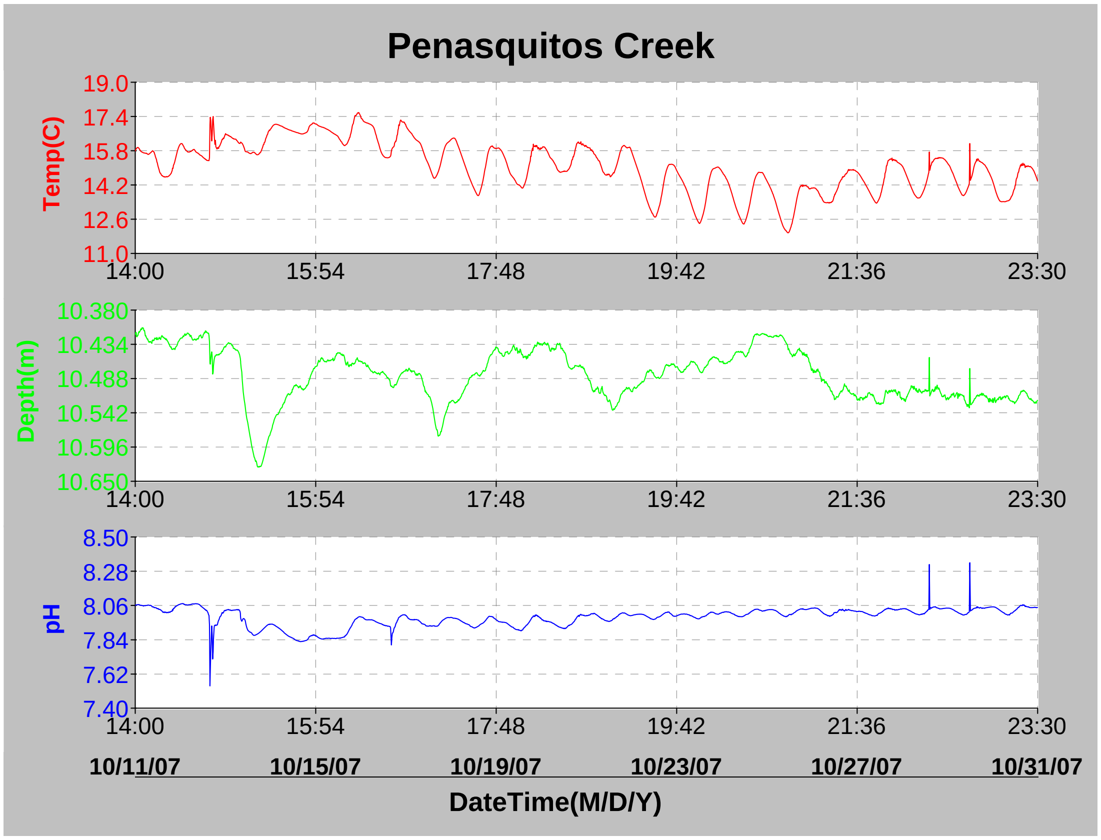

Carmel Creek
Temp(C)
16.0
14.4
12.8
11.2
9.6
8.0
Depth(m)
0.010
0.106
0.202
0.298
0.394
0.490
pH
8.30
8.12
7.94
7.76
7.58
7.40
01:45
05:45
09:45
13:45
17:45
21:45
03/01/08
03/07/08
03/13/08
03/19/08
03/25/08
03/31/08
DateTime(M/D/Y)


Carmel Creek
SpCond(mS/cm)
3.60
2.82
2.04
1.26
0.48
-0.30
ODO Conc(mg/L)
10.50
9.50
8.50
7.50
6.50
5.50
Turbidity+(NTU)
107.0
83.8
60.6
37.4
14.2
-9.0
01:45
05:45
09:45
13:45
17:45
21:45
03/01/08
03/07/08
03/13/08
03/19/08
03/25/08
03/31/08
DateTime(M/D/Y)


Carmel Creek
Temp(C)
16.0
14.8
13.6
12.4
11.2
10.0
Depth(m)
0.310
0.346
0.382
0.418
0.454
0.490
pH
7.840
7.800
7.760
7.720
7.680
7.640
00:45
12:03
23:21
10:39
21:57
09:15
04/01/08
04/02/08
04/03/08
04/05/08
04/06/08
04/08/08
DateTime(M/D/Y)


Carmel Creek
SpCond(mS/cm)
3.30
3.16
3.02
2.88
2.74
2.60
ODO Conc(mg/L)
8.20
7.62
7.04
6.46
5.88
5.30
Turbidity+(NTU)
13.0
10.4
7.8
5.2
2.6
0
00:45
12:03
23:21
10:39
21:57
09:15
04/01/08
04/02/08
04/03/08
04/05/08
04/06/08
04/08/08
DateTime(M/D/Y)

LOS PEÑASQUITOS CREEK



Penasquitos Creek
Temp(C)
19.0
17.4
15.8
14.2
12.6
11.0
Depth(m)
10.380
10.434
10.488
10.542
10.596
10.650
pH
8.50
8.28
8.06
7.84
7.62
7.40
14:00
15:54
17:48
19:42
21:36
23:30
10/11/07
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10/19/07
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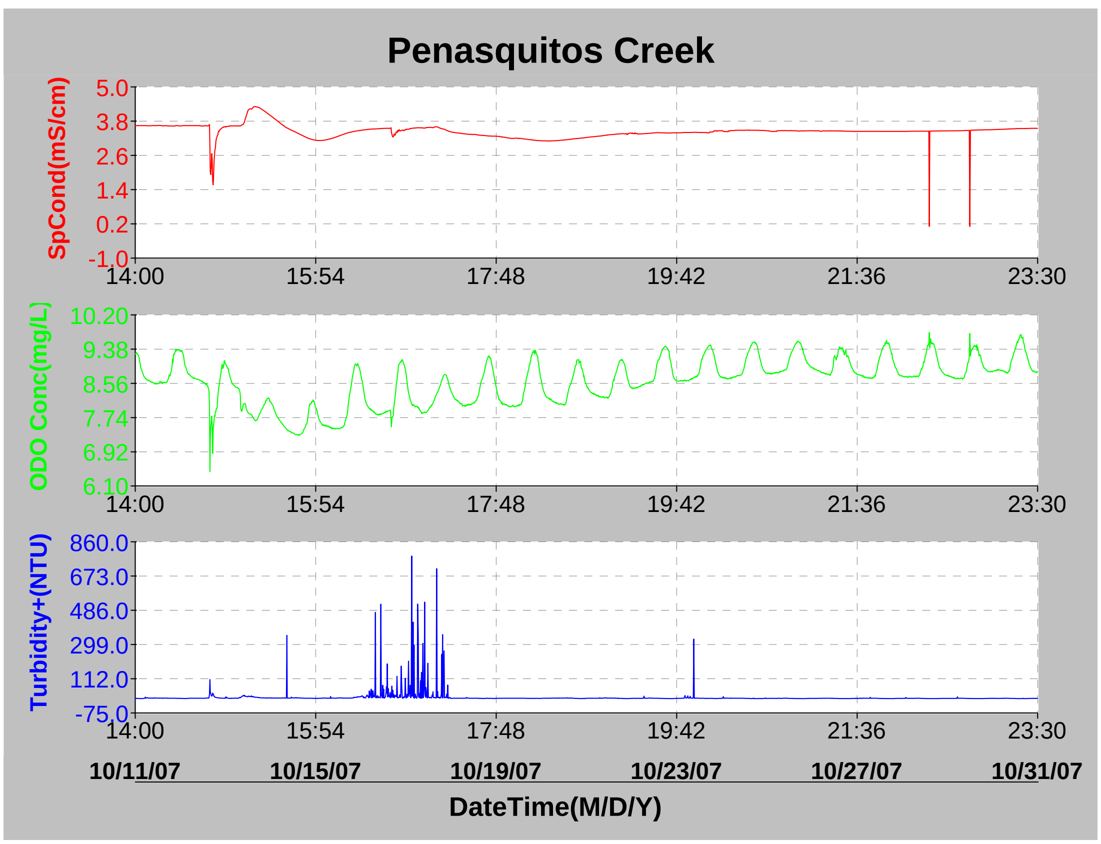
10/27/07
10/31/07
DateTime(M/D/Y)



Penasquitos Creek
SpCond(mS/cm)
5.0
3.8
2.6
1.4
0.2
-1.0
ODO Conc(mg/L)
10.20
9.38
8.56
7.74
6.92
6.10
Turbidity+(NTU)
860.0
673.0
486.0
299.0
112.0
-75.0
14:00
15:54
17:48
19:42
21:36
23:30
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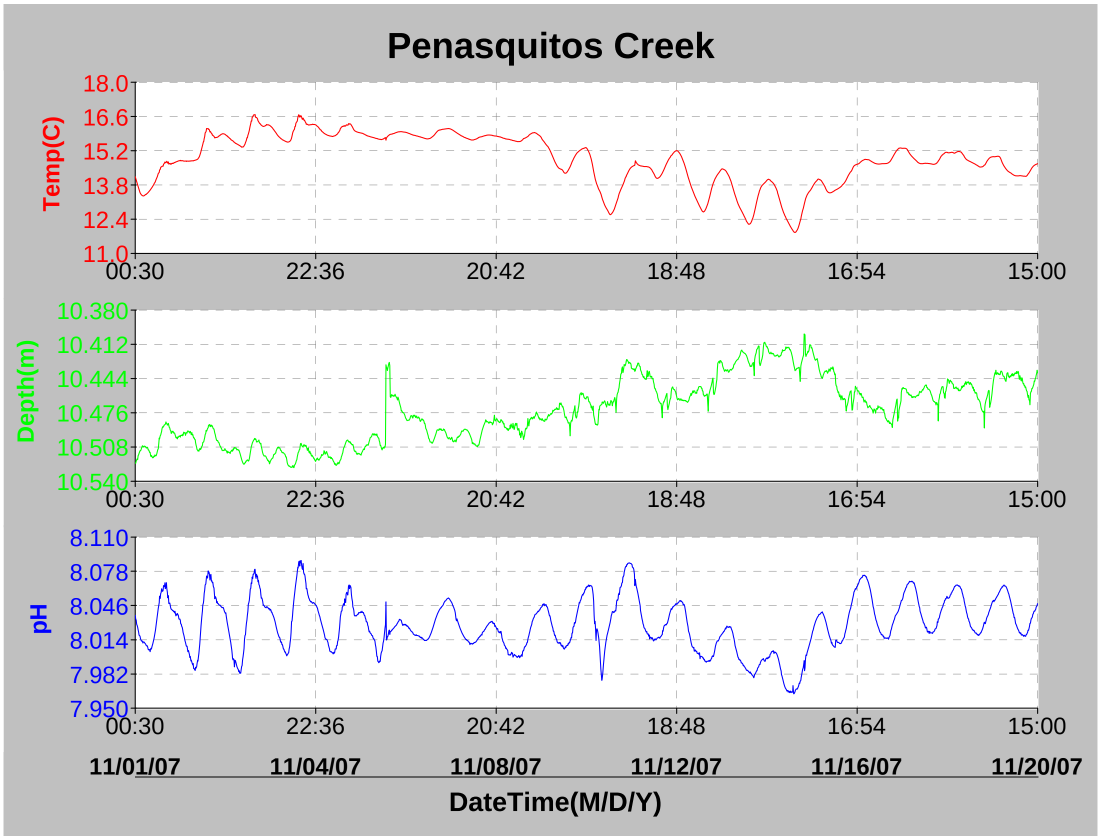
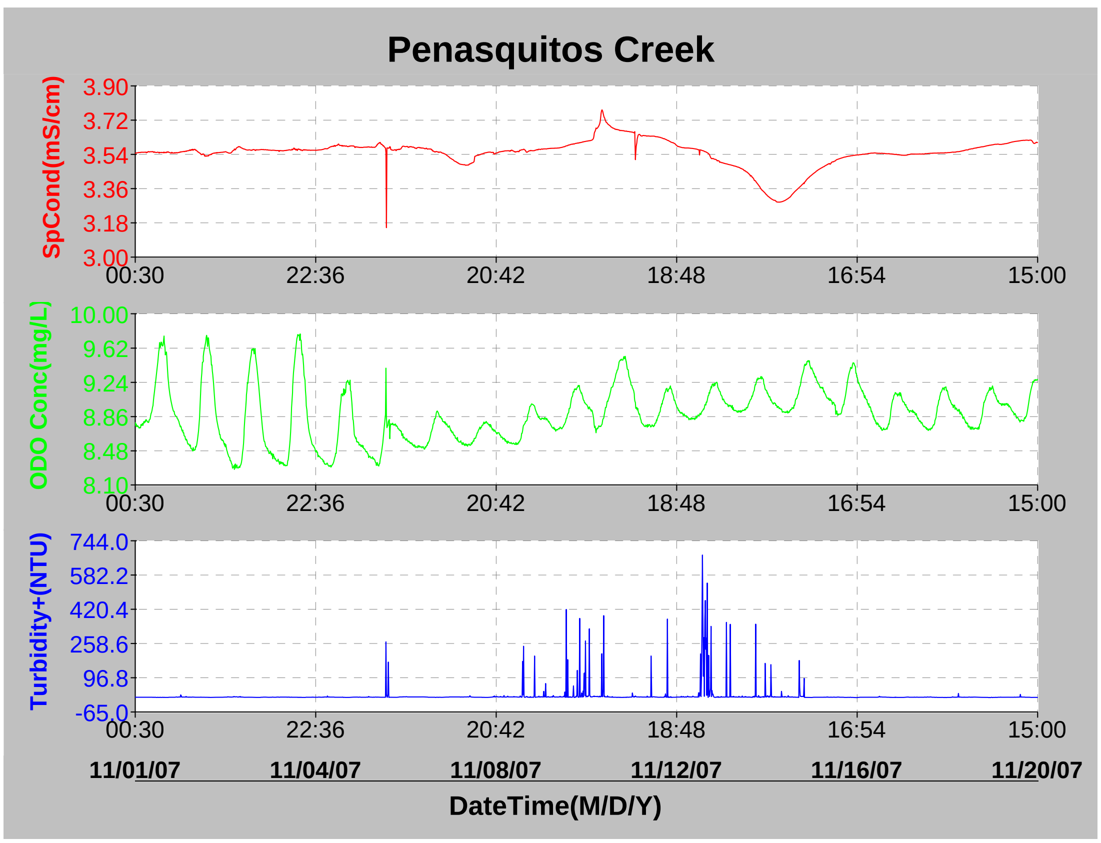
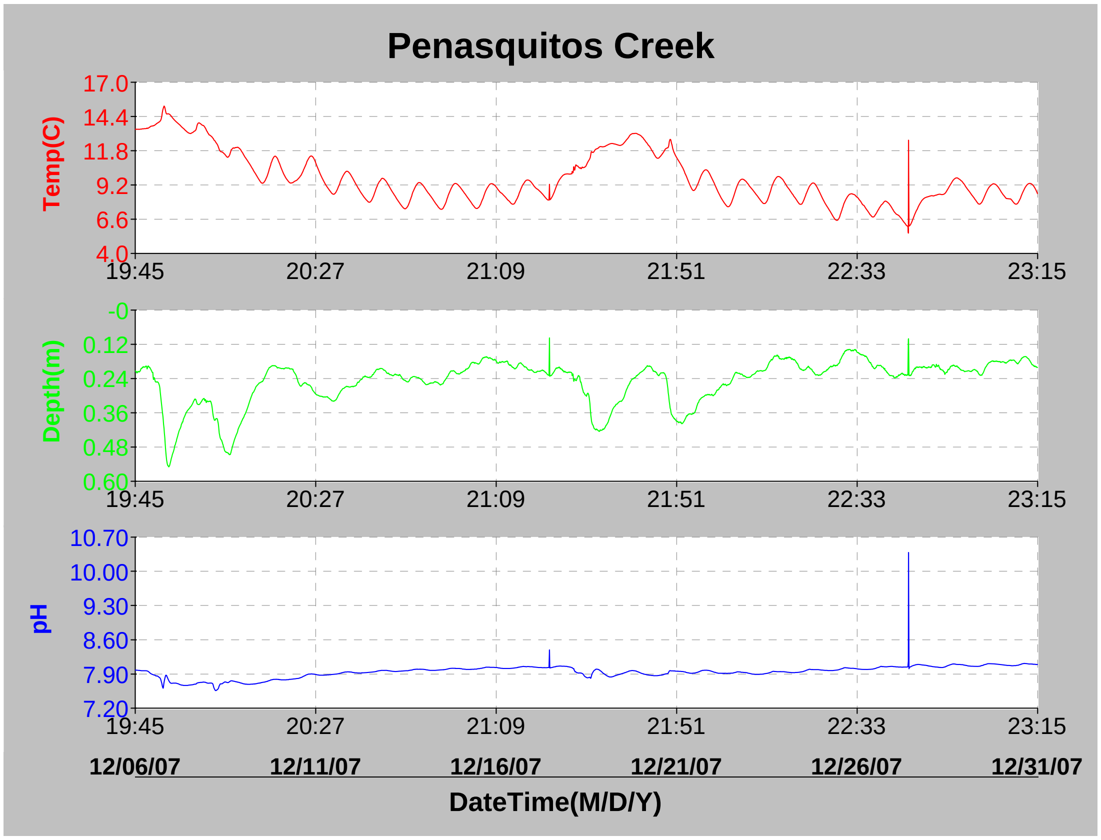
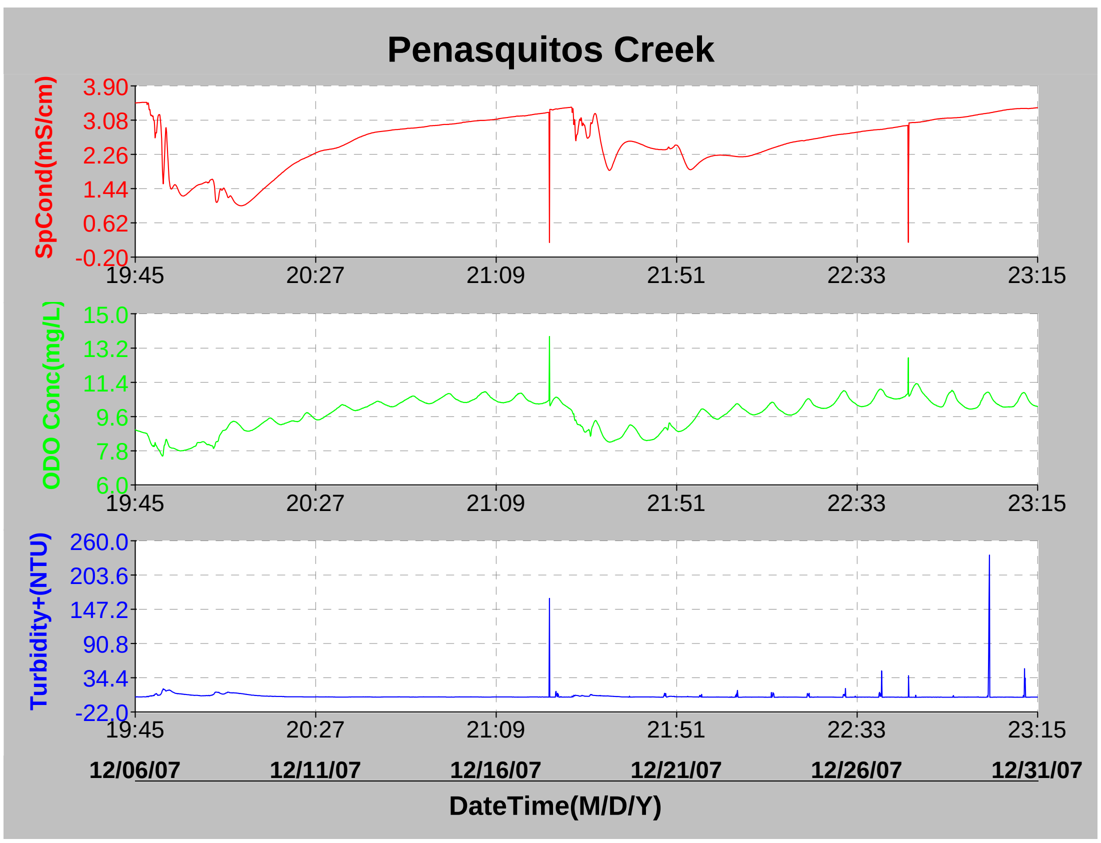
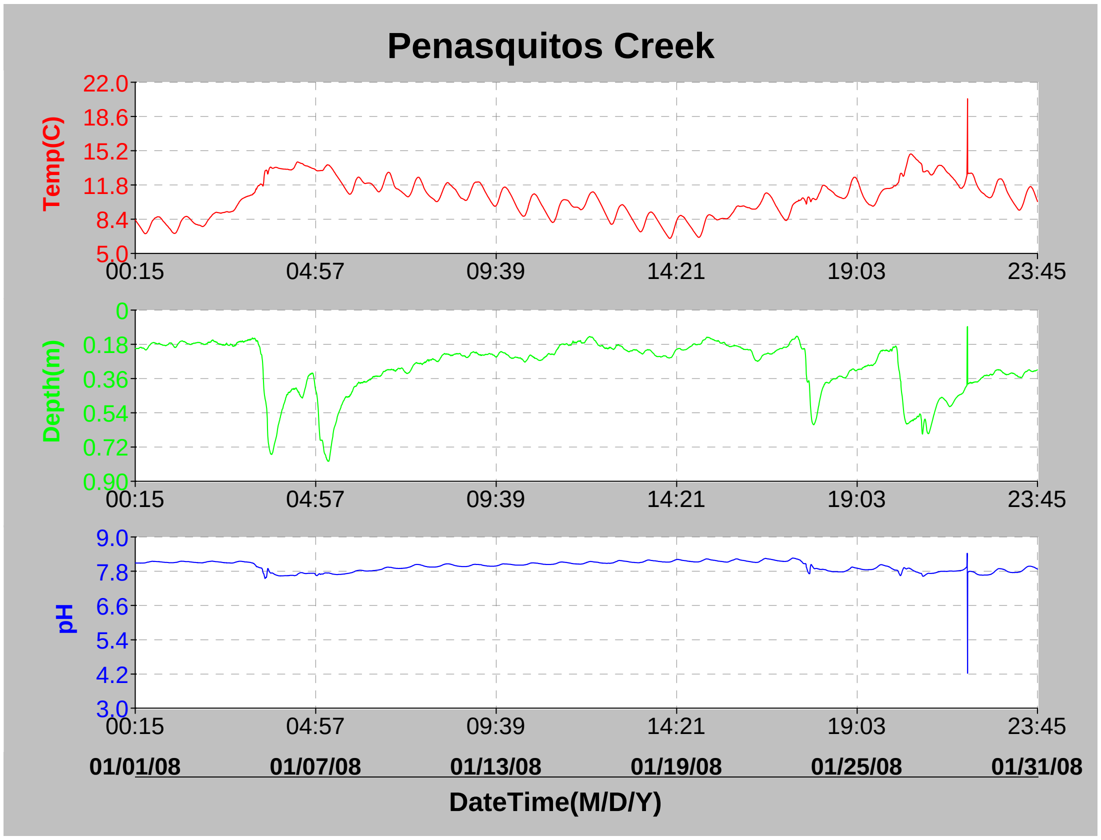
DateTime(M/D/Y)


Penasquitos Creek
Temp(C)
18.0
16.6
15.2
13.8
12.4
11.0
Depth(m)
10.380
10.412
10.444
10.476
10.508
10.540
pH
8.110
8.078
8.046
8.014
7.982
7.950
00:30
22:36
20:42
18:48
16:54
15:00
11/01/07
11/04/07
11/08/07
11/12/07
11/16/07
11/20/07
DateTime(M/D/Y)

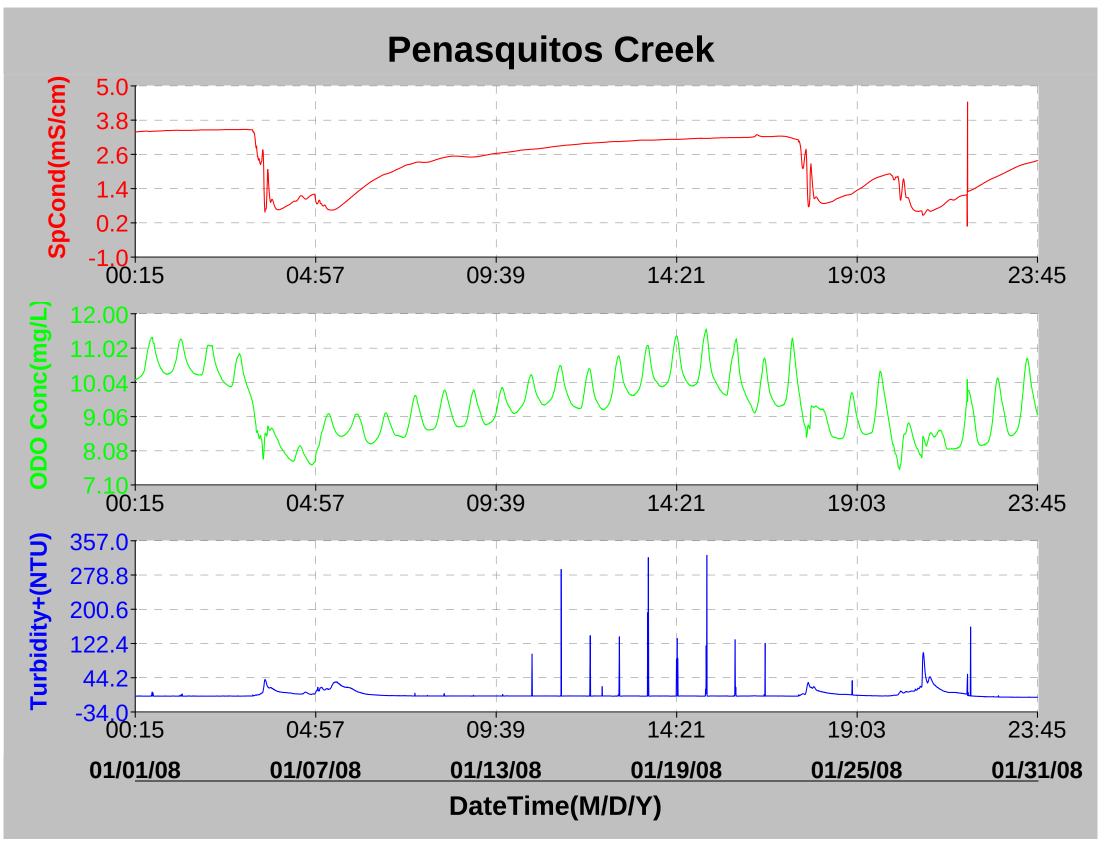

Penasquitos Creek
SpCond(mS/cm)
3.90
3.72
3.54
3.36
3.18
3.00
ODO Conc(mg/L)
10.00
9.62
9.24
8.86
8.48
8.10
Turbidity+(NTU)
744.0
582.2
420.4
258.6
96.8
-65.0
00:30
22:36
20:42
18:48
16:54
15:00
11/01/07
11/04/07
11/08/07
11/12/07
11/16/07
11/20/07
DateTime(M/D/Y)


Penasquitos Creek
Temp(C)
17.0
14.4
11.8
9.2
6.6
4.0
Depth(m)
-0
0.12
0.24
0.36
0.48
0.60
pH
10.70
10.00
9.30
8.60
7.90
7.20
19:45
20:27
21:09
21:51
22:33
23:15
12/06/07
12/11/07
12/16/07
12/21/07
12/26/07
12/31/07
DateTime(M/D/Y)

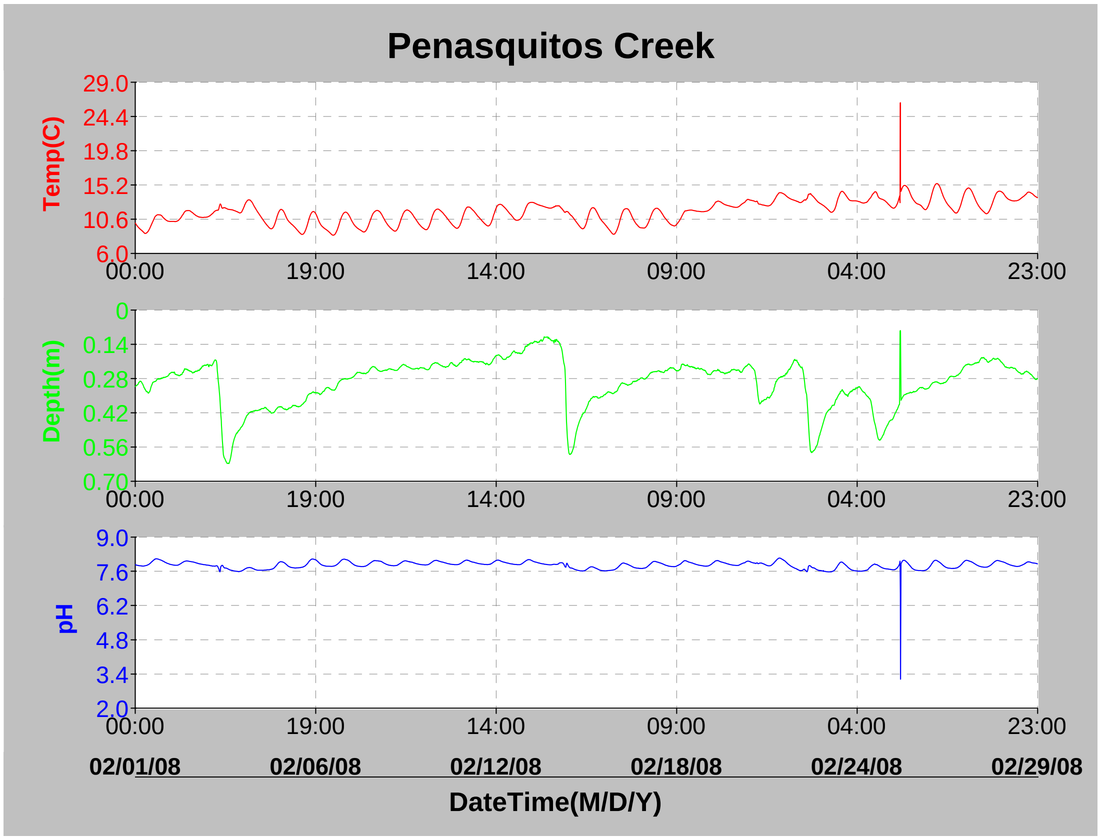

Penasquitos Creek
SpCond(mS/cm)
3.90
3.08
2.26
1.44
0.62
-0.20
ODO Conc(mg/L)
15.0
13.2
11.4
9.6
7.8
6.0
Turbidity+(NTU)
260.0
203.6
147.2
90.8
34.4
-22.0
19:45
20:27
21:09
21:51
22:33
23:15
12/06/07
12/11/07
12/16/07
12/21/07
12/26/07
12/31/07
DateTime(M/D/Y)

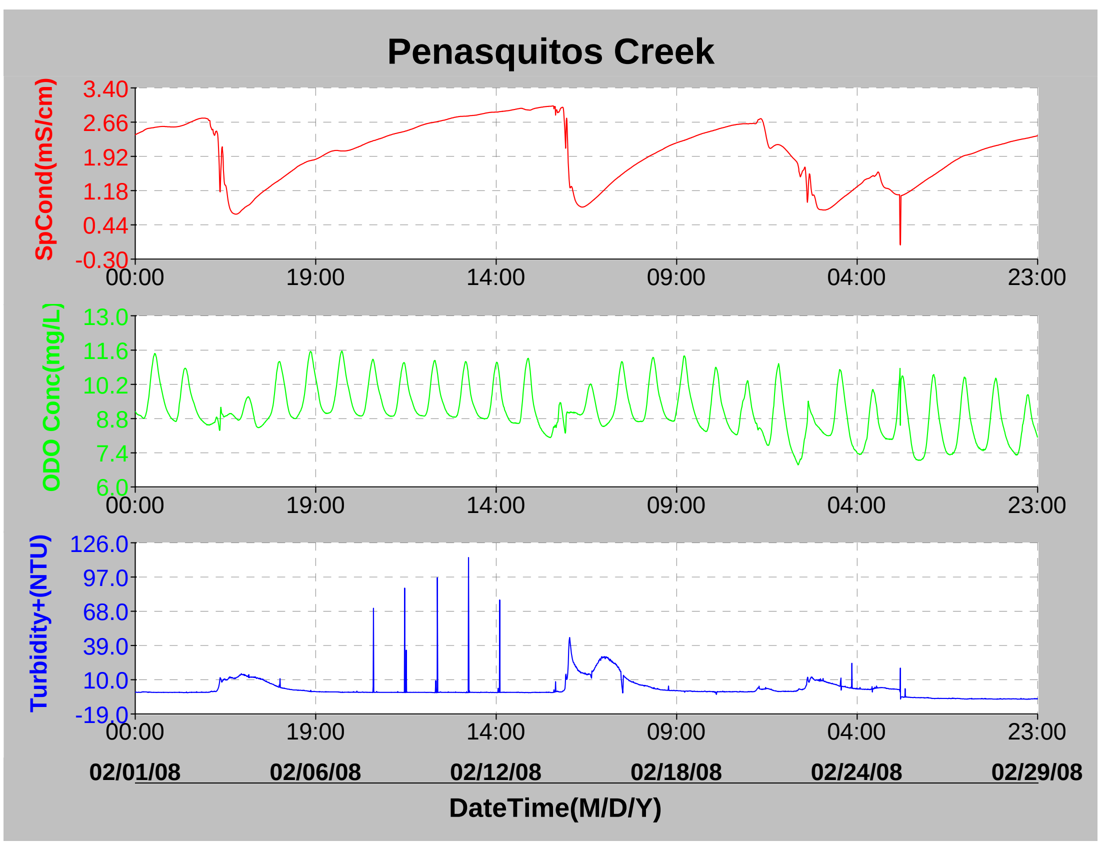


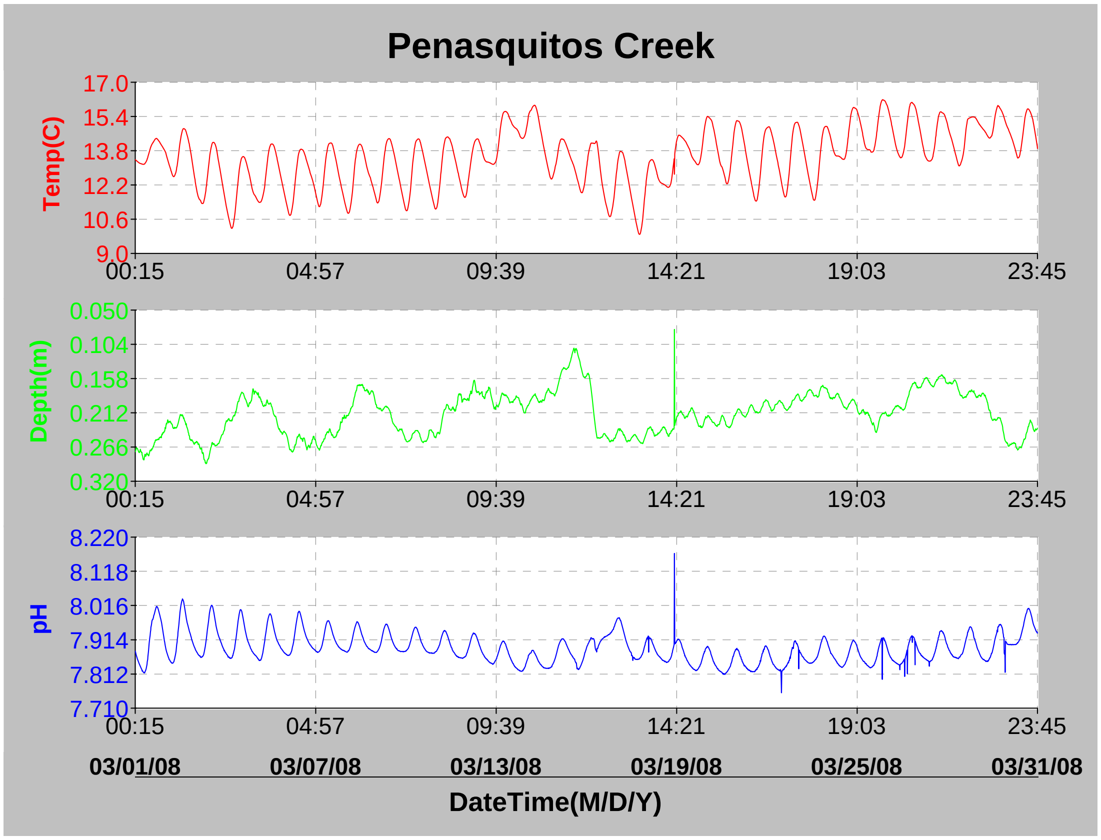
Penasquitos Creek
Temp(C)
22.0
18.6
15.2
11.8
8.4
5.0
Depth(m)
0
0.18
0.36
0.54
0.72
0.90
pH
9.0
7.8
6.6
5.4
4.2
3.0
00:15
04:57
09:39
14:21
19:03
23:45
01/01/08
01/07/08
01/13/08
01/19/08
01/25/08
01/31/08
DateTime(M/D/Y)

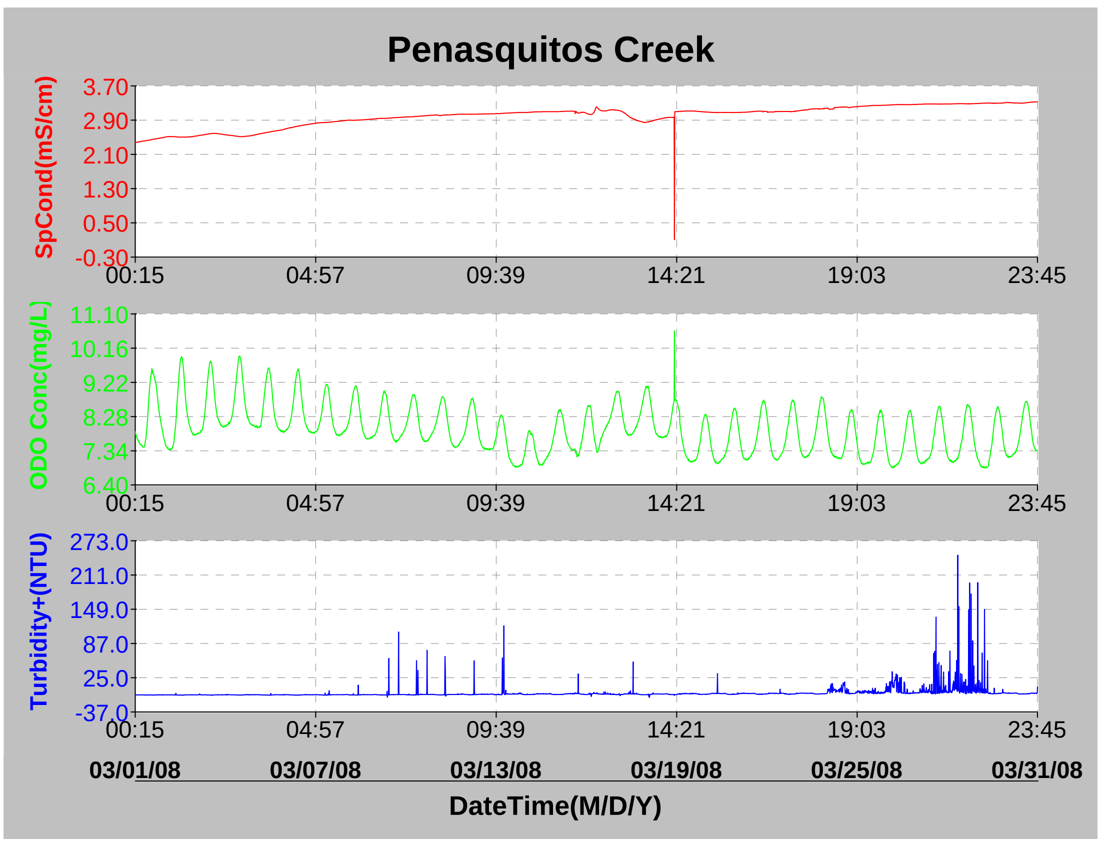


Penasquitos Creek
SpCond(mS/cm)
5.0
3.8
2.6
1.4
0.2
-1.0
ODO Conc(mg/L)
12.00
11.02
10.04
9.06
8.08
7.10
Turbidity+(NTU)
357.0
278.8
200.6
122.4
44.2
-34.0
00:15
04:57
09:39
14:21
19:03
23:45
01/01/08
01/07/08
01/13/08
01/19/08
01/25/08
01/31/08
DateTime(M/D/Y)

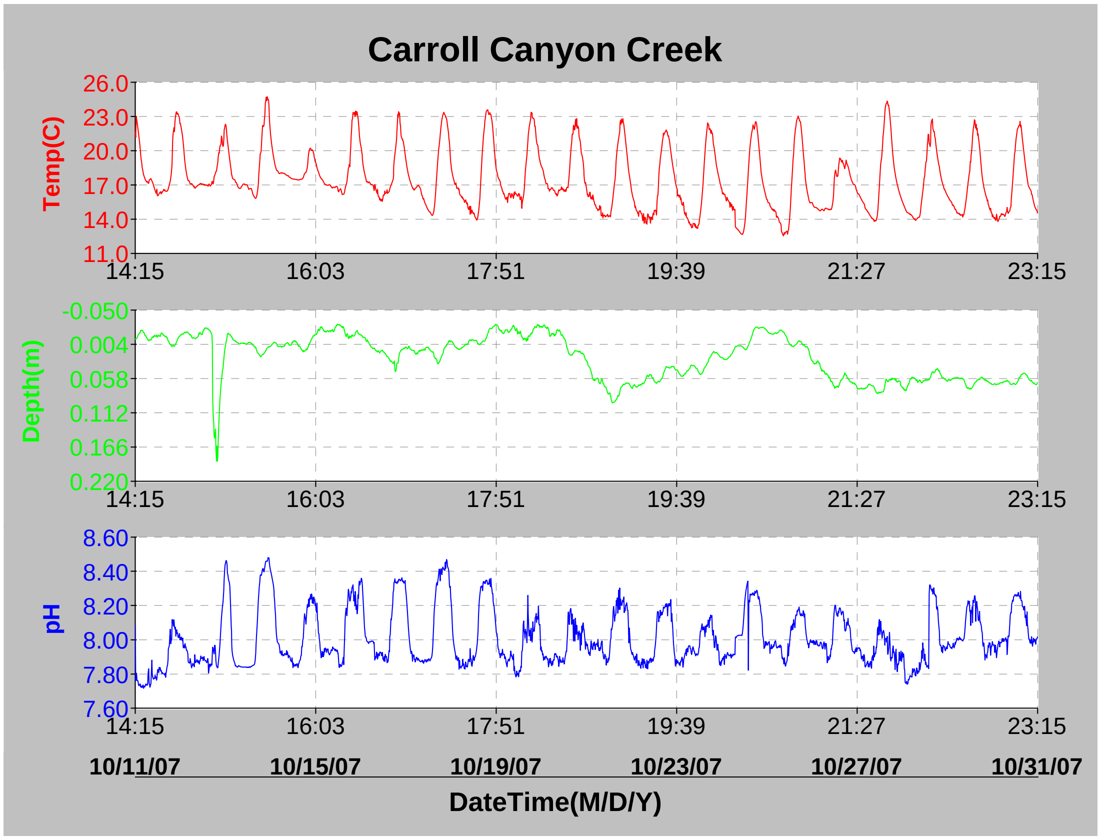

Penasquitos Creek
Temp(C)
29.0
24.4
19.8
15.2
10.6
6.0
Depth(m)
0
0.14
0.28
0.42
0.56
0.70
pH
9.0
7.6
6.2
4.8
3.4
2.0
00:00
19:00
14:00
09:00
04:00
23:00
02/01/08
02/06/08
02/12/08
02/18/08
02/24/08
02/29/08
DateTime(M/D/Y)

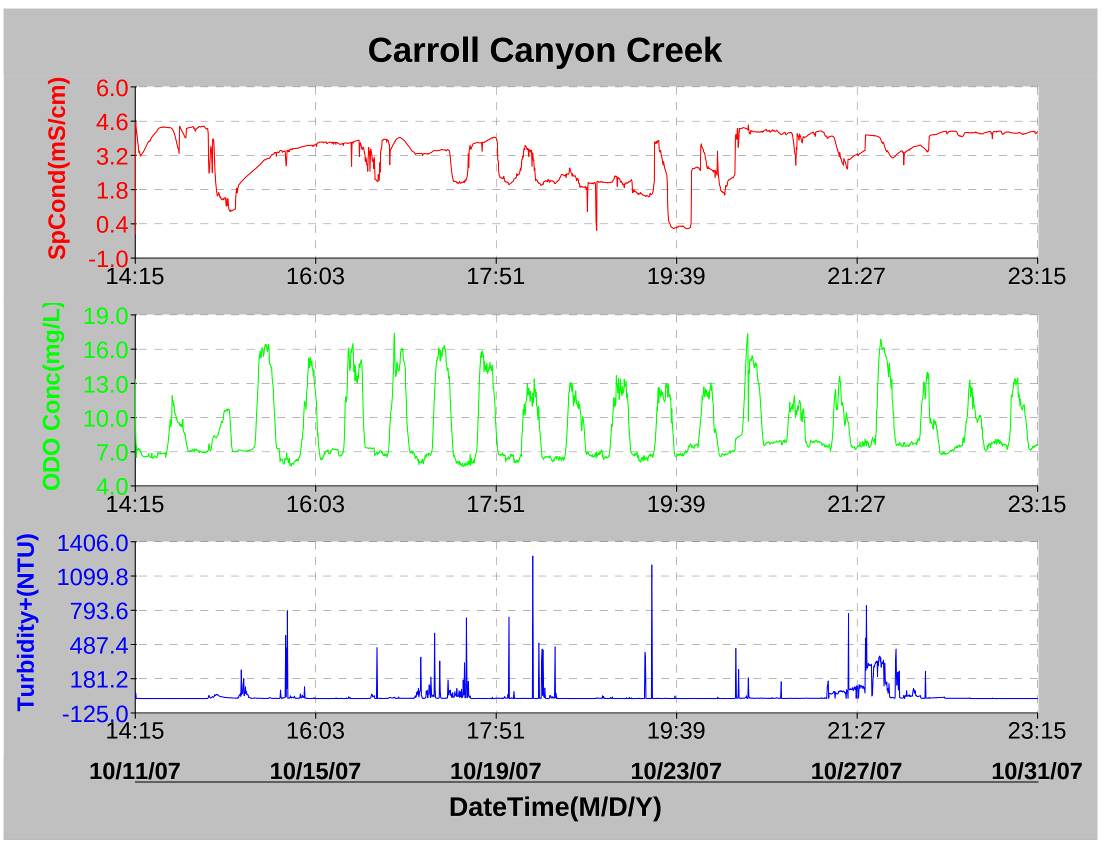

Penasquitos Creek
SpCond(mS/cm)
3.40
2.66
1.92
1.18
0.44
-0.30
ODO Conc(mg/L)
13.0
11.6
10.2
8.8
7.4
6.0
Turbidity+(NTU)
126.0
97.0
68.0
39.0
10.0
-19.0
00:00
19:00
14:00
09:00
04:00
23:00
02/01/08
02/06/08
02/12/08
02/18/08
02/24/08
02/29/08
DateTime(M/D/Y)

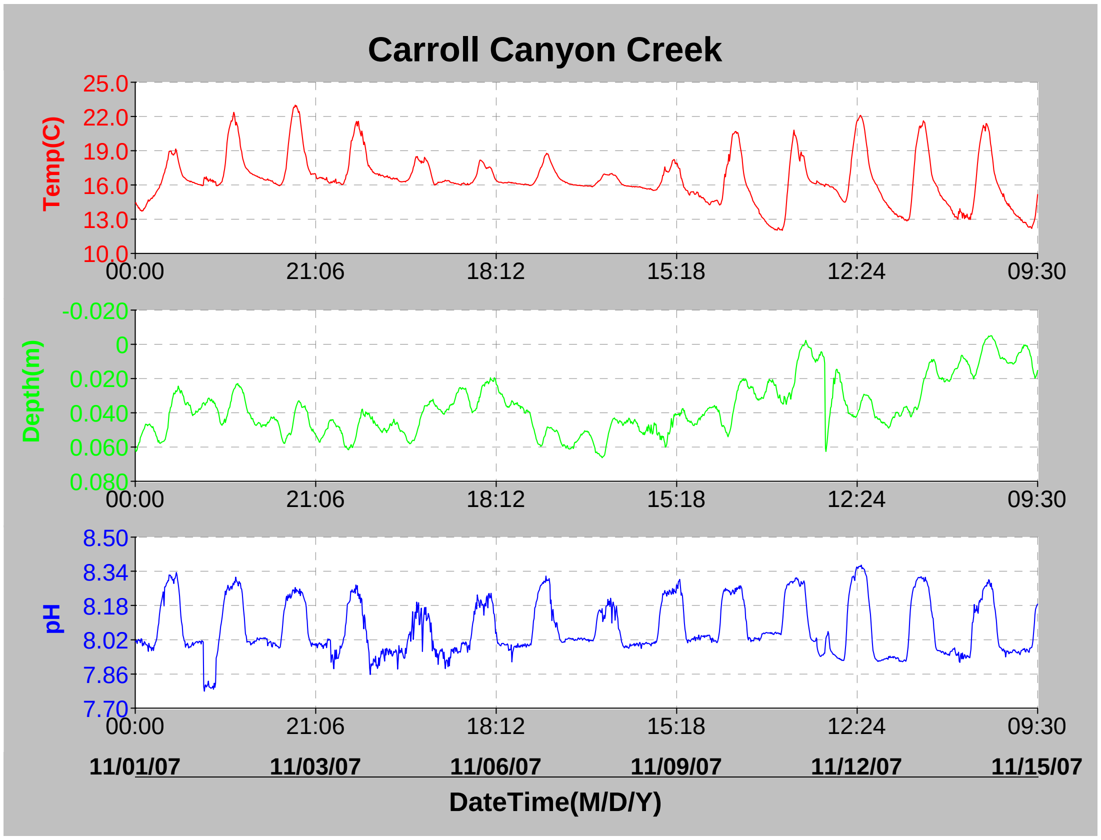

Penasquitos Creek
Temp(C)
17.0
15.4
13.8
12.2
10.6
9.0
Depth(m)
0.050
0.104
0.158
0.212
0.266
0.320
pH
8.220
8.118
8.016
7.914
7.812
7.710
00:15
04:57
09:39
14:21
19:03
23:45
03/01/08
03/07/08
03/13/08
03/19/08
03/25/08
03/31/08
DateTime(M/D/Y)

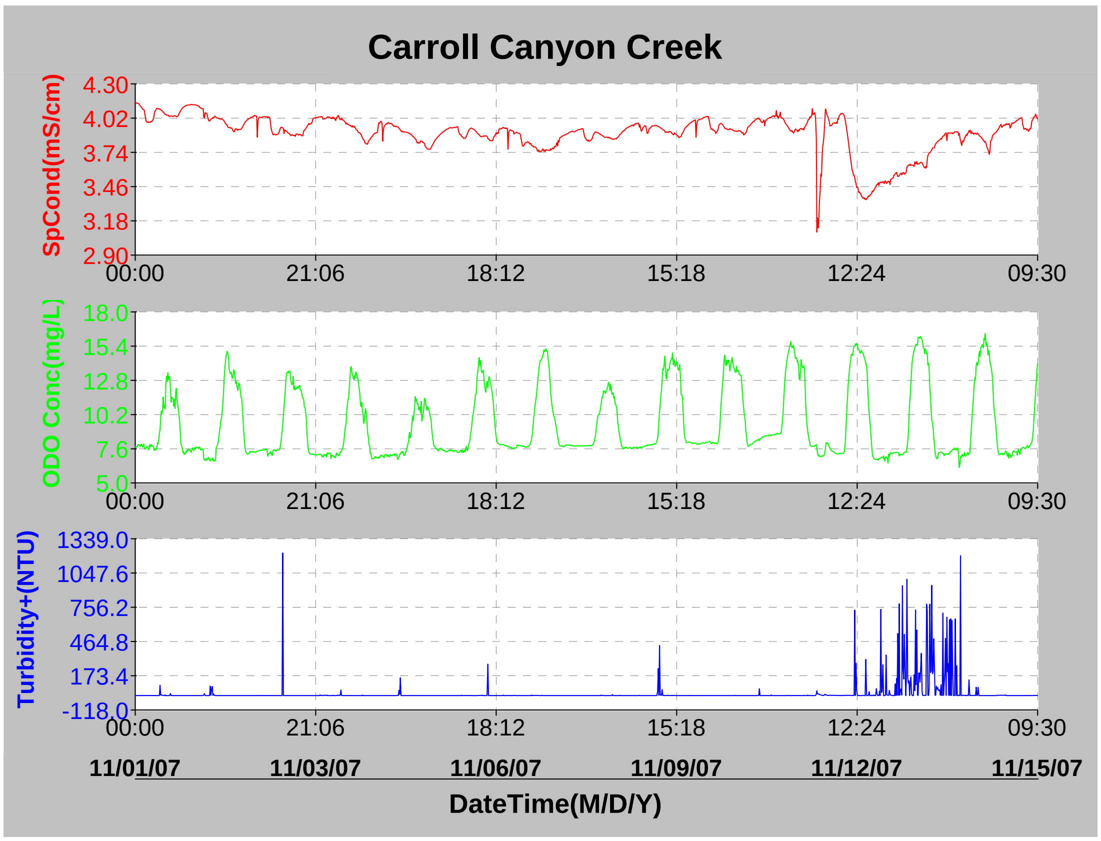

Penasquitos Creek
SpCond(mS/cm)
3.70
2.90
2.10
1.30
0.50
-0.30
ODO Conc(mg/L)
11.10
10.16
9.22
8.28
7.34
6.40
Turbidity+(NTU)
273.0
211.0
149.0
87.0
25.0
-37.0
00:15
04:57
09:39
14:21
19:03
23:45
03/01/08
03/07/08
03/13/08
03/19/08
03/25/08
03/31/08
DateTime(M/D/Y)

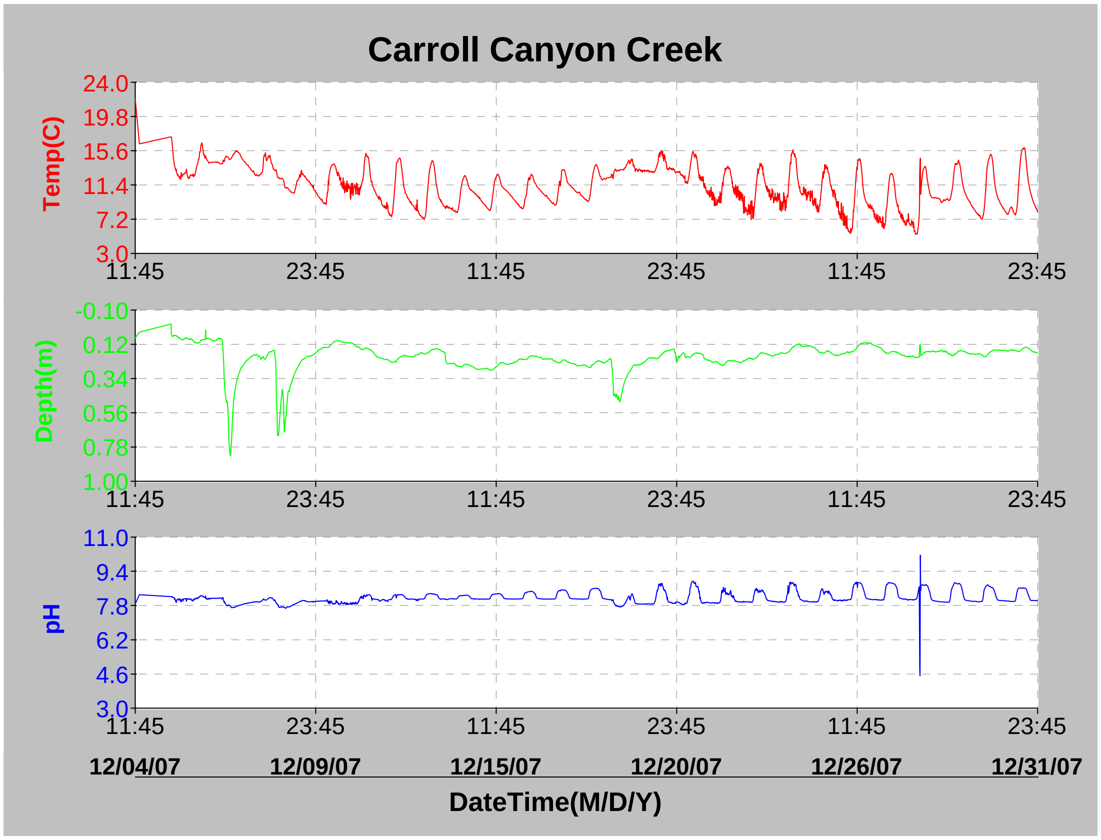
CARROLL CANYON CREEK

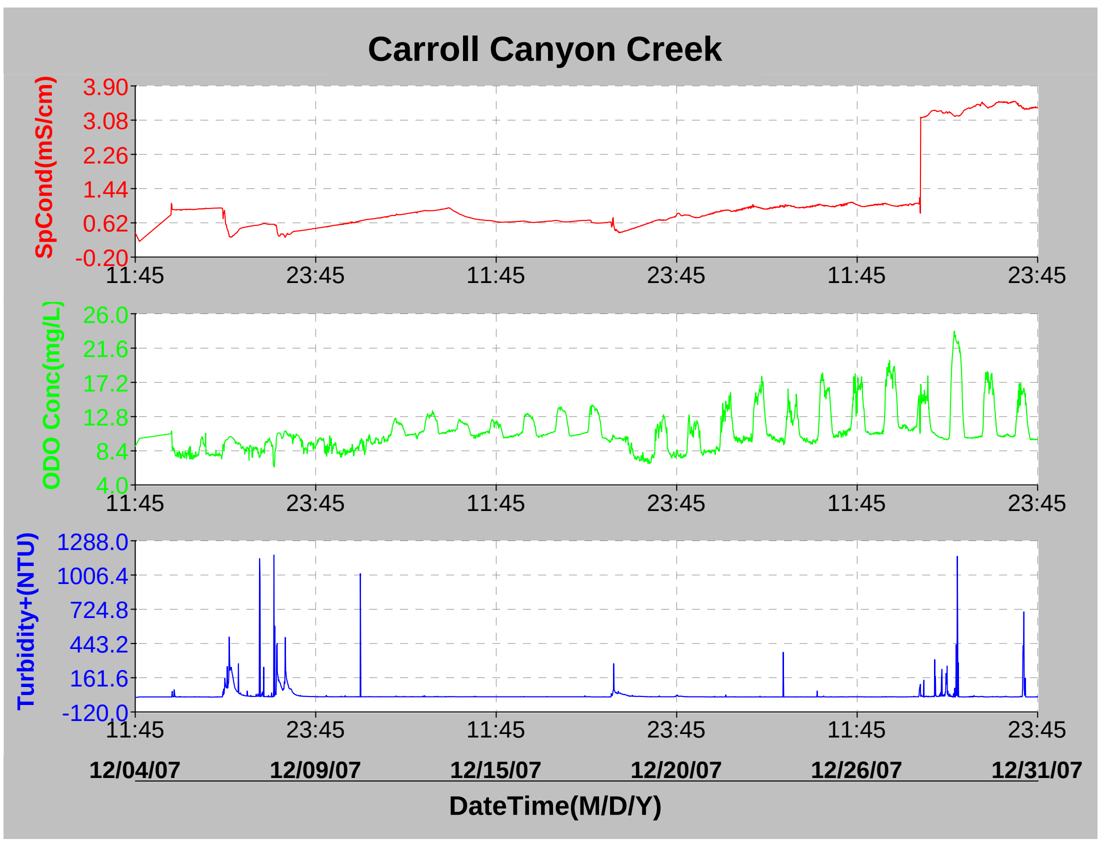

Carroll Canyon Creek
Temp(C)
26.0
23.0
20.0
17.0
14.0
11.0
Depth(m)
-0.050
0.004
0.058
0.112
0.166
0.220
pH
8.60
8.40
8.20
8.00
7.80
7.60
14:15
16:03
17:51
19:39
21:27
23:15
10/11/07
10/15/07
10/19/07
10/23/07
10/27/07
10/31/07
DateTime(M/D/Y)

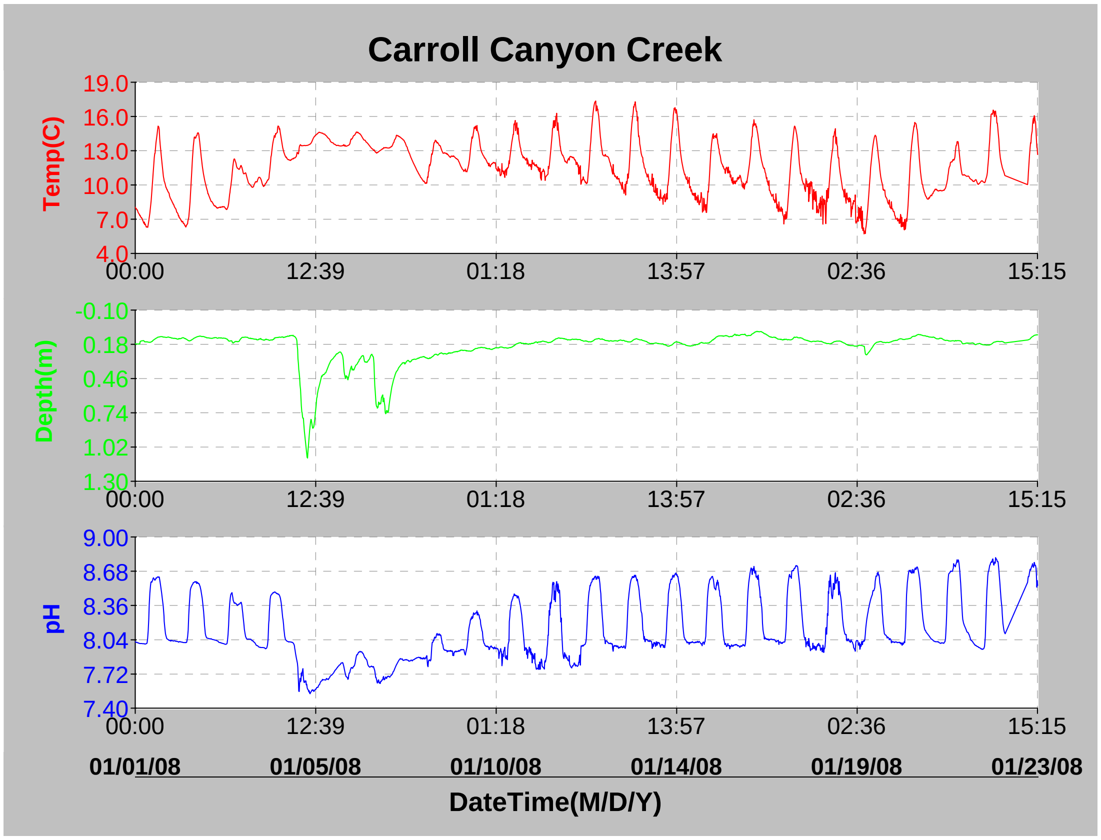

Carroll Canyon Creek
SpCond(mS/cm)
6.0
4.6
3.2
1.8
0.4
-1.0
ODO Conc(mg/L)
19.0
16.0
13.0
10.0
7.0
4.0
Turbidity+(NTU)
1406.0
1099.8
793.6
487.4
181.2
-125.0
14:15
16:03
17:51
19:39
21:27
23:15
10/11/07
10/15/07
10/19/07
10/23/07
10/27/07
10/31/07
DateTime(M/D/Y)

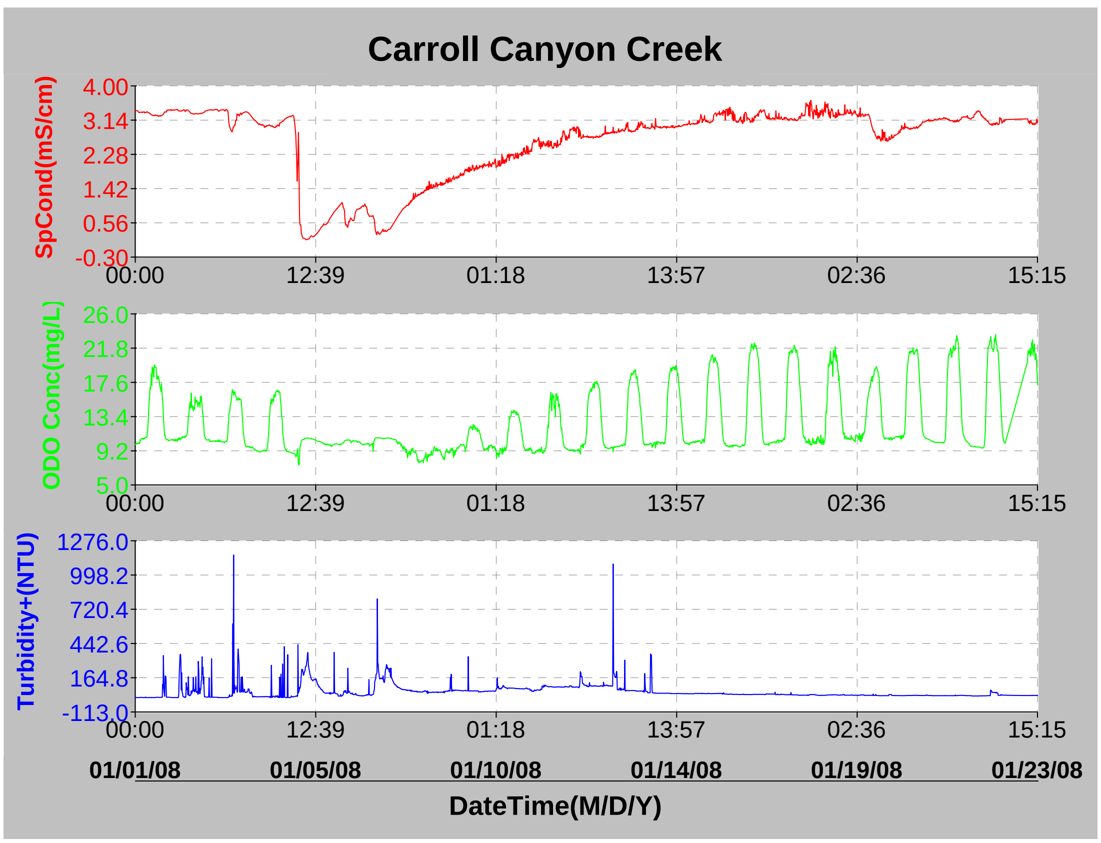

Carroll Canyon Creek
Temp(C)
25.0
22.0
19.0
16.0
13.0
10.0
Depth(m)
-0.020
0
0.020
0.040
0.060
0.080
pH
8.50
8.34
8.18
8.02
7.86
7.70
00:00
21:06
18:12
15:18
12:24
09:30
11/01/07
11/03/07
11/06/07
11/09/07
11/12/07
11/15/07
DateTime(M/D/Y)

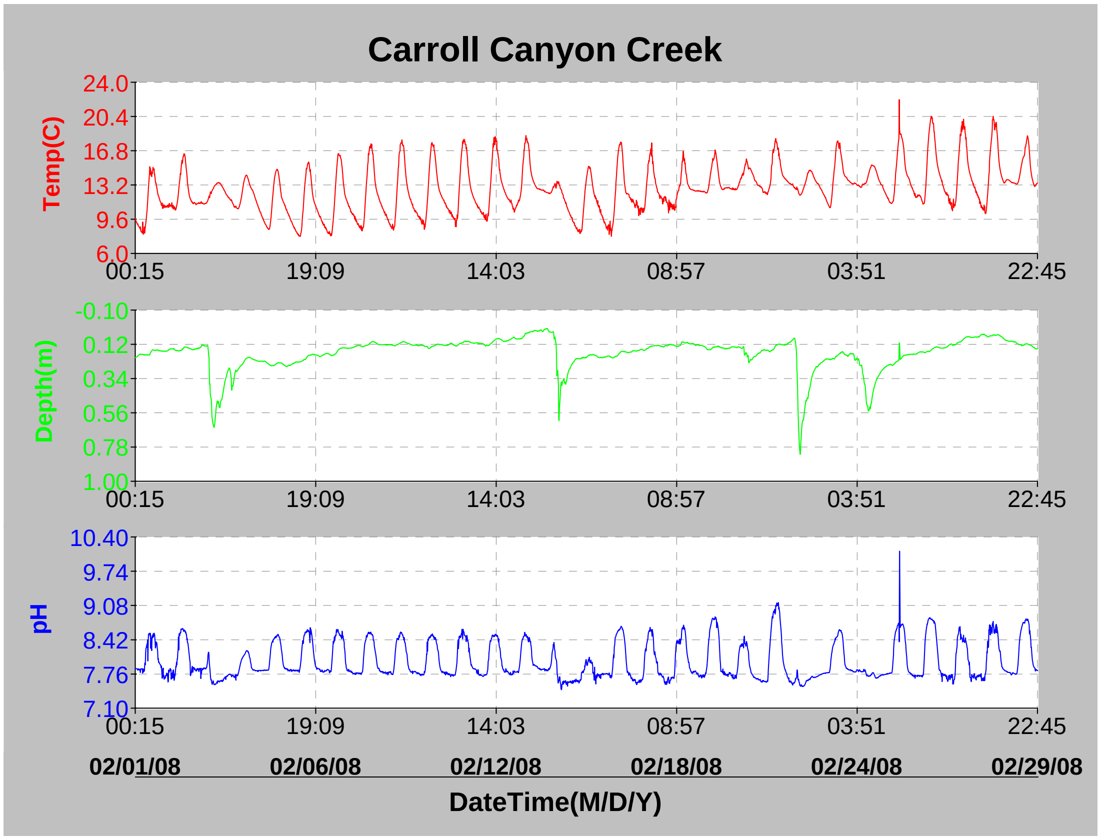

Carroll Canyon Creek
SpCond(mS/cm)
4.30
4.02
3.74
3.46
3.18
2.90
ODO Conc(mg/L)
18.0
15.4
12.8
10.2
7.6
5.0
Turbidity+(NTU)
1339.0
1047.6
756.2
464.8
173.4
-118.0
00:00
21:06
18:12
15:18
12:24
09:30
11/01/07
11/03/07
11/06/07
11/09/07
11/12/07
11/15/07
DateTime(M/D/Y)


Carroll Canyon Creek
Temp(C)
24.0
19.8
15.6
11.4
7.2
3.0
Depth(m)
-0.10
0.12
0.34
0.56
0.78
1.00
pH
11.0
9.4
7.8
6.2
4.6
3.0
11:45
23:45
11:45
23:45
11:45
23:45
12/04/07
12/09/07
12/15/07
12/20/07
12/26/07
12/31/07
DateTime(M/D/Y)

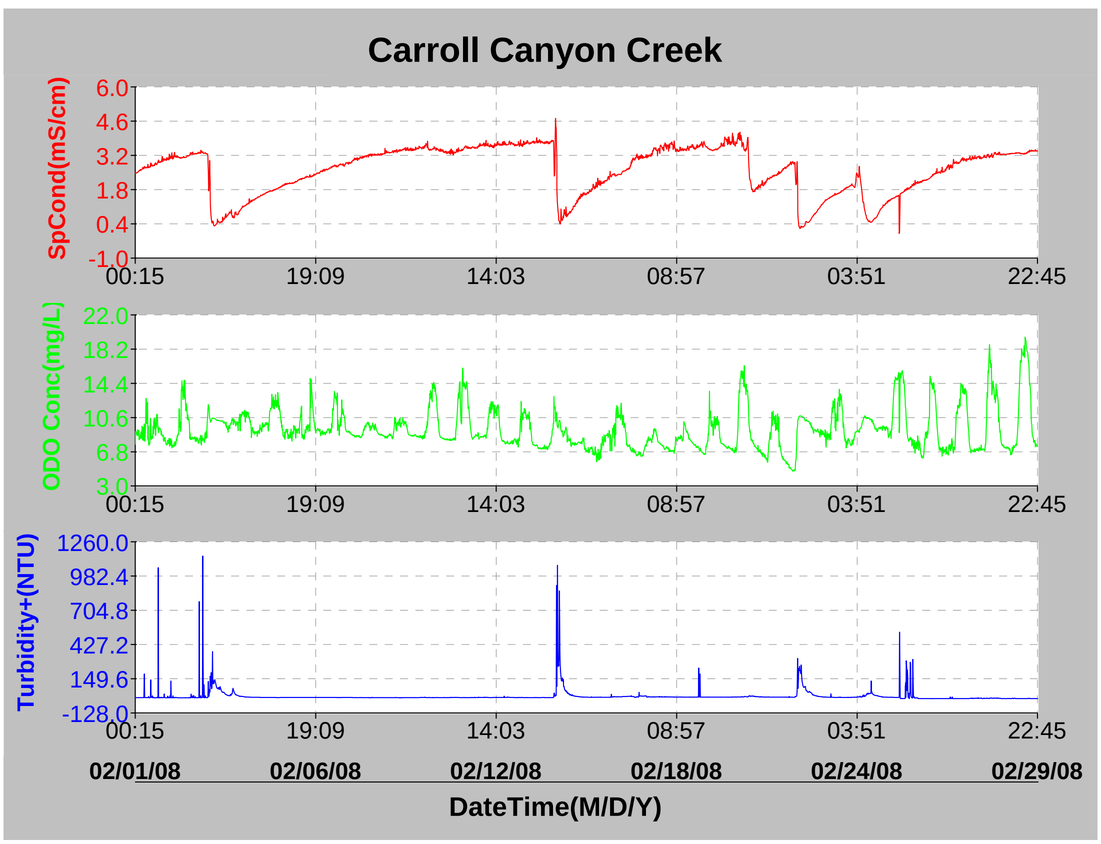

Carroll Canyon Creek
SpCond(mS/cm)
3.90
3.08
2.26
1.44
0.62
-0.20
ODO Conc(mg/L)
26.0
21.6
17.2
12.8
8.4
4.0
Turbidity+(NTU)
1288.0
1006.4
724.8
443.2
161.6
-120.0
11:45
23:45
11:45
23:45
11:45
23:45
12/04/07
12/09/07
12/15/07
12/20/07
12/26/07
12/31/07
DateTime(M/D/Y)


Carroll Canyon Creek
Temp(C)
19.0
16.0
13.0
10.0
7.0
4.0
Depth(m)
-0.10
0.18
0.46
0.74
1.02
1.30
pH
9.00
8.68
8.36
8.04
7.72
7.40
00:00
12:39
01:18
13:57
02:36
15:15
01/01/08
01/05/08
01/10/08
01/14/08
01/19/08
01/23/08
DateTime(M/D/Y)

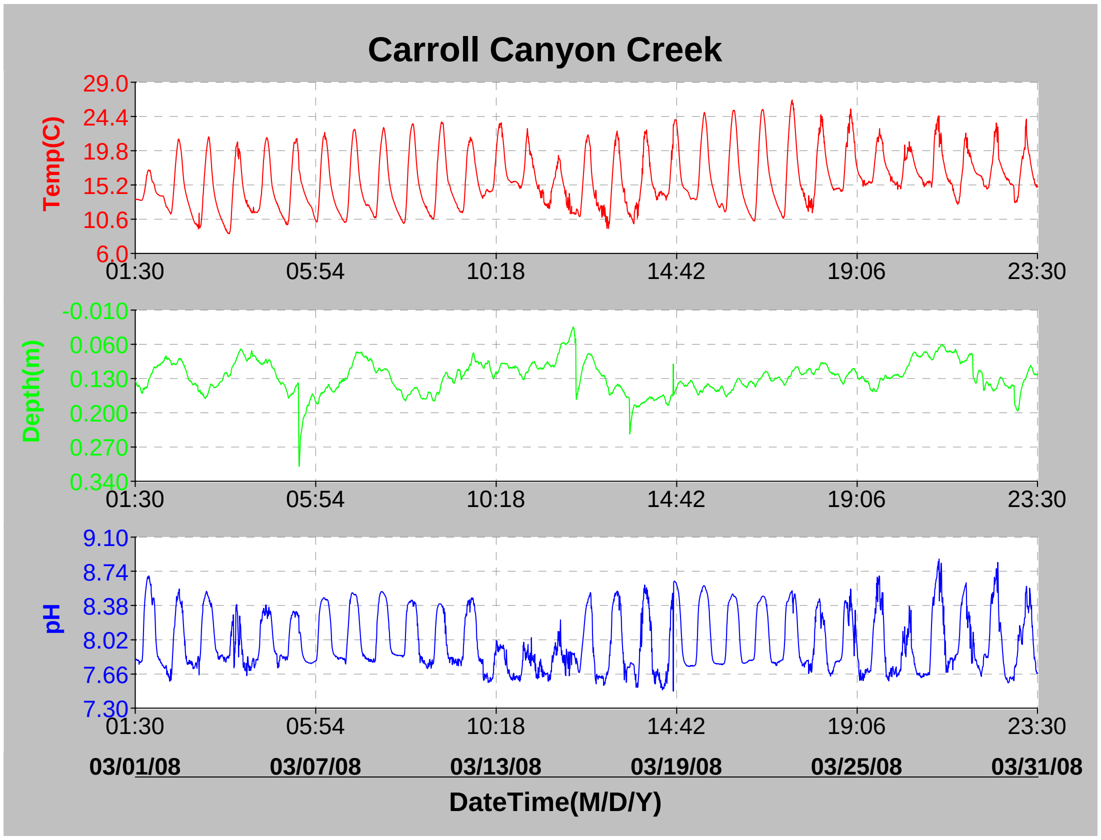

Carroll Canyon Creek
SpCond(mS/cm)
4.00
3.14
2.28
1.42
0.56
-0.30
ODO Conc(mg/L)
26.0
21.8
17.6
13.4
9.2
5.0
Turbidity+(NTU)
1276.0
998.2
720.4
442.6
164.8
-113.0
00:00
12:39
01:18
13:57
02:36
15:15
01/01/08
01/05/08
01/10/08
01/14/08
01/19/08
01/23/08
DateTime(M/D/Y)

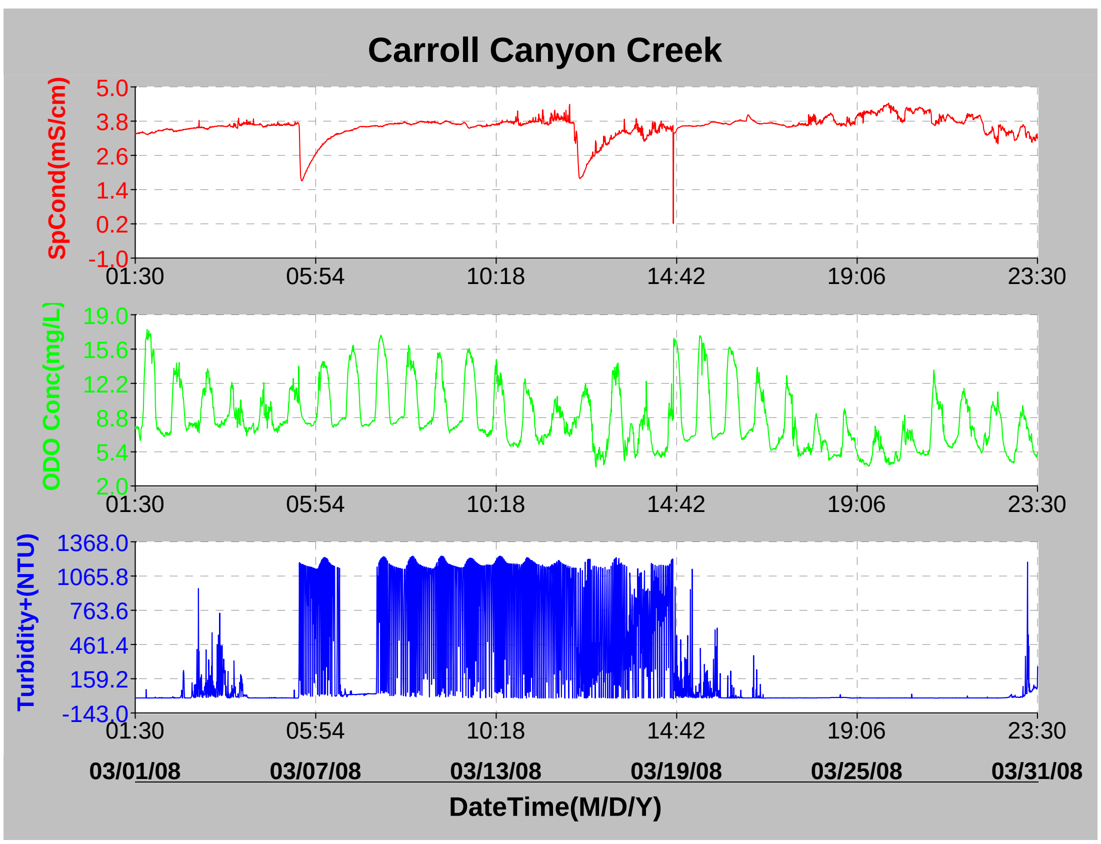


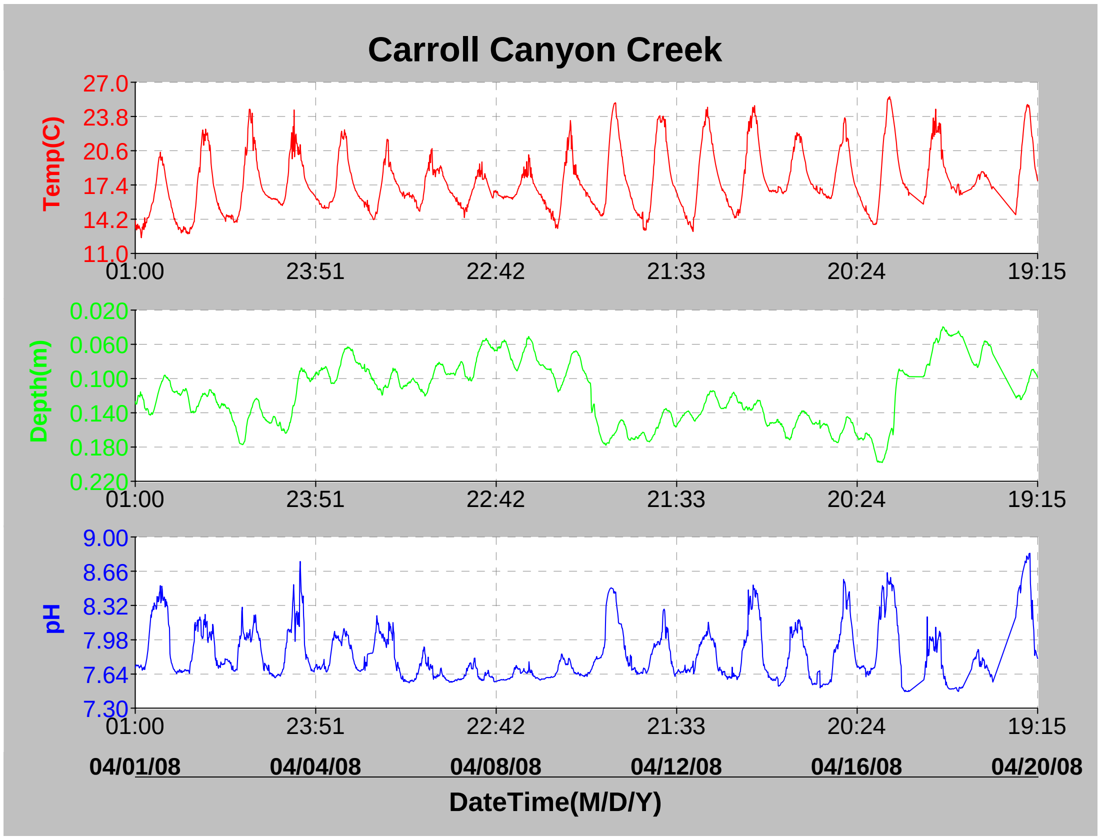
Carroll Canyon Creek
Temp(C)
24.0
20.4
16.8
13.2
9.6
6.0
Depth(m)
-0.10
0.12
0.34
0.56
0.78
1.00
pH
10.40
9.74
9.08
8.42
7.76
7.10
00:15
19:09
14:03
08:57
03:51
22:45
02/01/08
02/06/08
02/12/08
02/18/08
02/24/08
02/29/08
DateTime(M/D/Y)

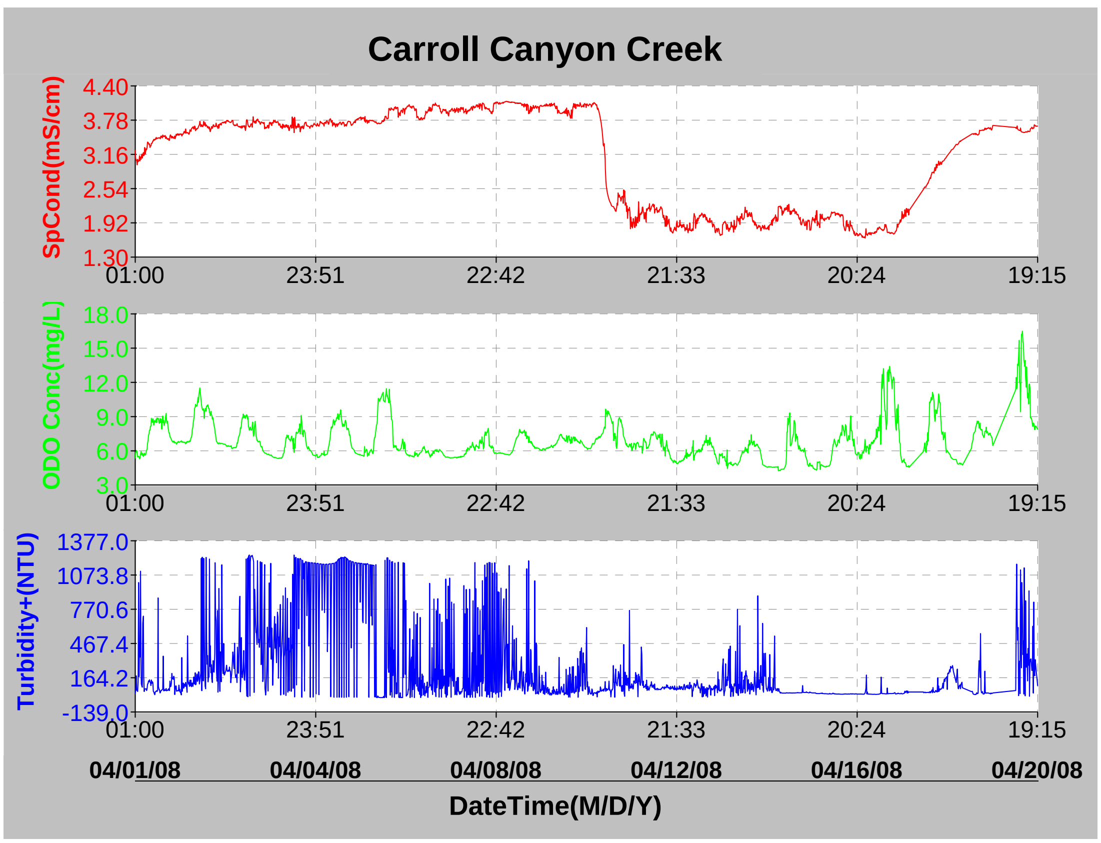


Carroll Canyon Creek
SpCond(mS/cm)
6.0
4.6
3.2
1.8
0.4
-1.0
ODO Conc(mg/L)
22.0
18.2
14.4
10.6
6.8
3.0
Turbidity+(NTU)
1260.0
982.4
704.8
427.2
149.6
-128.0
00:15
19:09
14:03
08:57
03:51
22:45
02/01/08
02/06/08
02/12/08
02/18/08
02/24/08
02/29/08
DateTime(M/D/Y)

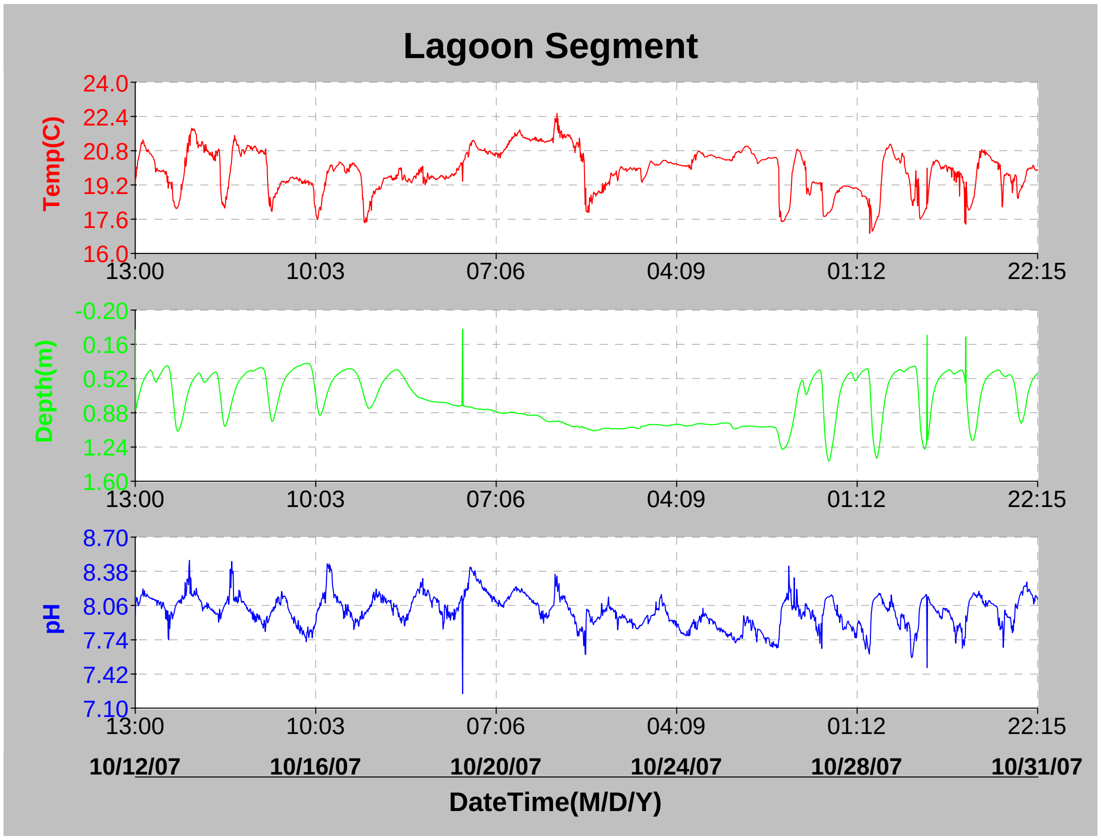

Carroll Canyon Creek
Temp(C)
29.0
24.4
19.8
15.2
10.6
6.0
Depth(m)
-0.010
0.060
0.130
0.200
0.270
0.340
pH
9.10
8.74
8.38
8.02
7.66
7.30
01:30
05:54
10:18
14:42
19:06
23:30
03/01/08
03/07/08
03/13/08
03/19/08
03/25/08
03/31/08
DateTime(M/D/Y)

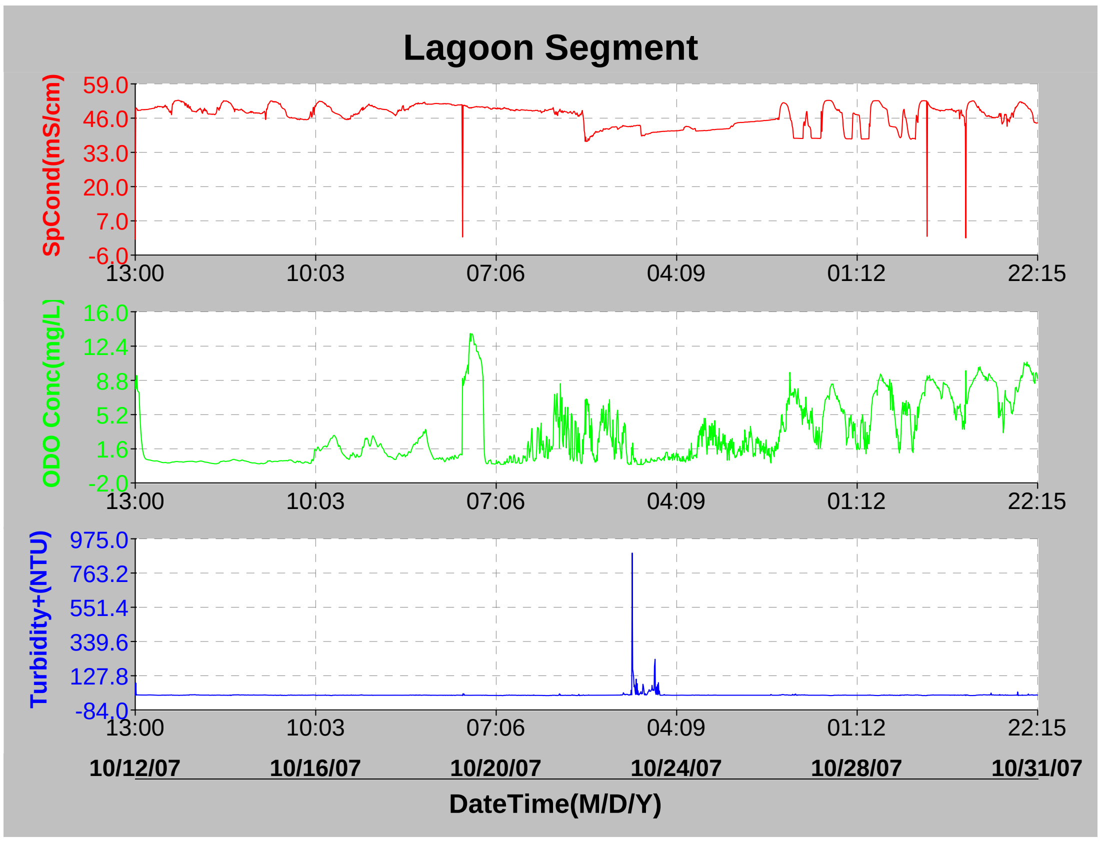

Carroll Canyon Creek
SpCond(mS/cm)
5.0
3.8
2.6
1.4
0.2
-1.0
ODO Conc(mg/L)
19.0
15.6
12.2
8.8
5.4
2.0
Turbidity+(NTU)
1368.0
1065.8
763.6
461.4
159.2
-143.0
01:30
05:54
10:18
14:42
19:06
23:30
03/01/08
03/07/08
03/13/08
03/19/08
03/25/08
03/31/08
DateTime(M/D/Y)

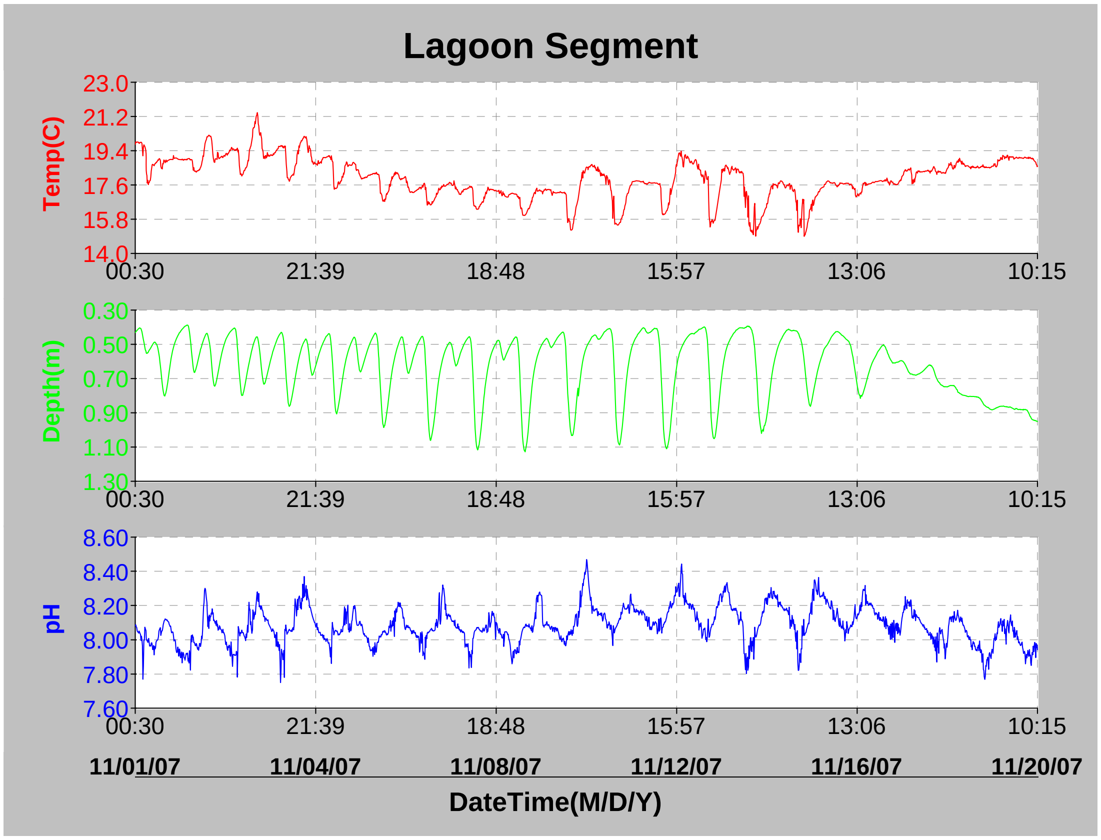

Carroll Canyon Creek
Temp(C)
27.0
23.8
20.6
17.4
14.2
11.0
Depth(m)
0.020
0.060
0.100
0.140
0.180
0.220
pH
9.00
8.66
8.32
7.98
7.64
7.30
01:00
23:51
22:42
21:33
20:24
19:15
04/01/08
04/04/08
04/08/08
04/12/08
04/16/08
04/20/08
DateTime(M/D/Y)

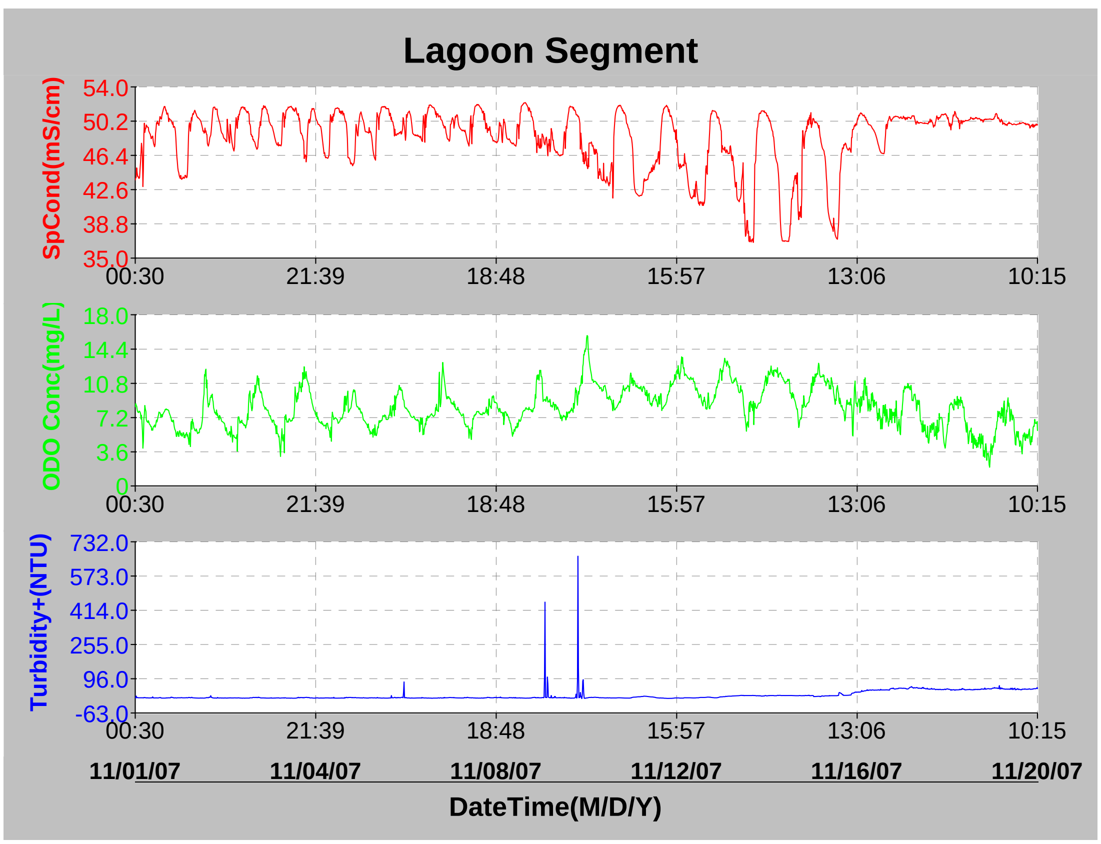

Carroll Canyon Creek
SpCond(mS/cm)
4.40
3.78
3.16
2.54
1.92
1.30
ODO Conc(mg/L)
18.0
15.0
12.0
9.0
6.0
3.0
Turbidity+(NTU)
1377.0
1073.8
770.6
467.4
164.2
-139.0
01:00
23:51
22:42
21:33
20:24
19:15
04/01/08
04/04/08
04/08/08
04/12/08
04/16/08
04/20/08
DateTime(M/D/Y)

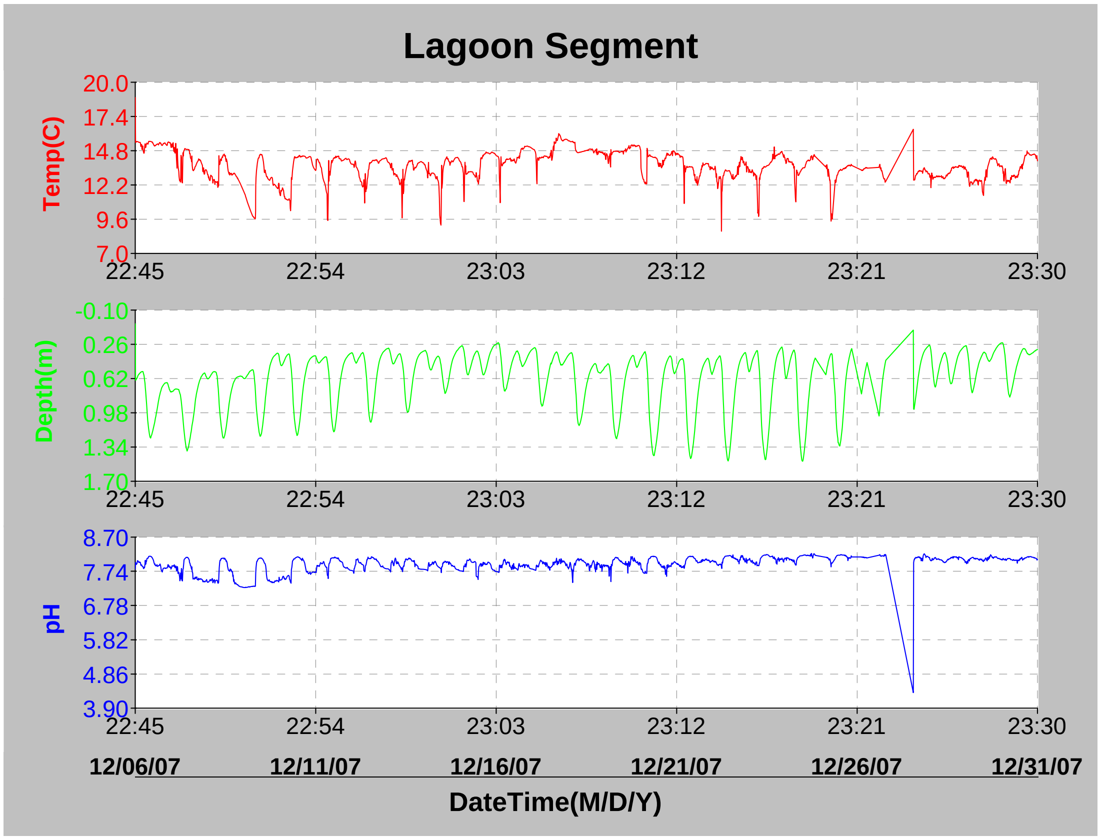
LAGOON SEGMENT


Lagoon Segment
Temp(C)
24.0
22.4
20.8
19.2
17.6
16.0
Depth(m)
-0.20
0.16
0.52
0.88
1.24
1.60
pH
8.70
8.38
8.06
7.74
7.42
7.10
13:00
10:03
07:06
04:09
01:12
22:15
10/12/07
10/16/07
10/20/07
10/24/07
10/28/07
10/31/07
DateTime(M/D/Y)

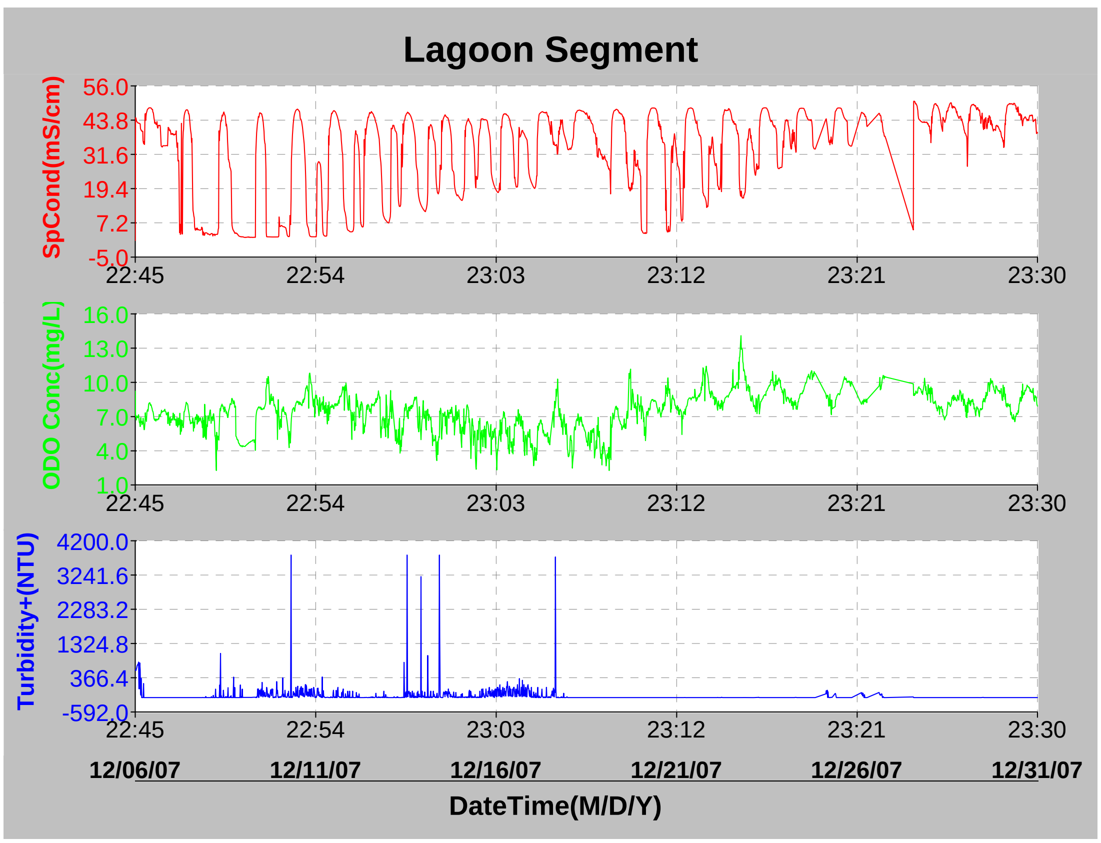

Lagoon Segment
SpCond(mS/cm)
59.0
46.0
33.0
20.0
7.0
-6.0
ODO Conc(mg/L)
16.0
12.4
8.8
5.2
1.6
-2.0
Turbidity+(NTU)
975.0
763.2
551.4
339.6
127.8
-84.0
13:00
10:03
07:06
04:09
01:12
22:15
10/12/07
10/16/07
10/20/07
10/24/07
10/28/07
10/31/07
DateTime(M/D/Y)


Lagoon Segment
Temp(C)
23.0
21.2
19.4
17.6
15.8
14.0
Depth(m)
0.30
0.50
0.70
0.90
1.10
1.30
pH
8.60
8.40
8.20
8.00
7.80
7.60
00:30
21:39
18:48
15:57
13:06
10:15
11/01/07
11/04/07
11/08/07
11/12/07
11/16/07
11/20/07
DateTime(M/D/Y)

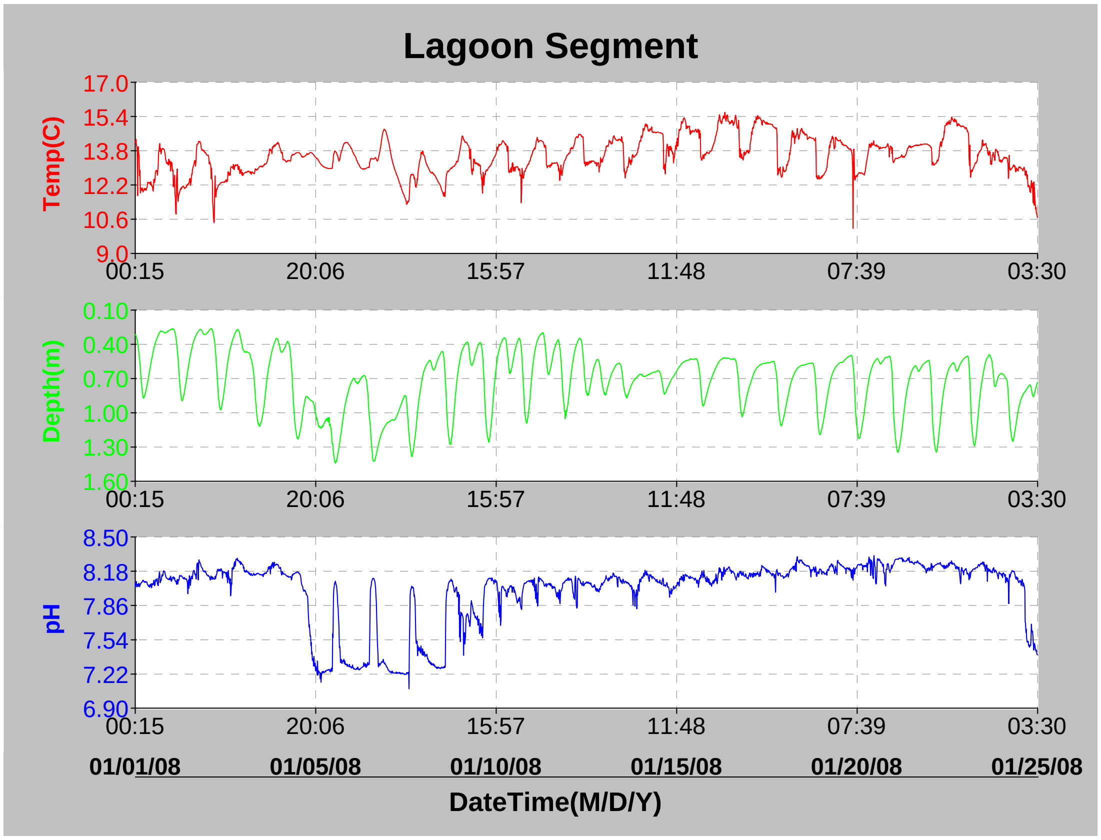

Lagoon Segment
SpCond(mS/cm)
54.0
50.2
46.4
42.6
38.8
35.0
ODO Conc(mg/L)
18.0
14.4
10.8
7.2
3.6
0
Turbidity+(NTU)
732.0
573.0
414.0
255.0
96.0
-63.0
00:30
21:39
18:48
15:57
13:06
10:15
11/01/07
11/04/07
11/08/07
11/12/07
11/16/07
11/20/07
DateTime(M/D/Y)

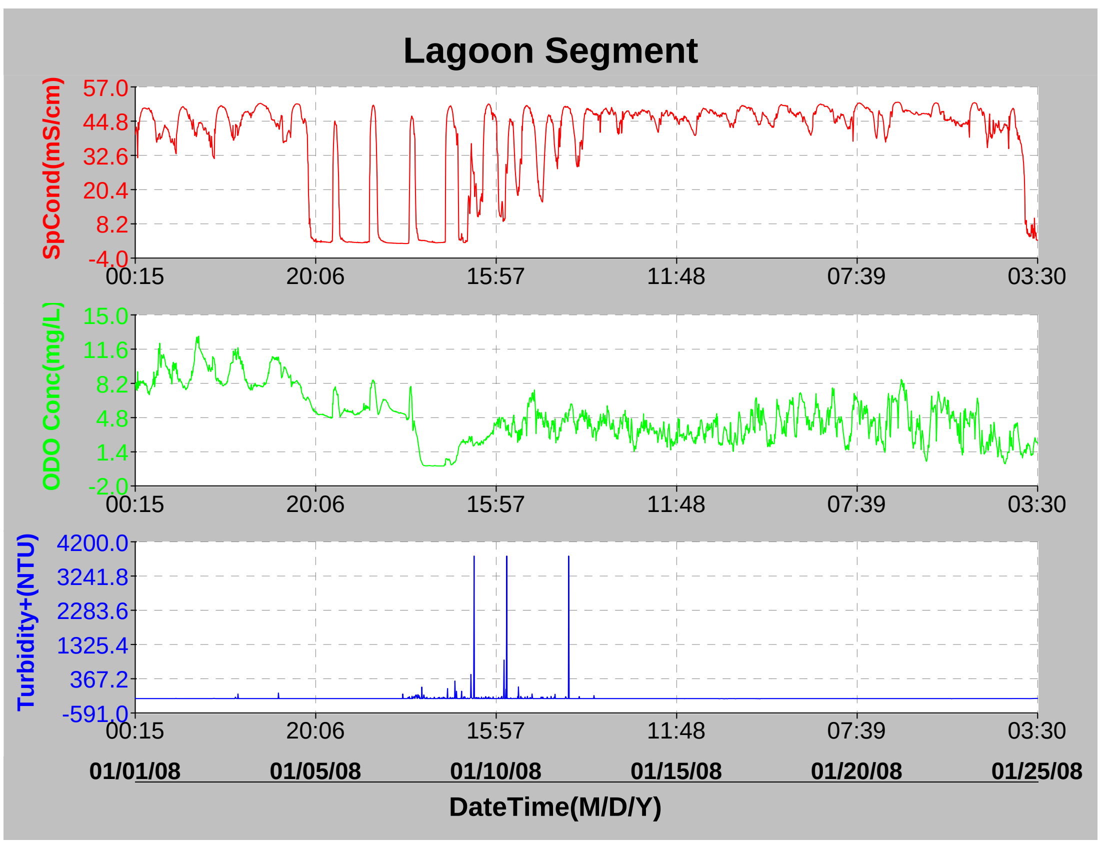


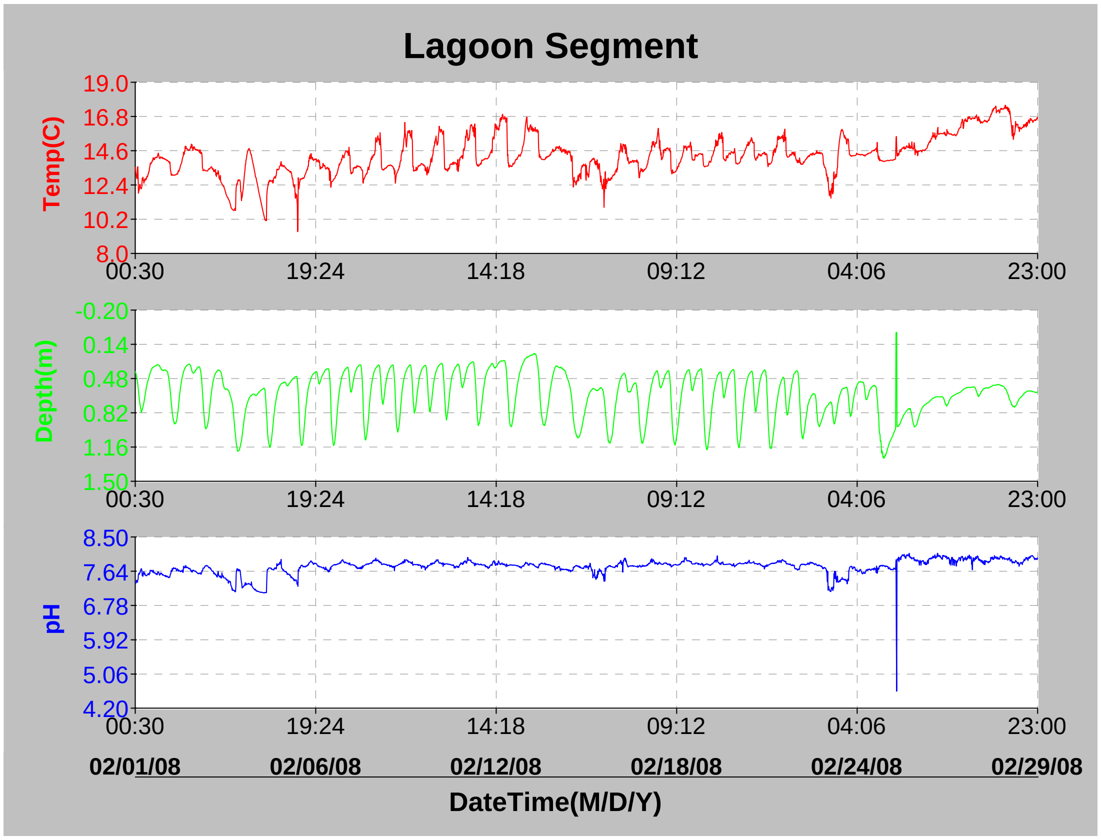
Lagoon Segment
Temp(C)
20.0
17.4
14.8
12.2
9.6
7.0
Depth(m)
-0.10
0.26
0.62
0.98
1.34
1.70
pH
8.70
7.74
6.78
5.82
4.86
3.90
22:45
22:54
23:03
23:12
23:21
23:30
12/06/07
12/11/07
12/16/07
12/21/07
12/26/07
12/31/07
DateTime(M/D/Y)



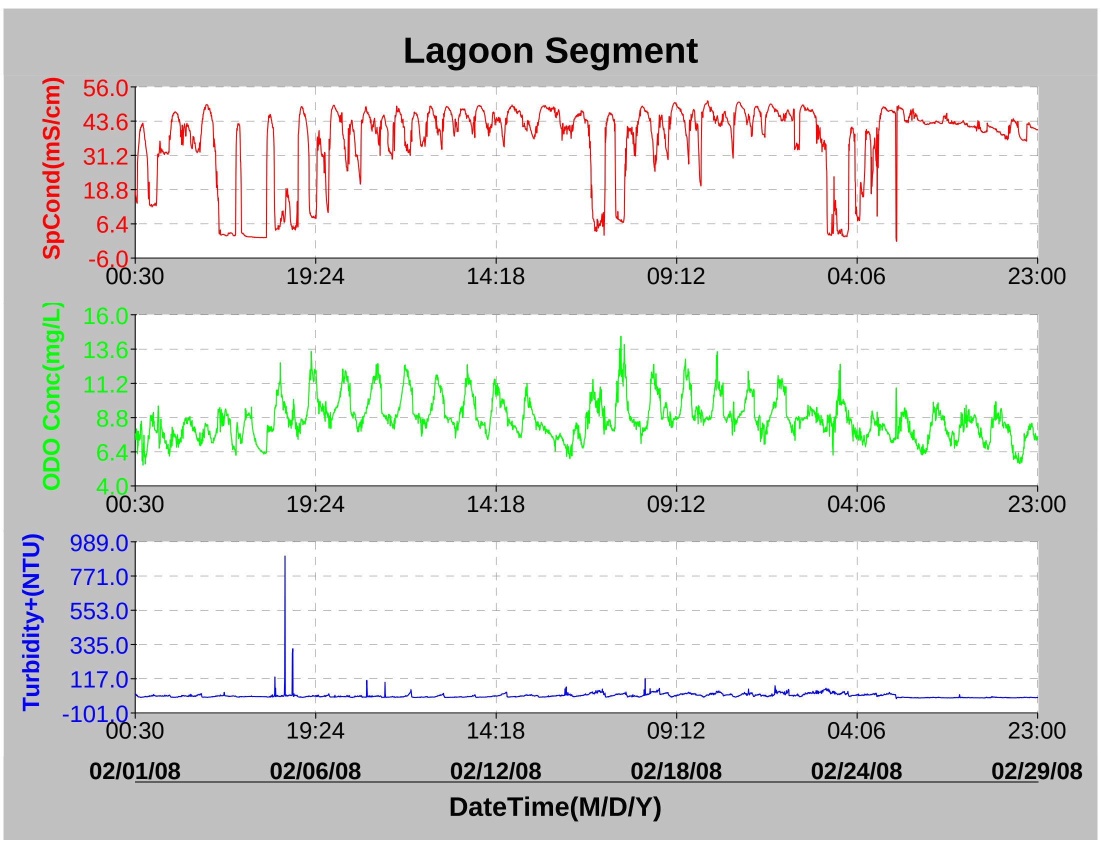
Lagoon Segment
SpCond(mS/cm)
56.0
43.8
31.6
19.4
7.2
-5.0
ODO Conc(mg/L)
16.0
13.0
10.0
7.0
4.0
1.0
Turbidity+(NTU)
4200.0
3241.6
2283.2
1324.8
366.4
-592.0
22:45
22:54
23:03
23:12
23:21
23:30
12/06/07
12/11/07
12/16/07
12/21/07
12/26/07
12/31/07
DateTime(M/D/Y)


Lagoon Segment
Temp(C)
17.0
15.4
13.8
12.2
10.6
9.0
Depth(m)
0.10
0.40
0.70
1.00
1.30
1.60
pH
8.50
8.18
7.86
7.54
7.22
6.90
00:15
20:06
15:57
11:48
07:39
03:30
01/01/08
01/05/08
01/10/08
01/15/08
01/20/08
01/25/08
DateTime(M/D/Y)

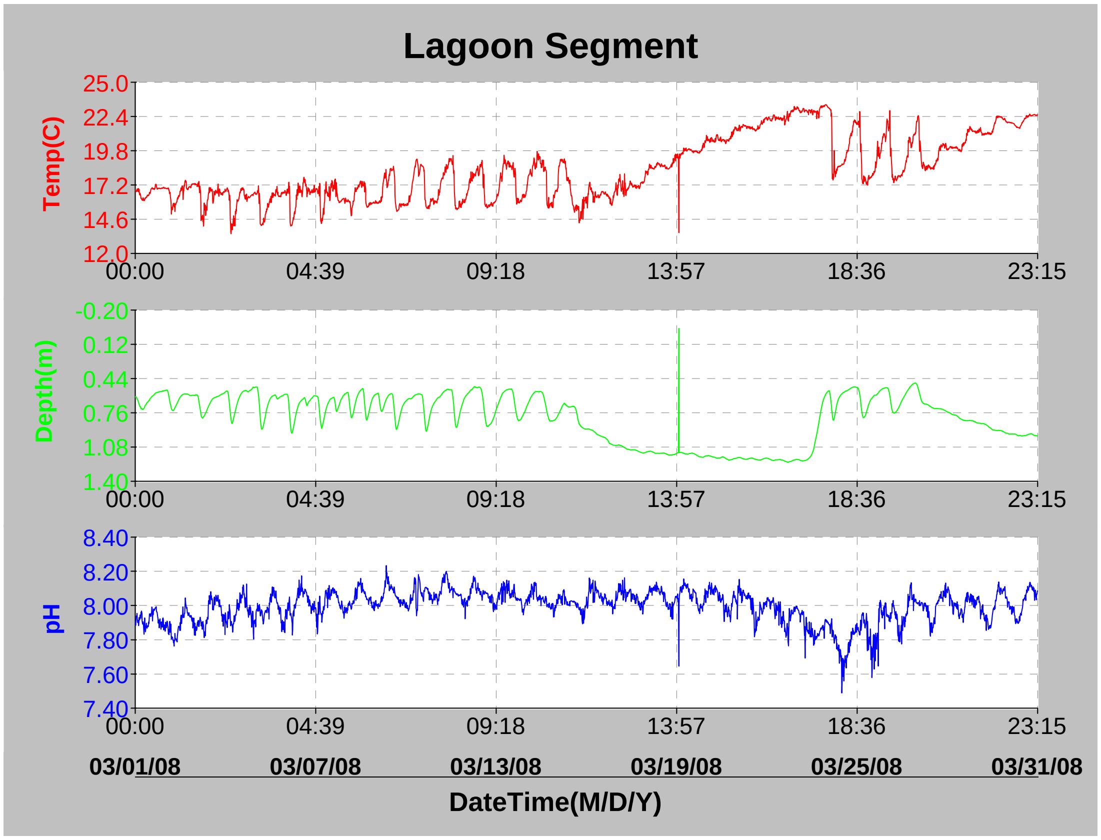

Lagoon Segment
SpCond(mS/cm)
57.0
44.8
32.6
20.4
8.2
-4.0
ODO Conc(mg/L)
15.0
11.6
8.2
4.8
1.4
-2.0
Turbidity+(NTU)
4200.0
3241.8
2283.6
1325.4
367.2
-591.0
00:15
20:06
15:57
11:48
07:39
03:30
01/01/08
01/05/08
01/10/08
01/15/08
01/20/08
01/25/08
DateTime(M/D/Y)

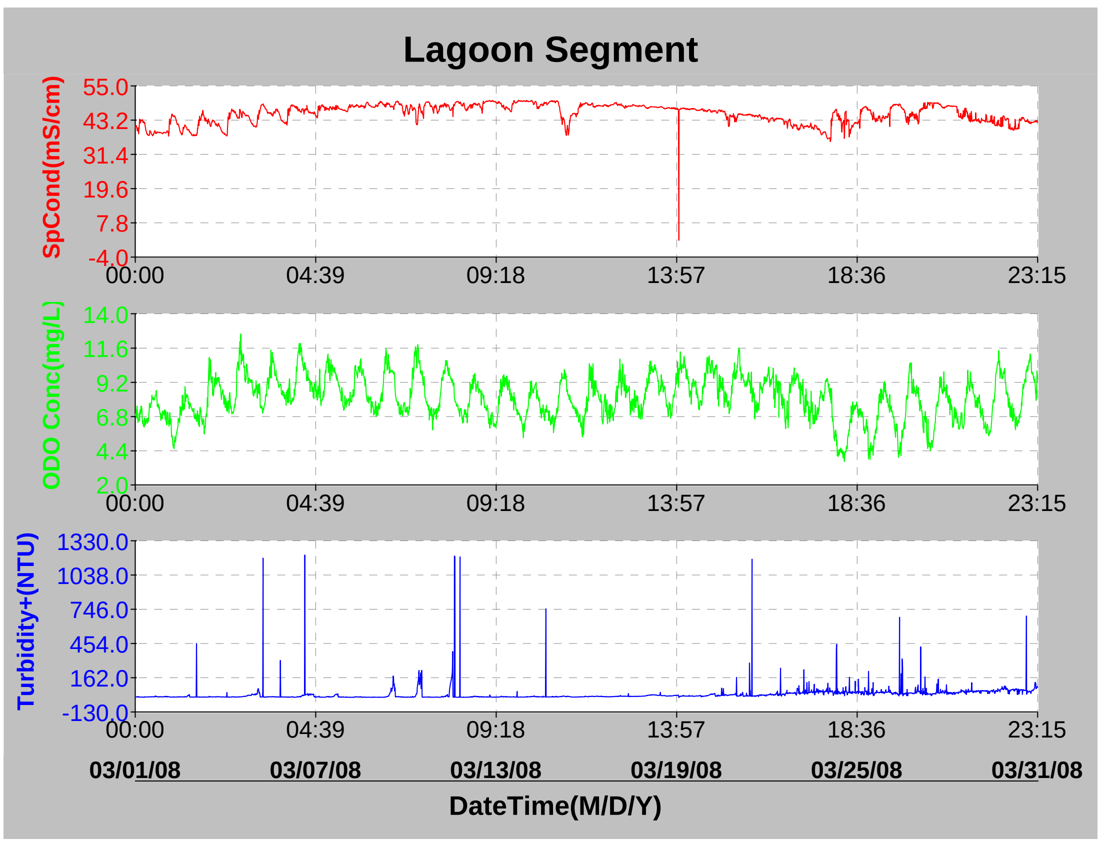


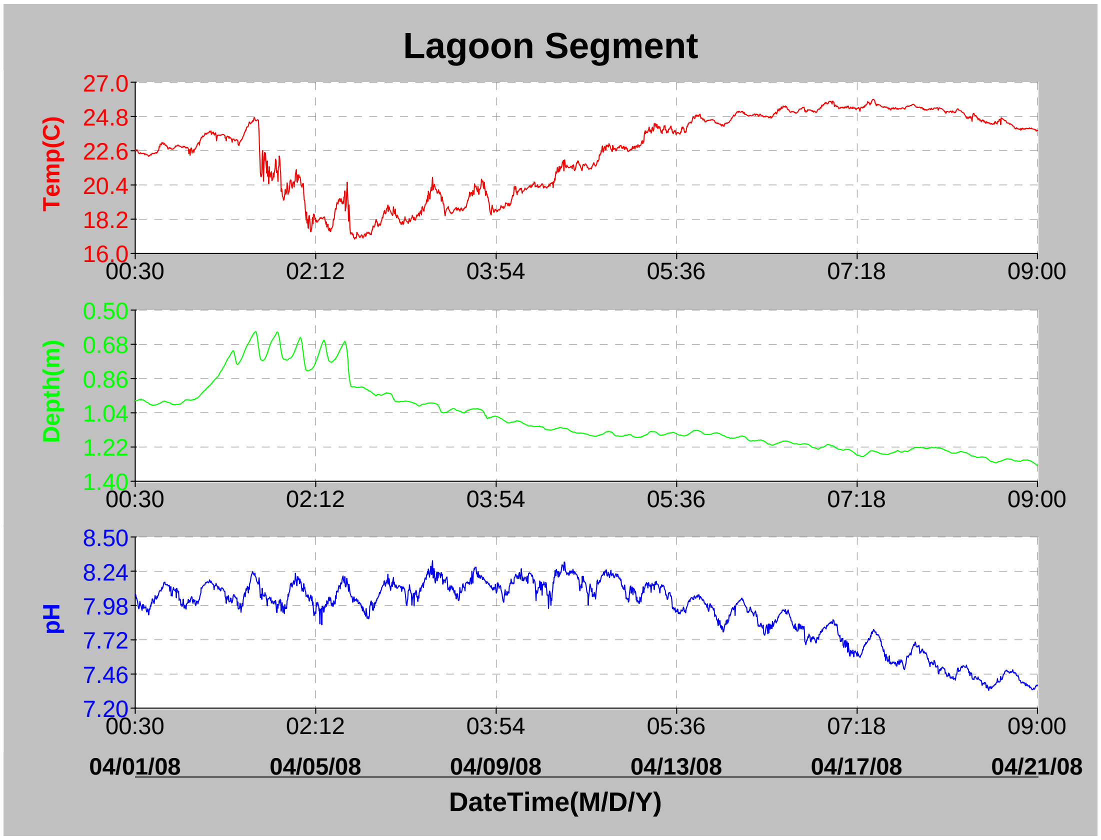
Lagoon Segment
Temp(C)
19.0
16.8
14.6
12.4
10.2
8.0
00:30
19:24
14:18
09:12
04:06
23:00
Depth(m)
-0.20
0.14
0.48
0.82
1.16
1.50
pH
8.50
7.64
6.78
5.92
5.06
4.20
02/01/08
02/06/08
02/12/08
02/18/08
02/24/08
02/29/08
DateTime(M/D/Y)

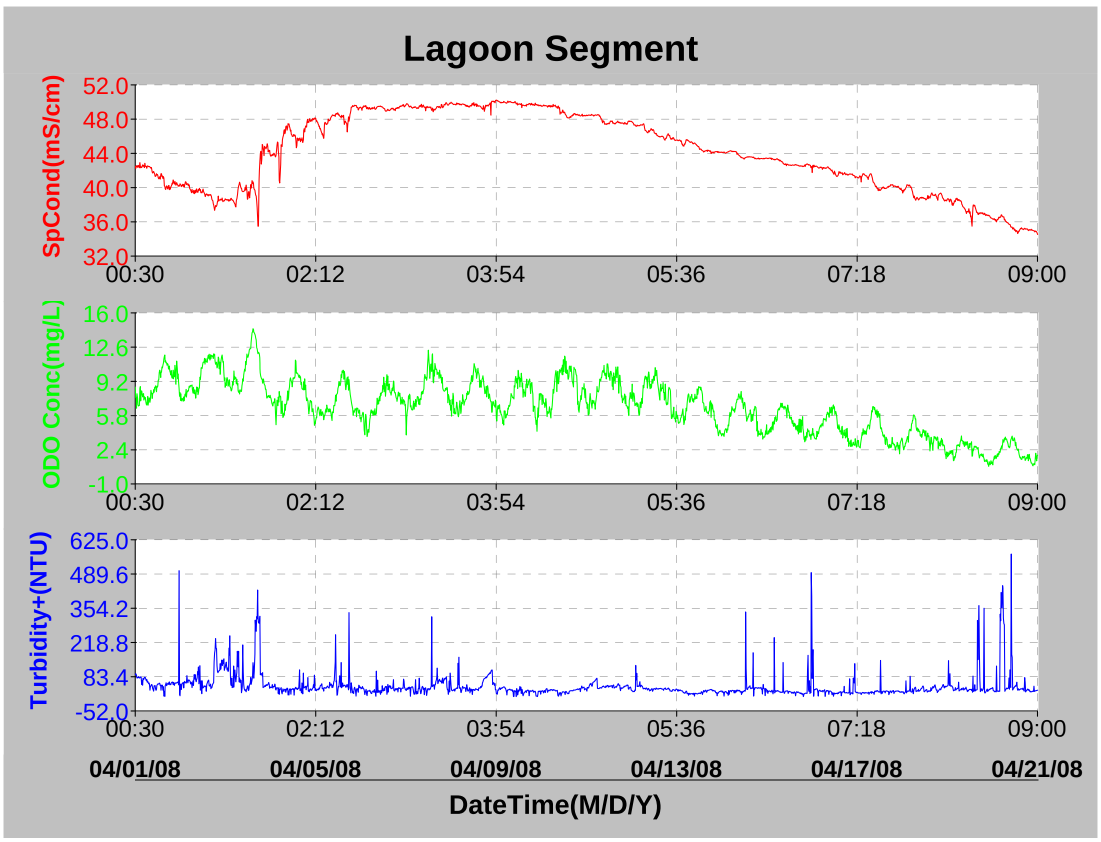


Lagoon Segment
SpCond(mS/cm)
56.0
43.6
31.2
18.8
6.4
-6.0
00:30
19:24
14:18
09:12
04:06
23:00
ODO Conc(mg/L)
16.0
13.6
11.2
8.8
6.4
4.0
Turbidity+(NTU)
989.0
771.0
553.0
335.0
117.0
-101.0
02/01/08
02/06/08
02/12/08
02/18/08
02/24/08
02/29/08
DateTime(M/D/Y)

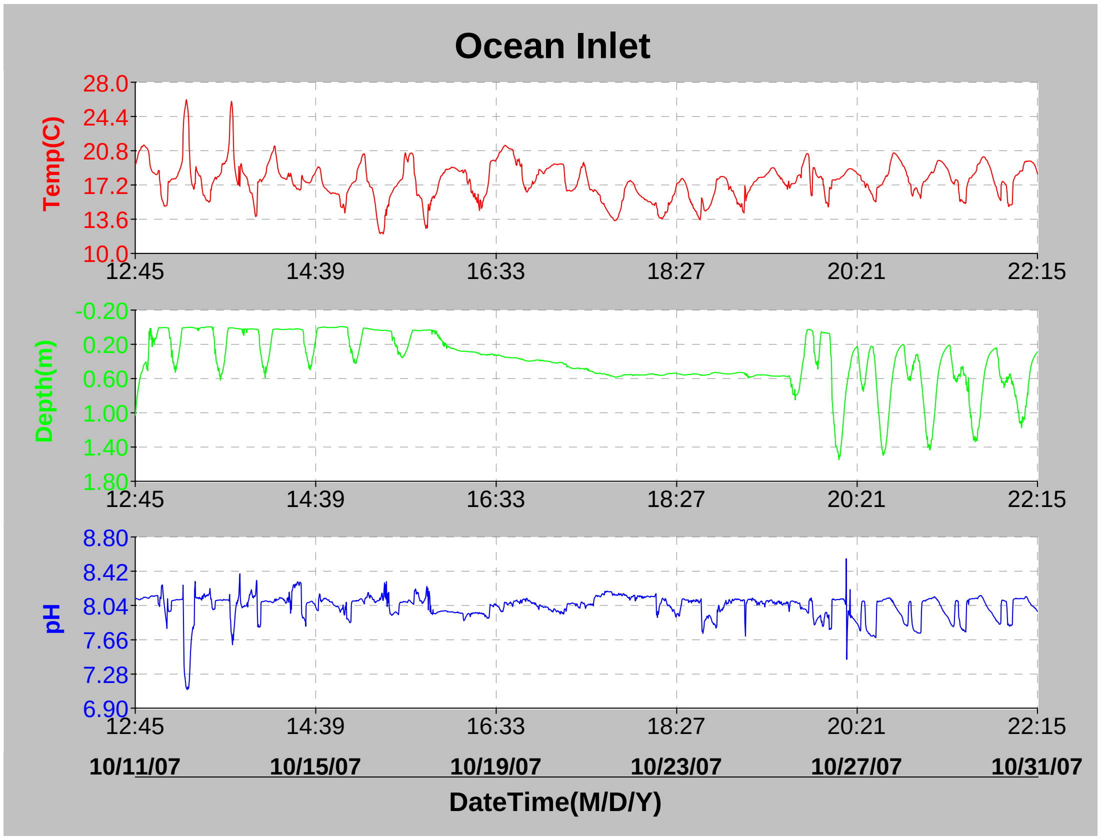

Lagoon Segment
Temp(C)
25.0
22.4
19.8
17.2
14.6
12.0
Depth(m)
-0.20
0.12
0.44
0.76
1.08
1.40
pH
8.40
8.20
8.00
7.80
7.60
7.40
00:00
04:39
09:18
13:57
18:36
23:15
03/01/08
03/07/08
03/13/08
03/19/08
03/25/08
03/31/08
DateTime(M/D/Y)

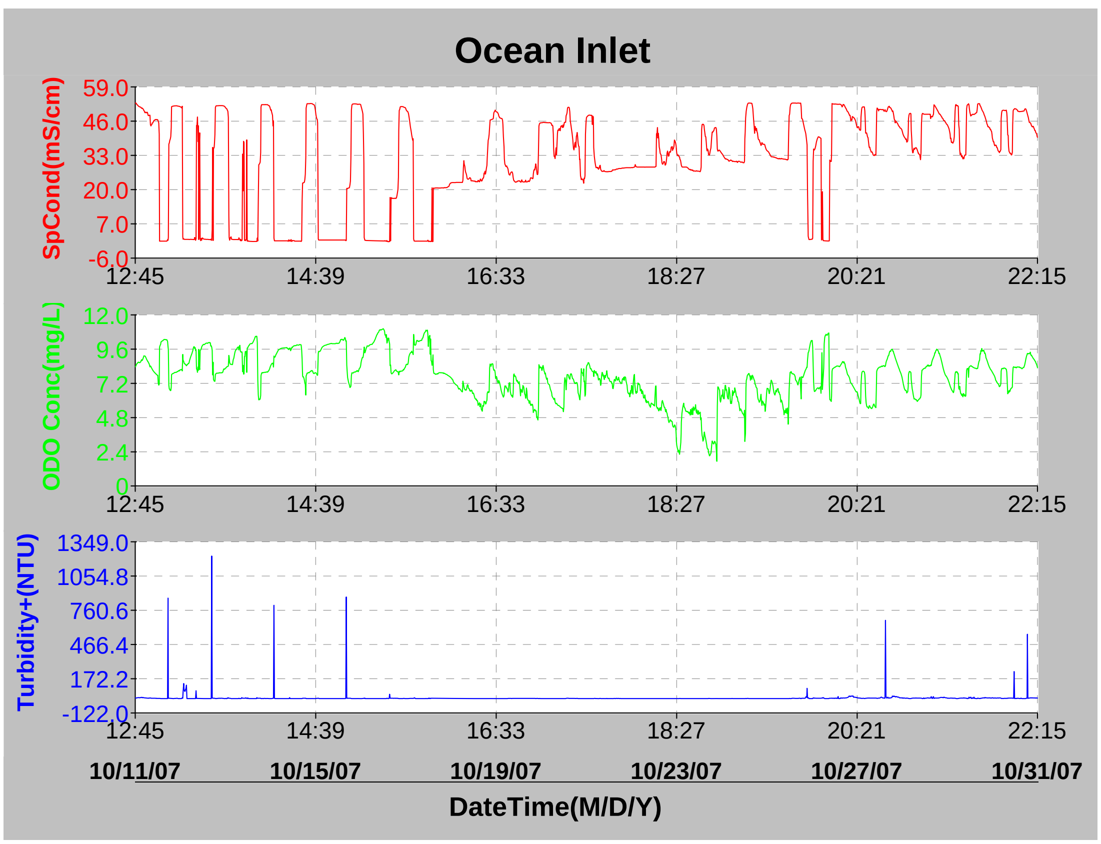

Lagoon Segment
SpCond(mS/cm)
55.0
43.2
31.4
19.6
7.8
-4.0
ODO Conc(mg/L)
14.0
11.6
9.2
6.8
4.4
2.0
Turbidity+(NTU)
1330.0
1038.0
746.0
454.0
162.0
-130.0
00:00
04:39
09:18
13:57
18:36
23:15
03/01/08
03/07/08
03/13/08
03/19/08
03/25/08
03/31/08
DateTime(M/D/Y)

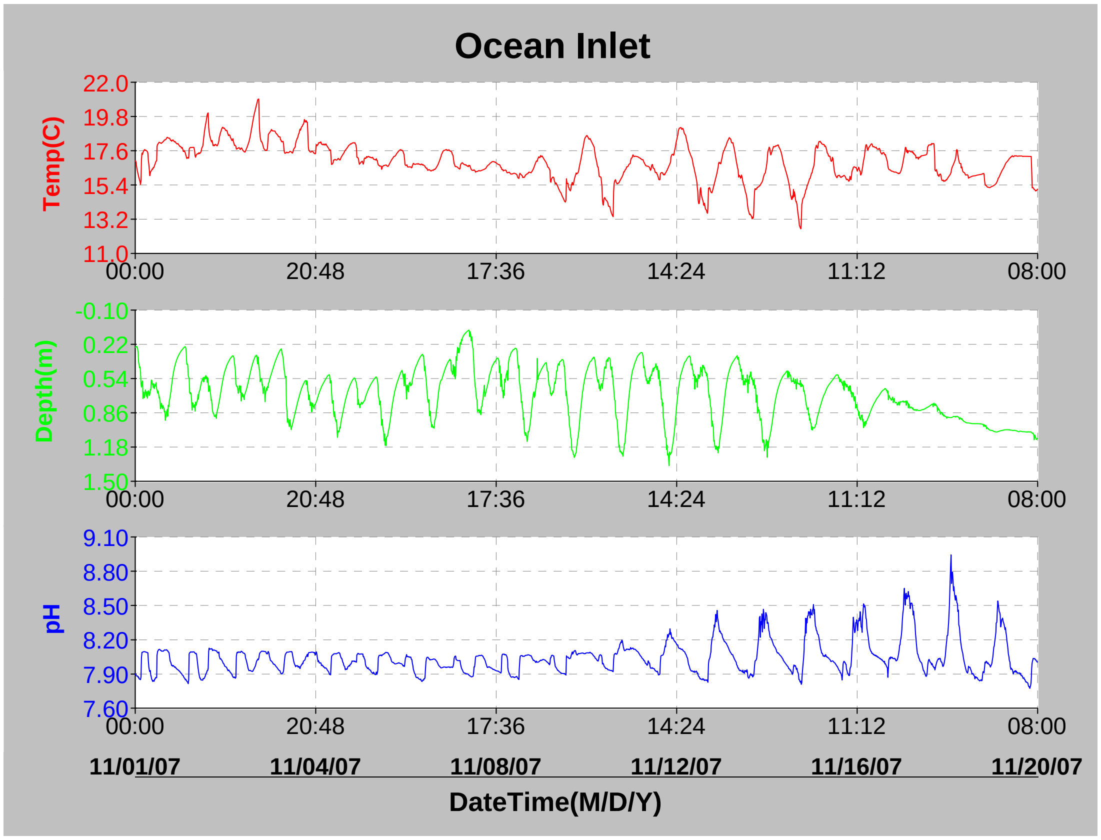

Lagoon Segment
Temp(C)
27.0
24.8
22.6
20.4
18.2
16.0
Depth(m)
0.50
0.68
0.86
1.04
1.22
1.40
pH
8.50
8.24
7.98
7.72
7.46
7.20
00:30
02:12
03:54
05:36
07:18
09:00
04/01/08
04/05/08
04/09/08
04/13/08
04/17/08
04/21/08
DateTime(M/D/Y)


Lagoon Segment
SpCond(mS/cm)
52.0
48.0
44.0
40.0
36.0
32.0
ODO Conc(mg/L)
16.0
12.6
9.2
5.8
2.4
-1.0
Turbidity+(NTU)
625.0
489.6
354.2
218.8
83.4
-52.0
00:30
02:12
03:54
05:36
07:18
09:00
04/01/08
04/05/08
04/09/08
04/13/08
04/17/08
04/21/08
DateTime(M/D/Y)

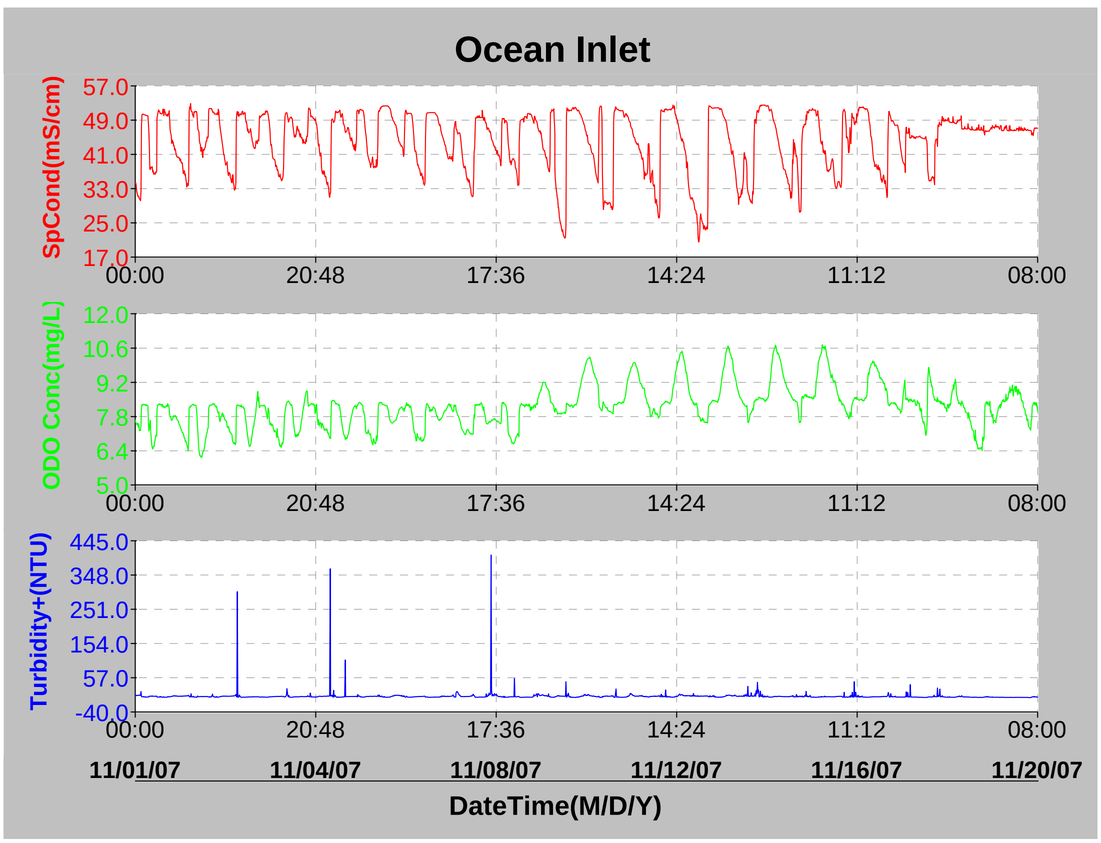
OCEAN INLET


Ocean Inlet
Temp(C)
28.0
24.4
20.8
17.2
13.6
10.0
12:45
14:39
16:33
18:27
20:21
22:15
Depth(m)
-0.20
0.20
0.60
1.00
1.40
1.80
pH
8.80
8.42
8.04
7.66
7.28
6.90
10/11/07
10/15/07
10/19/07
10/23/07
10/27/07
10/31/07
DateTime(M/D/Y)

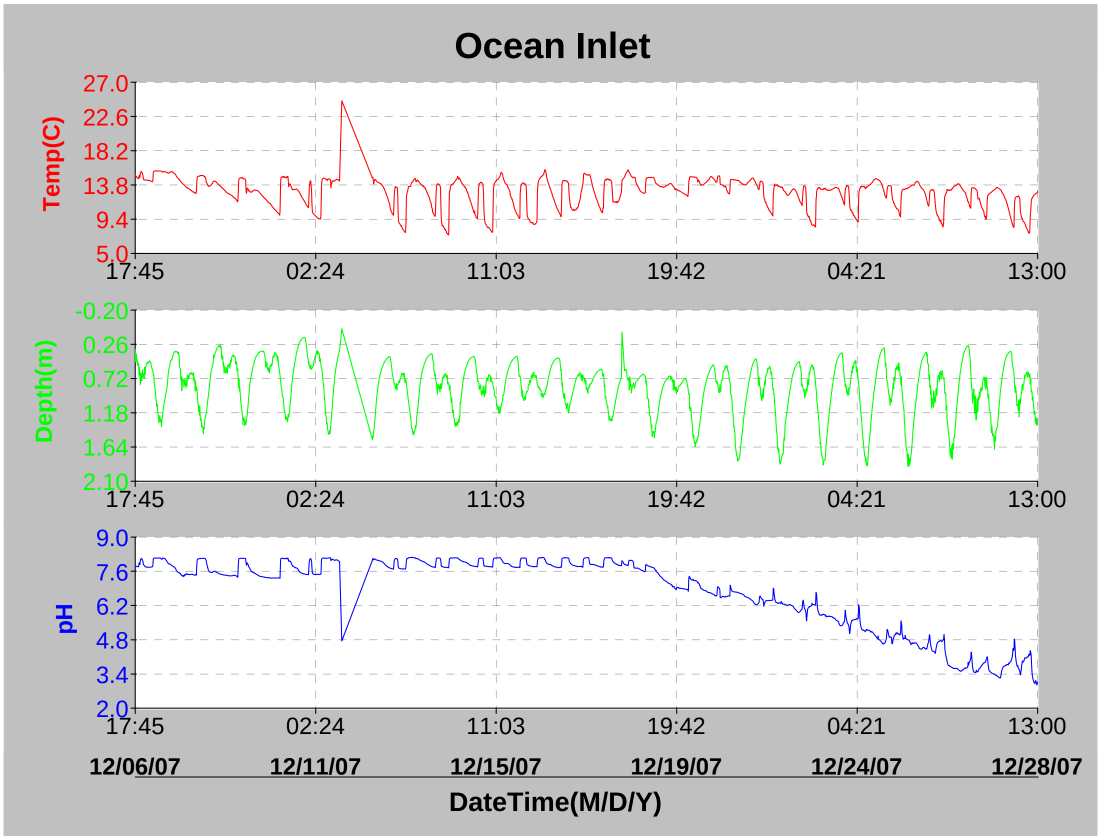

Ocean Inlet
SpCond(mS/cm)
59.0
46.0
33.0
20.0
7.0
-6.0
12:45
14:39
16:33
18:27
20:21
22:15
ODO Conc(mg/L)
12.0
9.6
7.2
4.8
2.4
0
Turbidity+(NTU)
1349.0
1054.8
760.6
466.4
172.2
-122.0
10/11/07
10/15/07
10/19/07
10/23/07
10/27/07
10/31/07
DateTime(M/D/Y)

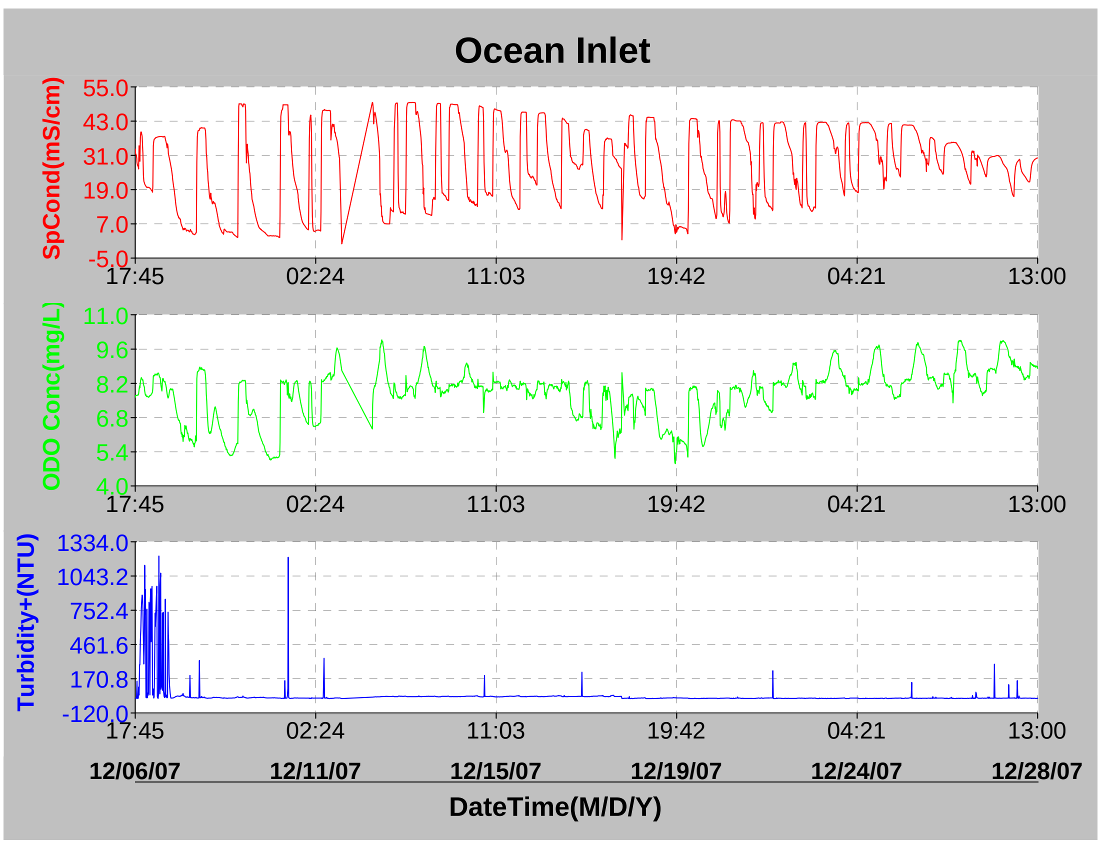


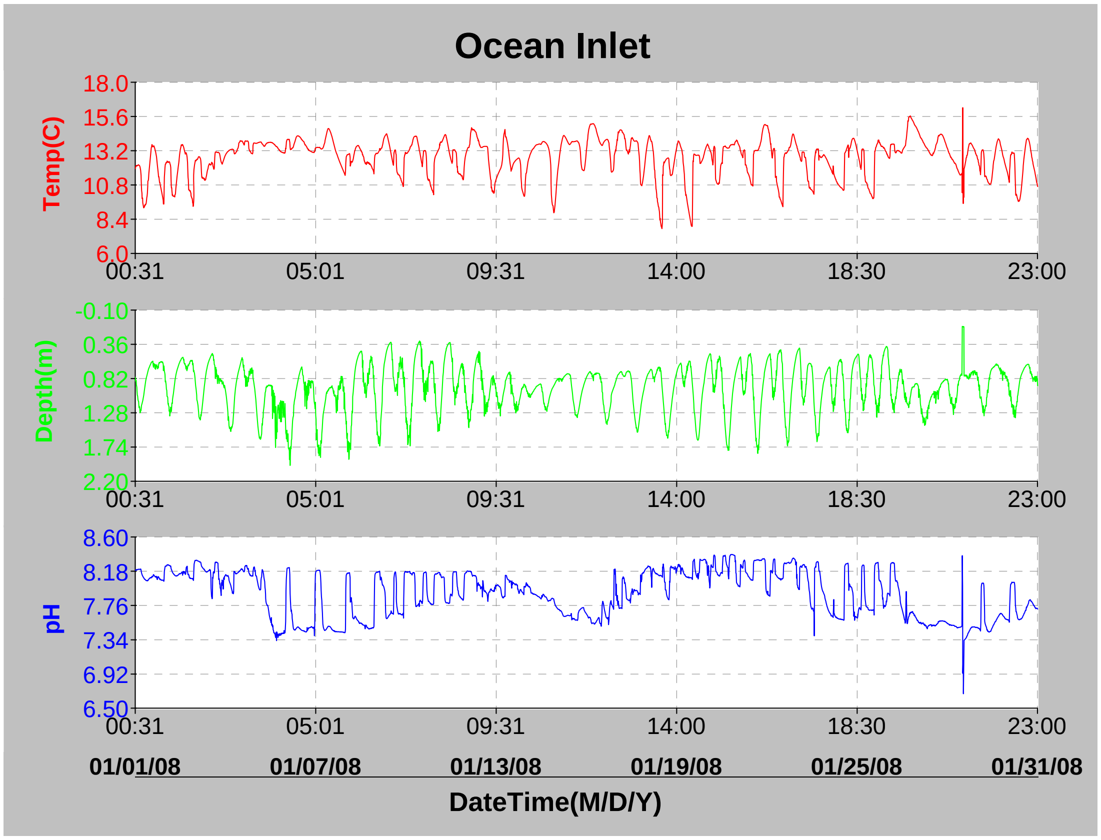
Ocean Inlet
Temp(C)
22.0
19.8
17.6
15.4
13.2
11.0
Depth(m)
-0.10
0.22
0.54
0.86
1.18
1.50
pH
9.10
8.80
8.50
8.20
7.90
7.60
00:00
20:48
17:36
14:24
11:12
08:00
11/01/07
11/04/07
11/08/07
11/12/07
11/16/07
11/20/07
DateTime(M/D/Y)

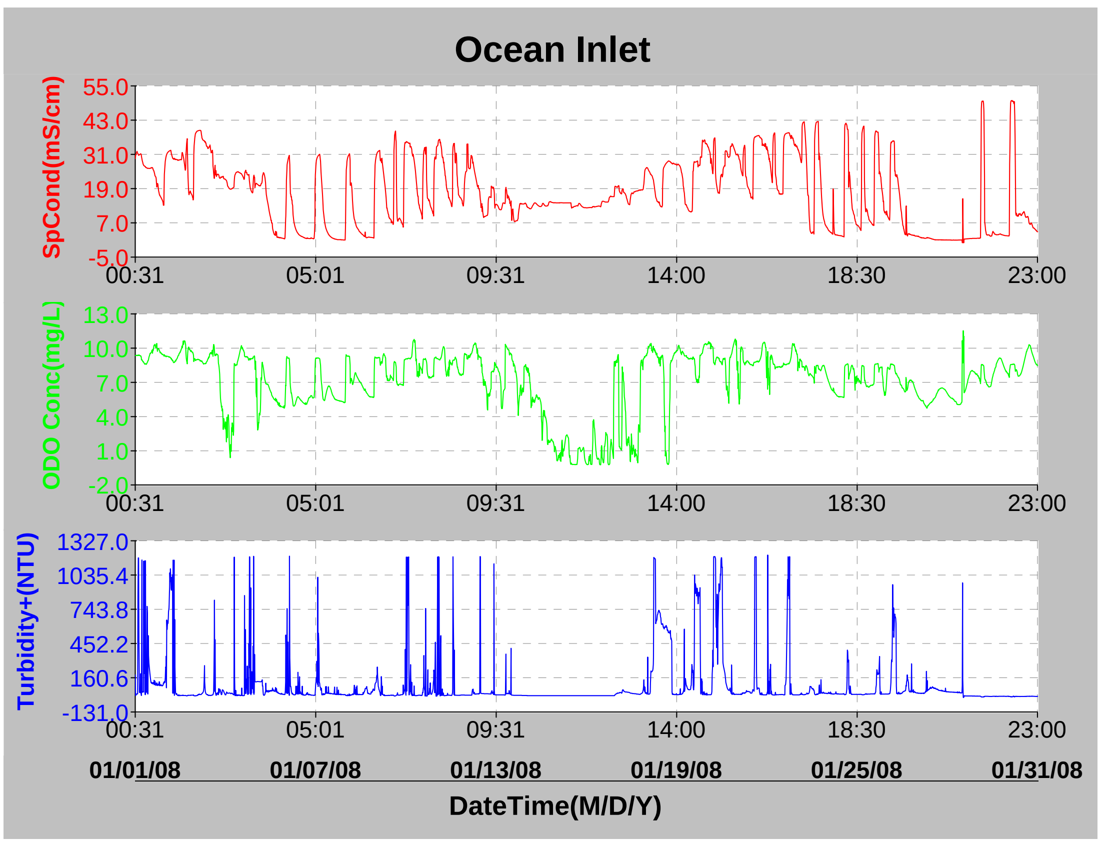


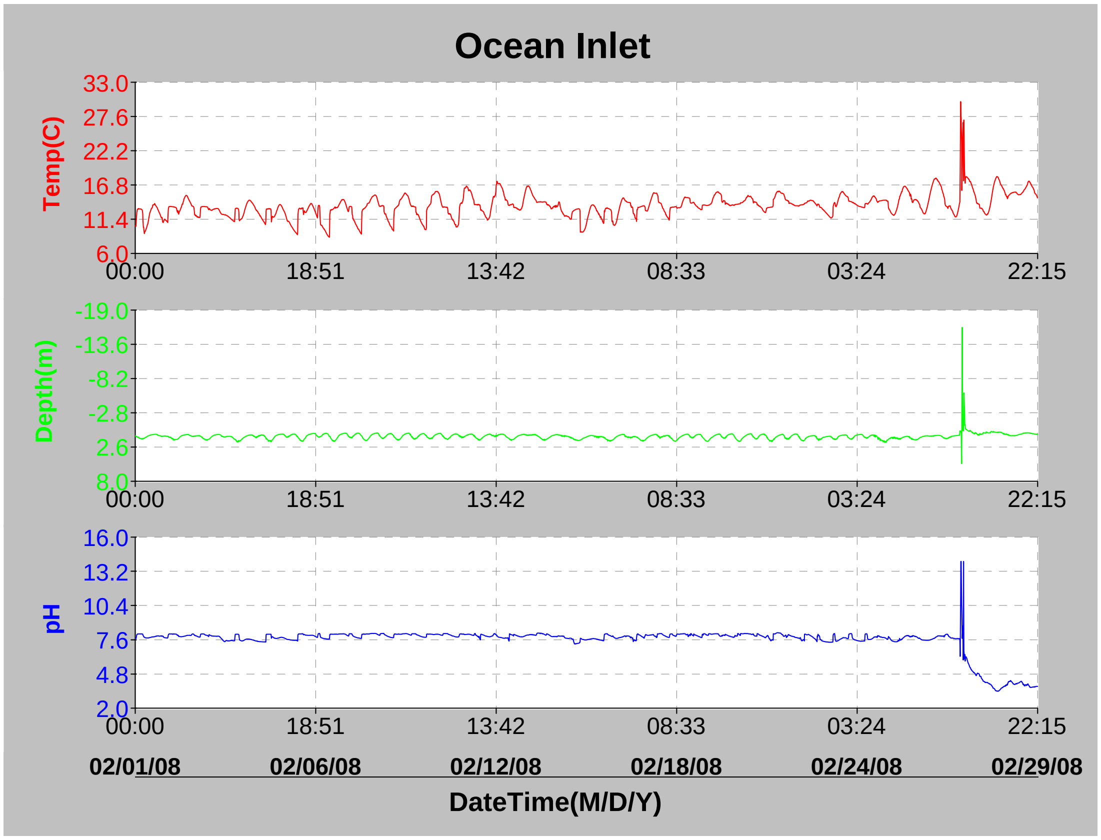
Ocean Inlet
SpCond(mS/cm)
57.0
49.0
41.0
33.0
25.0
17.0
ODO Conc(mg/L)
12.0
10.6
9.2
7.8
6.4
5.0
Turbidity+(NTU)
445.0
348.0
251.0
154.0
57.0
-40.0
00:00
20:48
17:36
14:24
11:12
08:00
11/01/07
11/04/07
11/08/07
11/12/07
11/16/07
11/20/07
DateTime(M/D/Y)


Ocean Inlet
Temp(C)
27.0
22.6
18.2
13.8
9.4
5.0
Depth(m)
-0.20
0.26
0.72
1.18
1.64
2.10
pH
9.0
7.6
6.2
4.8
3.4
2.0
17:45
02:24
11:03
19:42
04:21
13:00
12/06/07
12/11/07
12/15/07
12/19/07
12/24/07
12/28/07
DateTime(M/D/Y)

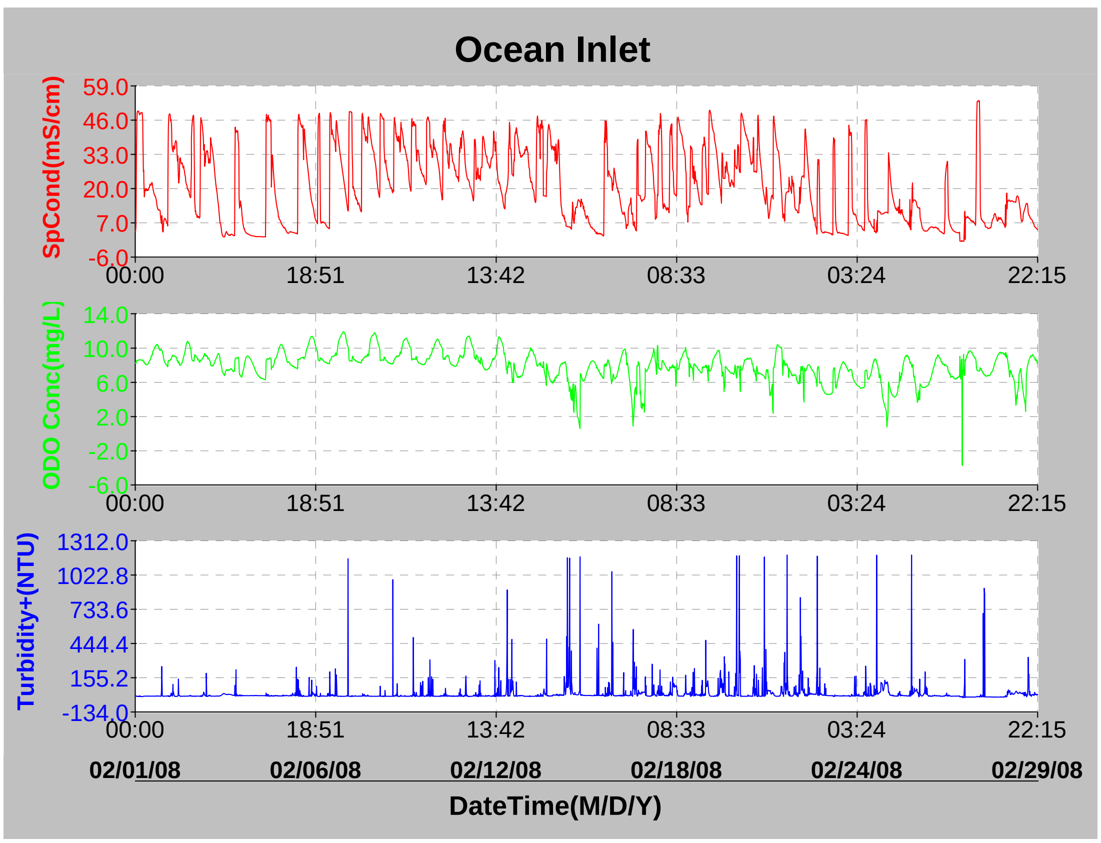

Ocean Inlet
SpCond(mS/cm)
55.0
43.0
31.0
19.0
7.0
-5.0
ODO Conc(mg/L)
11.0
9.6
8.2
6.8
5.4
4.0
Turbidity+(NTU)
1334.0
1043.2
752.4
461.6
170.8
-120.0
17:45
02:24
11:03
19:42
04:21
13:00
12/06/07
12/11/07
12/15/07
12/19/07
12/24/07
12/28/07
DateTime(M/D/Y)


Ocean Inlet
Temp(C)
18.0
15.6
13.2
10.8
8.4
6.0
Depth(m)
-0.10
0.36
0.82
1.28
1.74
2.20
pH
8.60
8.18
7.76
7.34
6.92
6.50
00:31
05:01
09:31
14:00
18:30
23:00
01/01/08
01/07/08
01/13/08
01/19/08
01/25/08
01/31/08
DateTime(M/D/Y)

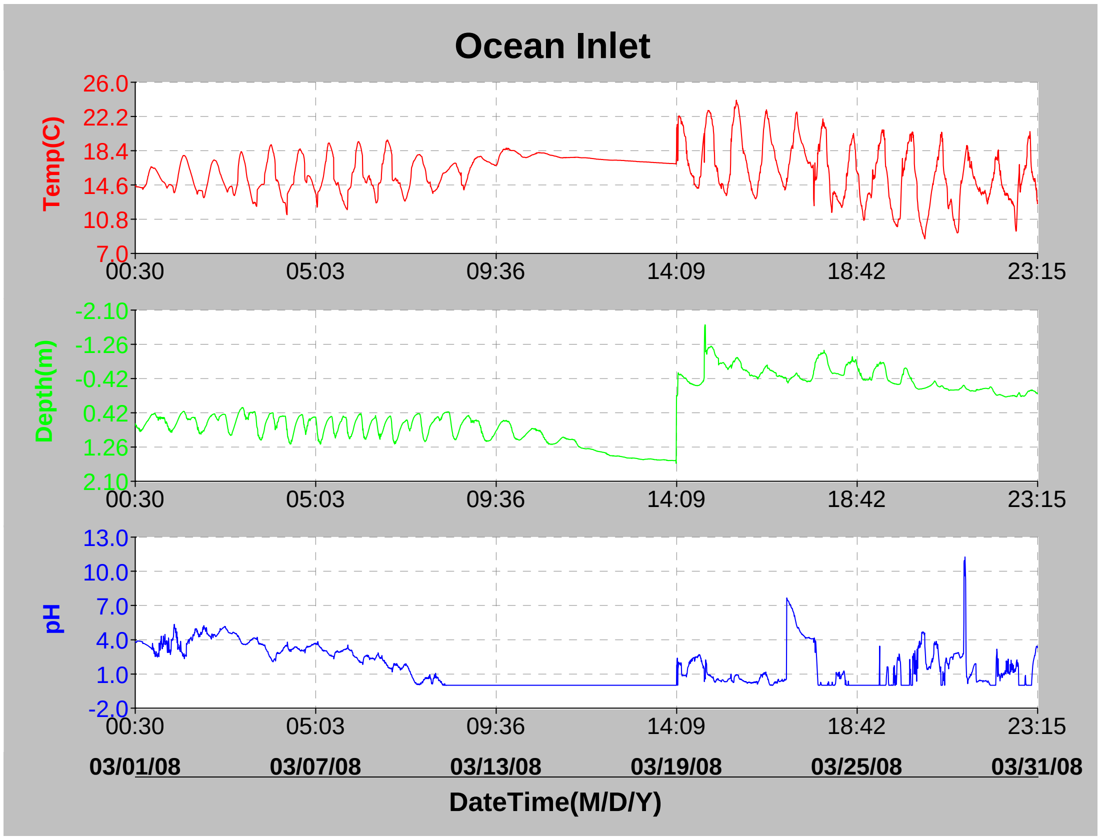

Ocean Inlet
SpCond(mS/cm)
55.0
43.0
31.0
19.0
7.0
-5.0
ODO Conc(mg/L)
13.0
10.0
7.0
4.0
1.0
-2.0
Turbidity+(NTU)
1327.0
1035.4
743.8
452.2
160.6
-131.0
00:31
05:01
09:31
14:00
18:30
23:00
01/01/08
01/07/08
01/13/08
01/19/08
01/25/08
01/31/08
DateTime(M/D/Y)

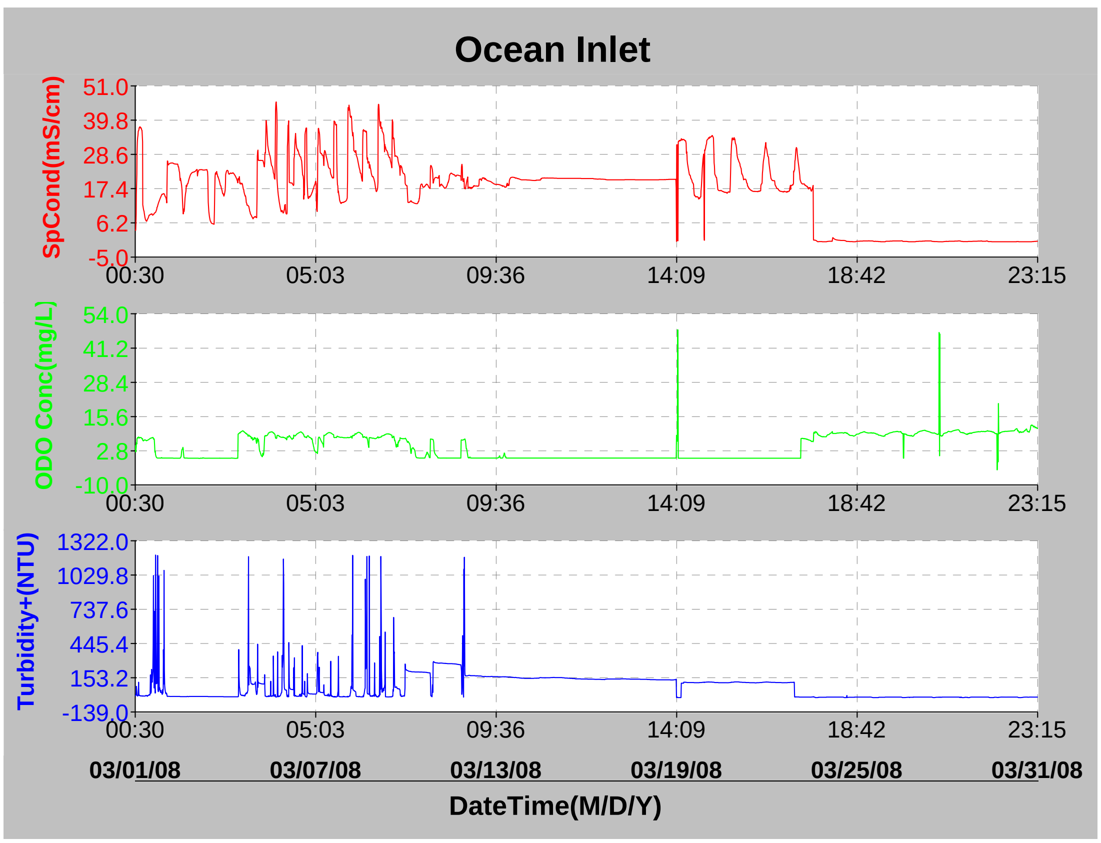


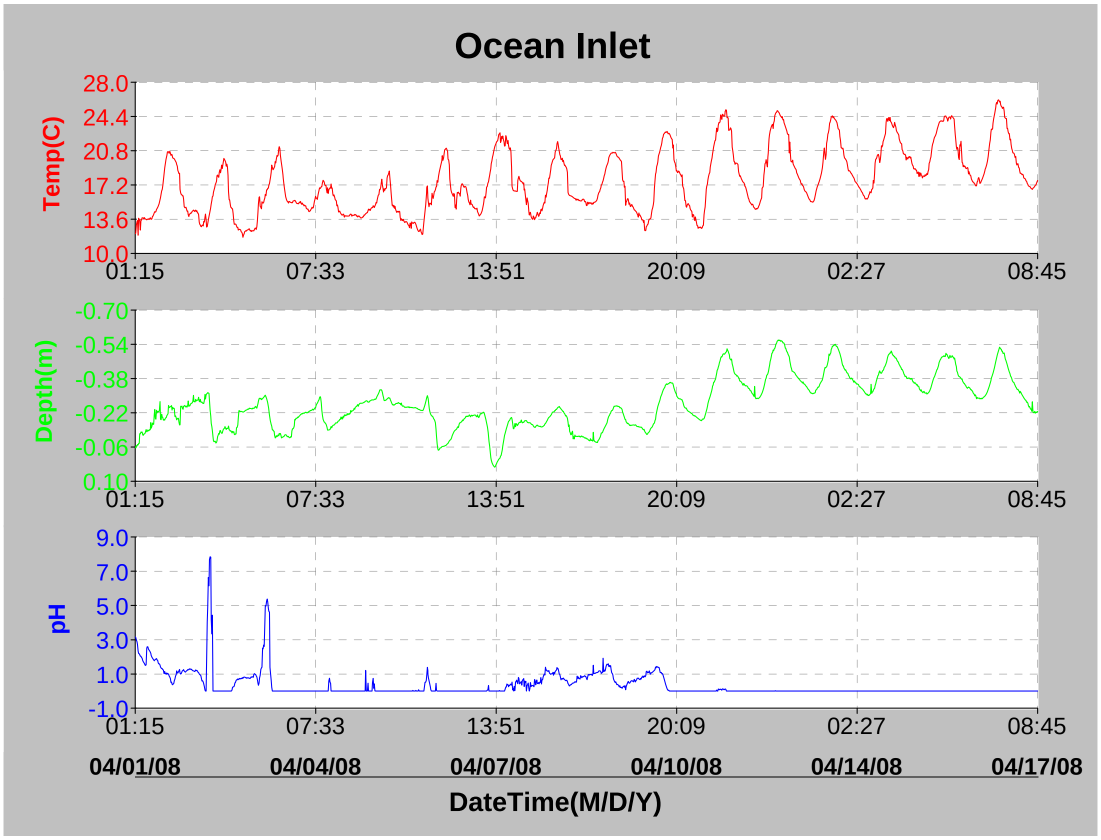
Ocean Inlet
Temp(C)
33.0
27.6
22.2
16.8
11.4
6.0
Depth(m)
-19.0
-13.6
-8.2
-2.8
2.6
8.0
pH
16.0
13.2
10.4
7.6
4.8
2.0
00:00
18:51
13:42
08:33
03:24
22:15
02/01/08
02/06/08
02/12/08
02/18/08
02/24/08
02/29/08
DateTime(M/D/Y)

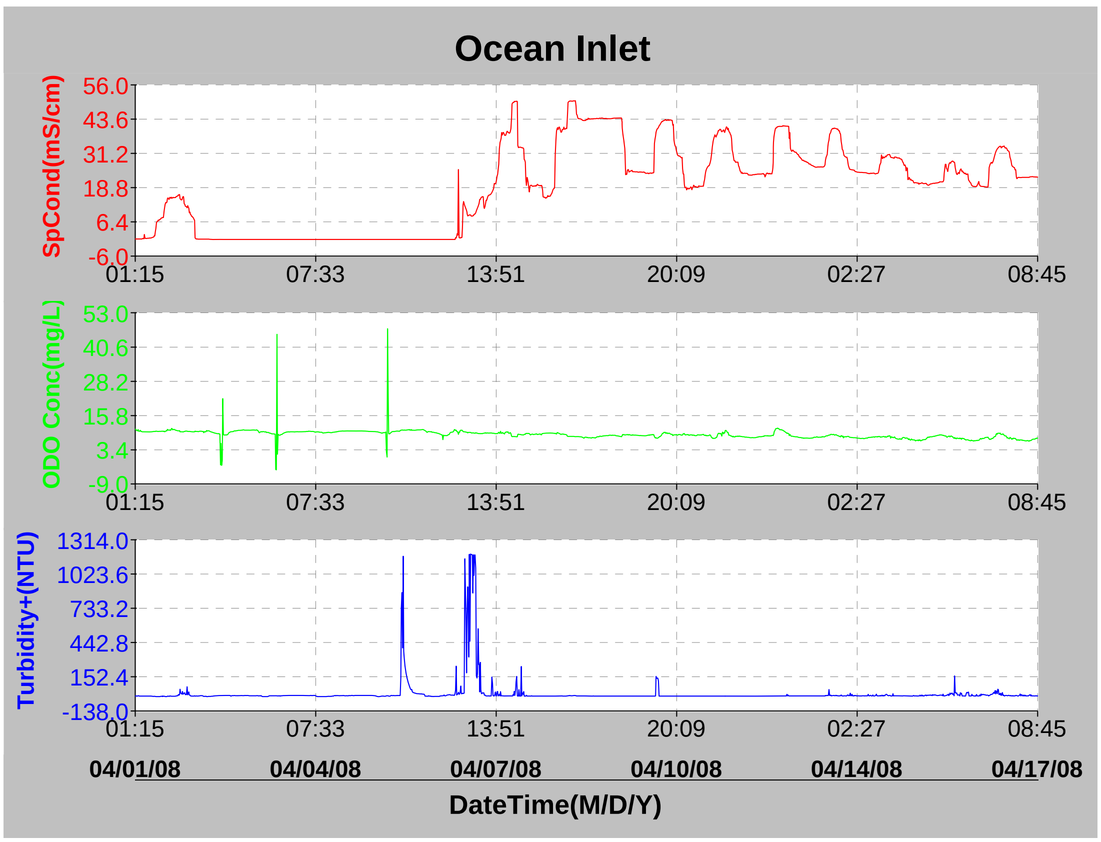


Ocean Inlet
SpCond(mS/cm)
59.0
46.0
33.0
20.0
7.0
-6.0
ODO Conc(mg/L)
14.0
10.0
6.0
2.0
-2.0
-6.0
Turbidity+(NTU)
1312.0
1022.8
733.6
444.4
155.2
-134.0
00:00
18:51
13:42
08:33
03:24
22:15
02/01/08
02/06/08
02/12/08
02/18/08
02/24/08
02/29/08
DateTime(M/D/Y)


Ocean Inlet
Temp(C)
26.0
22.2
18.4
14.6
10.8
7.0
Depth(m)
-2.10
-1.26
-0.42
0.42
1.26
2.10
pH
13.0
10.0
7.0
4.0
1.0
-2.0
00:30
05:03
09:36
14:09
18:42
23:15
03/01/08
03/07/08
03/13/08
03/19/08
03/25/08
03/31/08
DateTime(M/D/Y)


Ocean Inlet
SpCond(mS/cm)
51.0
39.8
28.6
17.4
6.2
-5.0
ODO Conc(mg/L)
54.0
41.2
28.4
15.6
2.8
-10.0
Turbidity+(NTU)
1322.0
1029.8
737.6
445.4
153.2
-139.0
00:30
05:03
09:36
14:09
18:42
23:15
03/01/08
03/07/08
03/13/08
03/19/08
03/25/08
03/31/08
DateTime(M/D/Y)


Ocean Inlet
Temp(C)
28.0
24.4
20.8
17.2
13.6
10.0
Depth(m)
-0.70
-0.54
-0.38
-0.22
-0.06
0.10
pH
9.0
7.0
5.0
3.0
1.0
-1.0
01:15
07:33
13:51
20:09
02:27
08:45
04/01/08
04/04/08
04/07/08
04/10/08
04/14/08
04/17/08
DateTime(M/D/Y)


Ocean Inlet
SpCond(mS/cm)
56.0
43.6
31.2
18.8
6.4
-6.0
ODO Conc(mg/L)
53.0
40.6
28.2
15.8
3.4
-9.0
Turbidity+(NTU)
1314.0
1023.6
733.2
442.8
152.4
-138.0
01:15
07:33
13:51
20:09
02:27
08:45
04/01/08
04/04/08
04/07/08
04/10/08
04/14/08
04/17/08
DateTime(M/D/Y)

Carmel Creek
Statistical Report

From 10/11/07 to 10/31/07
Number of samples: 1975

Parameter	Min	Max	Mean	Std
Temp (C)	13.28	49.86	15.40	1.56
Depth (m)	10.419	10.908	10.749	0.039
pH ()	6.32	8.15	7.81	0.07
SpCond (mS/cm)	0.000	3.582	3.272	0.301
ODO Conc (mg/L)	4.94	9.20	6.31	0.46
Turbidity+ (NTU)	0.2	80.8	5.4	9.0

From 11/1/07 to 11/30/07
Number of samples: 2879

Parameter	Min	Max	Mean	Std
Temp (C)	8.62	18.15	13.98	2.06
Depth (m)	0.038	10.854	7.112	4.918
pH ()	7.36	9.07	7.89	0.09
SpCond (mS/cm)	0.084	3.504	3.002	0.528
ODO Conc (mg/L)	5.03	10.73	7.13	0.99
Turbidity+ (NTU)	-0.7	312.3	2.6	10.2

From 12/01/07 to 12/31/07
Number of samples: 2950

Parameter	Min	Max	Mean	Std
Temp (C)	5.15	15.75	9.19	2.37
Depth (m)	-0.012	0.968	0.459	0.094
pH ()	6.06	8.21	7.86	0.12
SpCond (mS/cm)	0.062	2.666	1.953	0.377
ODO Conc (mg/L)	7.40	11.98	9.34	0.77
Turbidity+ (NTU)	-0.7	248.5	0.7	6.0

From 01/01/08 to 01/31/08
Number of samples: 2971

Parameter	Min	Max	Mean	Std
Temp (C)	5.99	15.54	9.65	2.08
Depth (m)	0.079	0.789	0.481	0.094
pH ()	6.82	8.07	7.88	0.12
SpCond (mS/cm)	0.043	10.065	1.987	0.593
ODO Conc (mg/L)	7.61	11.15	9.33	0.74
Turbidity+ (NTU)	-3.5	102.1	1.3	5.3

From 02/01/08 to 02/29/08
Number of samples: 2779

Parameter	Min	Max	Mean	Std
Temp (C)	6.62	20.06	10.35	1.80
Depth (m)	0.071	0.702	0.449	0.086
pH ()	4.44	7.96	7.70	0.15
SpCond (mS/cm)	0.005	2.939	2.105	0.507
ODO Conc (mg/L)	7.02	10.99	8.98	0.90
Turbidity+ (NTU)	-6.9	80.2	-1.3	4.6

From 03/01/08 to 03/31/08
Number of samples: 2961

Parameter	Min	Max	Mean	Std
Temp (C)	8.86	14.73	12.17	1.31
Depth (m)	0.050	0.448	0.352	0.032
pH ()	7.54	8.14	7.79	0.05
SpCond (mS/cm)	0.085	3.231	2.982	0.233
ODO Conc (mg/L)	6.00	10.02	7.41	0.82
Turbidity+ (NTU)	1.0	96.9	1.9	3.2

From 04/01/08 to 04/08/08
Number of samples: 707

Parameter	Min	Max	Mean	Std
Temp (C)	11.13	15.52	13.75	1.15
Depth (m)	0.333	0.469	0.377	0.026
pH ()	7.67	7.82	7.75	0.03
SpCond (mS/cm)	2.683	3.199	3.085	0.075
ODO Conc (mg/L)	5.60	7.88	6.49	0.58
Turbidity+ (NTU)	1.7	11.5	2.2	1.0

Carroll Canyon Creek
Statistical Report

From 10/11/07 to 10/31/07
Number of samples: 1957

Parameter	Min	Max	Mean	Std
Temp (C)	12.53	24.72	17.53	2.71
Depth (m)	-0.028	0.189	0.024	0.035
pH ()	7.72	8.48	8.01	0.16
SpCond (mS/cm)	0.000	4.554	3.197	0.968
ODO Conc (mg/L)	5.70	17.40	9.07	2.85
Turbidity+ (NTU)	3.4	1277.8	27.0	83.4

From 11/01/07 to 11/15/07
Number of samples: 1383

Parameter	Min	Max	Mean	Std
Temp (C)	12.01	22.99	16.50	2.11
Depth (m)	-0.005	0.066	0.037	0.016
pH ()	7.78	8.37	8.07	0.13
SpCond (mS/cm)	3.089	4.152	3.897	0.149
ODO Conc (mg/L)	6.18	16.33	9.47	2.68
Turbidity+ (NTU)	3.7	1217.3	23.9	103.6

From 12/04/07 to 12/31/07
Number of samples: 2538

Parameter	Min	Max	Mean	Std
Temp (C)	5.33	21.95	11.22	2.34
Depth (m)	-0.010	0.836	0.203	0.087
pH ()	4.51	10.15	8.15	0.28
SpCond (mS/cm)	0.175	3.531	1.120	0.906
ODO Conc (mg/L)	6.30	23.78	10.88	2.61
Turbidity+ (NTU)	-2.4	1170.6	15.6	64.8

From 01/01/08 to 01/23/08
Number of samples: 2121

Parameter	Min	Max	Mean	Std
Temp (C)	5.70	17.35	11.47	2.40
Depth (m)	0.075	1.111	0.201	0.135
pH ()	7.53	8.81	8.13	0.30
SpCond (mS/cm)	0.137	3.635	2.604	0.910
ODO Conc (mg/L)	7.47	23.45	12.42	3.91
Turbidity+ (NTU)	3.2	1160.0	53.5	67.1

From 2/1/08 to 2/29/08
Number of samples: 2775

Parameter	Min	Max	Mean	Std
Temp (C)	7.77	22.15	12.81	2.48
Depth (m)	0.019	0.828	0.175	0.100
pH ()	7.45	10.13	8.01	0.36
SpCond (mS/cm)	0.003	4.710	2.616	0.957
ODO Conc (mg/L)	4.64	19.52	9.29	2.23
Turbidity+ (NTU)	-12.2	1143.7	7.3	57.7

From 3/1/08 to 3/31/08
Number of samples: 2969

Parameter	Min	Max	Mean	Std
Temp (C)	8.64	26.59	15.91	3.81
Depth (m)	0.025	0.310	0.127	0.032
pH ()	7.48	8.87	8.00	0.31
SpCond (mS/cm)	0.211	4.428	3.604	0.386
ODO Conc (mg/L)	3.87	17.56	8.71	2.98
Turbidity+ (NTU)	-17.0	1241.3	298.4	463.9

From 04/01/08 to 04/20/08
Number of samples: 1791

Parameter	Min	Max	Mean	Std
Temp (C)	12.46	25.65	17.73	2.81
Depth (m)	0.039	0.198	0.119	0.036
pH ()	7.46	8.84	7.84	0.27
SpCond (mS/cm)	1.644	4.119	3.102	0.884
ODO Conc (mg/L)	4.23	16.47	6.86	1.72
Turbidity+ (NTU)	-12.3	1250.6	255.0	368.2

Los Peñasquitos Creek
Statistical Report

From 10/11/07 to 10/31/07
Number of samples: 1959

Parameter	Min	Max	Mean	Std
Temp (C)	11.95	17.58	15.09	1.18
Depth (m)	10.408	10.628	10.483	0.041
pH ()	7.54	8.33	7.98	0.06
SpCond (mS/cm)	0.105	4.305	3.437	0.241
ODO Conc (mg/L)	6.45	9.78	8.60	0.55
Turbidity+ (NTU)	3.4	781.7	10.5	41.3

From 11/01/07 to 11/20/07
Number of samples: 1883

Parameter	Min	Max	Mean	Std
Temp (C)	11.85	16.68	14.85	1.04
Depth (m)	10.402	10.527	10.473	0.030
pH ()	7.96	8.09	8.03	0.02
SpCond (mS/cm)	3.155	3.774	3.549	0.071
ODO Conc (mg/L)	8.27	9.78	8.89	0.30
Turbidity+ (NTU)	3.2	676.6	10.7	41.9

From 12/06/07 to 12/31/07
Number of samples: 2415

Parameter	Min	Max	Mean	Std
Temp (C)	5.54	15.18	9.65	1.93
Depth (m)	0.098	0.550	0.249	0.077
pH ()	7.56	10.38	7.94	0.12
SpCond (mS/cm)	0.148	3.504	2.592	0.606
ODO Conc (mg/L)	7.52	13.81	9.78	0.84
Turbidity+ (NTU)	2.0	236.5	3.7	7.2

From 1/1/08 to 1/31/08
Number of samples: 2972

Parameter	Min	Max	Mean	Std
Temp (C)	6.48	20.36	10.50	1.87
Depth (m)	0.087	0.795	0.295	0.136
pH ()	4.22	8.43	7.97	0.18
SpCond (mS/cm)	0.078	4.434	2.317	0.933
ODO Conc (mg/L)	7.54	11.56	9.39	0.87
Turbidity+ (NTU)	-0.7	323.6	6.7	15.2

From 2/1/08 to 2/29/08
Number of samples: 2777

Parameter	Min	Max	Mean	Std
Temp (C)	8.43	26.24	11.65	1.54
Depth (m)	0.084	0.628	0.295	0.097
pH ()	3.18	8.14	7.85	0.16
SpCond (mS/cm)	0.004	3.006	2.015	0.647
ODO Conc (mg/L)	6.91	11.55	9.14	1.00
Turbidity+ (NTU)	-6.6	113.5	2.0	8.0

From 3/1/08 to 3/31/08
Number of samples: 2972

Parameter	Min	Max	Mean	Std
Temp (C)	9.88	16.18	13.50	1.33
Depth (m)	0.081	0.292	0.214	0.034
pH ()	7.76	8.17	7.89	0.04
SpCond (mS/cm)	0.108	3.327	2.994	0.251
ODO Conc (mg/L)	6.86	10.63	7.91	0.65
Turbidity+ (NTU)	-10.8	246.9	-2.7	12.1

Lagoon Segment
Statistical Report

From 10/12/07 to 10/31/07
Number of samples: 1862

Parameter	Min	Max	Mean	Std
Temp (C)	16.93	22.54	19.89	0.99
Depth (m)	-0.000	1.388	0.762	0.254
pH ()	7.24	8.48	8.01	0.15
SpCond (mS/cm)	0.000	52.760	46.910	4.592
ODO Conc (mg/L)	-0.05	13.71	3.02	3.19
Turbidity+ (NTU)	4.4	886.5	8.7	22.9

From 11/01/07 to 11/20/07
Number of samples: 1864

Parameter	Min	Max	Mean	Std
Temp (C)	14.89	21.40	17.95	1.06
Depth (m)	0.388	1.128	0.625	0.180
pH ()	7.75	8.47	8.09	0.11
SpCond (mS/cm)	36.735	52.245	48.352	3.285
ODO Conc (mg/L)	1.97	15.83	8.26	2.10
Turbidity+ (NTU)	4.0	665.2	17.9	24.6

From 12/06/07 to 12/31/07
Number of samples: 2241

Parameter	Min	Max	Mean	Std
Temp (C)	8.67	18.83	13.68	1.09
Depth (m)	0.045	1.490	0.614	0.292
pH ()	4.34	8.24	7.94	0.22
SpCond (mS/cm)	0.936	50.583	33.091	15.063
ODO Conc (mg/L)	2.27	14.07	7.50	1.72
Turbidity+ (NTU)	-192.1	3799.9	-146.7	210.2

From 01/01/08 to 01/25/08
Number of samples: 2318

Parameter	Min	Max	Mean	Std
Temp (C)	10.17	15.59	13.56	0.87
Depth (m)	0.262	1.441	0.714	0.266
pH ()	7.08	8.33	8.00	0.30
SpCond (mS/cm)	1.143	51.481	37.688	16.504
ODO Conc (mg/L)	-0.02	12.87	4.92	2.64
Turbidity+ (NTU)	-191.5	3799.9	-180.4	147.1

From 2/1/08 to 2/29/08
Number of samples: 2777

Parameter	Min	Max	Mean	Std
Temp (C)	9.39	17.51	14.28	1.25
Depth (m)	0.022	1.274	0.632	0.225
pH ()	4.62	8.09	7.75	0.19
SpCond (mS/cm)	0.028	50.890	36.518	14.054
ODO Conc (mg/L)	5.47	14.50	8.73	1.40
Turbidity+ (NTU)	-10.1	897.5	8.9	22.1

From 3/1/08 to 3/31/08
Number of samples: 2970

Parameter	Min	Max	Mean	Std
Temp (C)	13.49	23.29	18.41	2.38
Depth (m)	-0.028	1.223	0.807	0.226
pH ()	7.49	8.23	7.99	0.09
SpCond (mS/cm)	1.762	49.992	45.431	3.254
ODO Conc (mg/L)	3.65	12.58	8.13	1.48
Turbidity+ (NTU)	-7.7	1207.5	19.7	66.1

From 04/01/08 to 04/21/08
Number of samples: 1955

Parameter	Min	Max	Mean	Std
Temp (C)	16.92	25.90	22.52	2.59
Depth (m)	0.614	1.317	1.072	0.177
pH ()	7.34	8.32	7.93	0.25
SpCond (mS/cm)	34.510	50.220	44.116	4.486
ODO Conc (mg/L)	0.75	14.41	6.67	2.69
Turbidity+ (NTU)	4.8	568.4	45.5	49.0

Ocean Inlet
Statistical Report

From 10/11/07to 10/31/07
Number of samples: 1959

Parameter	Min	Max	Mean	Std
Temp (C)	12.05	26.15	17.59	1.94
Depth (m)	-0.006	1.549	0.398	0.309
pH ()	7.11	8.56	8.03	0.13
SpCond (mS/cm)	0.197	52.845	31.279	17.855
ODO Conc (mg/L)	1.73	11.02	7.69	1.64
Turbidity+ (NTU)	1.0	1225.9	6.4	48.0

From 11/01/07 to 11/20/07
Number of samples: 1857

Parameter	Min	Max	Mean	Std
Temp (C)	12.57	20.92	16.86	1.19
Depth (m)	0.088	1.355	0.683	0.244
pH ()	7.77	8.94	8.04	0.15
SpCond (mS/cm)	20.502	52.890	44.082	6.941
ODO Conc (mg/L)	6.13	10.73	8.23	0.85
Turbidity+ (NTU)	0.9	404.3	4.5	14.9

From 12/06/07 to 12/28/07
Number of samples: 2015

Parameter	Min	Max	Mean	Std
Temp (C)	7.37	24.61	12.87	1.84
Depth (m)	0.052	1.900	0.830	0.352
pH ()	2.95	8.16	6.77	1.48
SpCond (mS/cm)	0.000	49.545	27.527	13.677
ODO Conc (mg/L)	4.91	9.97	7.80	1.04
Turbidity+ (NTU)	1.5	1212.0	26.3	107.8

From 1/1/08 to 1/31/08
Number of samples: 2969

Parameter	Min	Max	Mean	Std
Temp (C)	7.73	16.21	12.77	1.30
Depth (m)	0.120	1.987	0.939	0.309
pH ()	6.68	8.39	7.90	0.28
SpCond (mS/cm)	0.009	49.860	17.548	11.834
ODO Conc (mg/L)	-0.23	11.52	7.15	2.61
Turbidity+ (NTU)	-9.1	1204.8	95.6	224.4

From 2/1/08 to 2/29/08
Number of samples: 2773

Parameter	Min	Max	Mean	Std
Temp (C)	8.53	29.93	13.57	1.82
Depth (m)	-16.265	5.223	0.922	0.510
pH ()	3.39	14.00	7.56	1.06
SpCond (mS/cm)	0.000	53.350	21.013	14.114
ODO Conc (mg/L)	-3.72	11.91	7.91	1.69
Turbidity+ (NTU)	-13.0	1191.2	24.3	99.7

From 3/1/08 to 3/31/08
Number of samples: 2970

Parameter	Min	Max	Mean	Std
Temp (C)	8.61	23.99	16.20	2.50
Depth (m)	-1.737	1.661	0.353	0.725
pH ()	0.00	11.25	1.55	1.73
SpCond (mS/cm)	0.002	45.770	15.917	10.715
ODO Conc (mg/L)	-4.39	48.01	4.28	4.67
Turbidity+ (NTU)	-16.8	1199.5	75.7	119.1

From 04/01/08 to 04/17/08
Number of samples: 1567

Parameter	Min	Max	Mean	Std
Temp (C)	11.70	26.14	17.64	3.36
Depth (m)	-0.560	0.034	-0.266	0.121
pH ()	0.00	7.84	0.35	0.77
SpCond (mS/cm)	0.000	50.237	18.829	15.272
ODO Conc (mg/L)	-3.89	47.20	8.93	1.91
Turbidity+ (NTU)	-16.2	1192.8	9.6	121.8