# Scripps Watershed
# Comprehensive Load Reduction Plan

## Appendices

*FINAL*

July 20, 2012

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# Appendix A. Bacterial Conceptual Models and Literature Review

The County of San Diego and other Responsible Parties led a source identification review of bacteria to assist with CLRP development. These documents were prepared in association with Armand Ruby Consulting in collaboration with AMEC. The five bacteria conceptual models and associated literature review memorandum are incorporated directly from this effort on the following 83 pages.

# Appendix B. Watershed Modeling Report

## Introduction

Watershed models have been used to support TMDL development for bacteria and other water quality constituents in the San Diego region over the past decade. The Loading Simulation Program in C++ (LSPC) was the model of choice during development of the recently approved Bacteria TMDL and is currently being used to develop TMDLs for other targeted pollutants. These models were updated to support pollutant source characterization and identification of high priority management areas (HPMAs) for the Comprehensive Load Reduction Plans (CLRPs) and future implementation planning efforts. Future implementation planning efforts will include linkage to BMP simulation and optimization processes that require additional spatial resolution and representation of key land characteristics that influence BMP selection (e.g., imperviousness, soil infiltration, slope). Therefore, significant updates of the previously developed LSPC models were primarily focused on hydrology, which will have the largest impact of many of the structural BMP functions planned in the CLRPs. Additional refinements of water quality calibrations were also performed.

LSPC is a watershed modeling system that excels at simulating hydrology, sediment and pollutant generation, transformation, and transport on land, as well as fate and transport within streams (Shen et al., 2004; USEPA, 2003; Tetra Tech and USEPA, 2002). The LSPC model has been successfully applied and calibrated for a large number of watersheds in southern California including, but not limited to, the Los Angeles River, San Gabriel River, San Jacinto River, Lake Mathews, Chollas Creek, Los Peñasquitos, B Street/Downtown Anchorage, and multiple watersheds that drain to impaired beaches in the San Diego Region (USEPA, 2011, City of San Diego, 2010). The current effort builds on the results of previous modeling studies through the incorporation of recent monitoring data and key modeling enhancements.

### Modeling Approach

A watershed model is necessary to address the generation of pollutant loads over the land surface and through groundwater contributions and to predict the resulting water quality impact on receiving waters. A watershed model is comprised of a series of algorithms applied to watershed characteristics and meteorological data to simulate land- and stream-based processes over an extended period of time. Once a model has been adequately set up and calibrated, it can be used to quantify the existing loading of pollutants from subwatersheds or from land use categories, quantify pollutant loading from ungaged tributaries and diffuse overland flow sources, and assess the impacts of a variety of management scenarios.

The modeling analysis to support CLRP development builds on previous models developed in the region. TMDLs for indicator bacteria were developed to address 19 of the 38 bacteria-impaired waterbodies in the San Diego region, as identified on the 2002 Clean Water Act Section 303(d) List of Water Quality Limited Segments. This project is referred to as “Project I Beaches and Creeks in the San Diego Region” or Bacti-I and is documented in San Diego Water Board (2007a). An expansion of the regional modeling approach used in Bacti-I was conducted under Bacteria Impaired Waters TMDL Project II for Bays and Lagoons (Bacti-II) and included representation of watersheds draining to impaired lagoons (San Diego Water Board and USEPA, 2005). Using Bacti-I and II as a foundation, additional modeling was conducted to support San Diego Region Lagoon TMDLs (San Diego Water Board and USEPA, 2008). This effort added a number of additional parameters to the modeling framework (SDRWQCB, 2007b, SDRWQCB, 2010).

In addition to this previous work, Los Peñasquitos was the subject of more recent LSPC modeling for hydrology and sediment to support the Los Peñasquitos Lagoon sediment TMDL (City of San Diego, 2010). Likewise Chollas Creek has been the subject of recent efforts including those in 2006 (SCCWRP and Tetra Tech, 2007; SDRWQCB, 2007b) and in 2011 as a part of the Chollas, Switzer, and Paleta TMDL modeling (City of San Diego, 2012).

LSPC includes Hydrologic Simulation Program, FORTRAN (HSPF) algorithms for simulating watershed hydrology, erosion, and water quality processes, as well as in-stream transport processes. LSPC integrates a geographical information system (GIS), comprehensive data storage and management capabilities, the original HSPF algorithms, and a data analysis/post-processing system into a convenient PC-based windows interface. LSPC is currently freely distributed by EPA's Office of Research and Development in Athens, Georgia, and is a component of EPA's National TMDL Toolbox (http://www.epa.gov/athens/wwqtsc/index.html). A brief overview of the underlying HSPF model is provided below, and additional detailed discussion of HSPF-simulated processes and model parameters is available in the HSPF User's Manual (Bicknell et al. 1997).

HSPF is a comprehensive watershed and receiving water quality modeling framework that was originally developed in the mid-1970s. During the past several years HSPF and LSPC have been extensively used to develop hundreds of EPA-approved TMDLs, as these models are generally considered to be the most advanced hydrologic and watershed loading models available. The hydrologic portion of the underlying model is based on the Stanford Watershed Model (Crawford and Linsley, 1966), which was one of the pioneering watershed models. The HSPF framework is modular, with different components that can be assembled in different ways, depending on the objectives of the individual project. The model includes these major modules:

- PERLND/IMPLND for simulating watershed processes on pervious/impervious land areas
- SEDMNT/SOLIDS for simulating production and removal of sediment/solids from pervious/impervious land
- PQUAL/IQUAL for simulating production/removal of pollutants from pervious/impervious land
- RCHRES for simulating flow and water quality processes in streams and vertically mixed lakes
- SEDTRN for simulating transport, deposition, and scour of sediment in modeled waterbodies
- GQUAL for simulating transport, transformations, and loss of pollutants in modeled waterbodies

All these modules include various submodules that calculate hydrologic, sediment, and water quality processes in the watershed. Many options are available for both simplified and complex process formulations. Spatially, the watershed is divided into a series of subwatersheds representing the drainage areas that contribute to each of the stream reaches. The subwatersheds are then further subdivided into segments representing different land uses. For the developed areas, the land use segments are further divided into the pervious and impervious fractions. The stream network links the surface runoff and groundwater flow contributions from each of the land segments and subwatersheds and routes them through the waterbodies using storage routing techniques. The stream model includes precipitation and evaporation from the water surfaces, as well as flow contributions from the watershed, tributaries, and upstream stream reaches. Flow withdrawals can also be accommodated. The stream network is constructed to represent all the major tributary streams and different portions of stream reaches where significant changes in water quality occur.

Like the watershed components, several options are available for simulating water quality in the receiving waters. The simpler options consider transport through the waterways and represent all transformations and removal processes using simple first-order decay approaches. Decay is used to represent the net loss from processes such as settling and adsorption. The framework is flexible and allows different combinations of constituents to be modeled depending on data availability and the objectives of the study.

# Data Summary

## Hydrology Data

Available hydrologic data were reviewed and used for evaluating the predictive ability of the CLRP watershed models. Hydrology monitoring stations were first georeferenced with both the subwatershed boundaries and reach layers to identify the associated model outflow points for comparison. Upstream drainage area characteristics, such as contributing land use distribution, were also summarized for each flow gage. Table B-1 provides a summary of the stations. Figure B-1 shows the selected in-stream hydrology stations in the CLRP watersheds available for use in hydrology calibration. Relatively few continuous flow monitoring stations were available within the CLRP watersheds that had significant data within the past twenty years. The station on Los Peñasquitos Creek provides the longest continuous flow monitoring downstream of developed areas among the available gages. The Chollas stations that were used for calibration are downstream of significant urbanized areas, but only provide short term data for two years. The three stations in San Dieguito are located in the upper half of the watershed and receive drainage from areas with little or no development.

### Table B-1. Flow Monitoring Stations Used for Model Calibration/Validation

| Watershed | Waterbody | Gage ID | Period of Record |
|---|---|---|---|
| Los Peñasquitos | Los Peñasquitos Creek | USGS 11023340 | 1964 – Present |
| San Dieguito | Guejito Creek | USGS 11027000 | 2004 – Present * |
| San Dieguito | Santa Ysabel Creek | USGS 11025500 | 1943 – Present |
| San Dieguito | Santa Maria Creek | USGS 11028500 | 1946 – Present |
| Chollas | North Chollas Creek | Chollas North** | Spring 2006 |
| Chollas | North Chollas Creek | MAC 11** | Winter 2009/2010 |
| Chollas | South Chollas Creek | Chollas South** | Spring 2006 |
| Chollas | South Chollas Creek | MAC 17** | Winter 2009/2010 |

* Flow was monitored at Guejito Creek from 1947 through 1982, and was suspended until 2004.

** Chollas temporary flow gage stations are not shown in Figure B-1

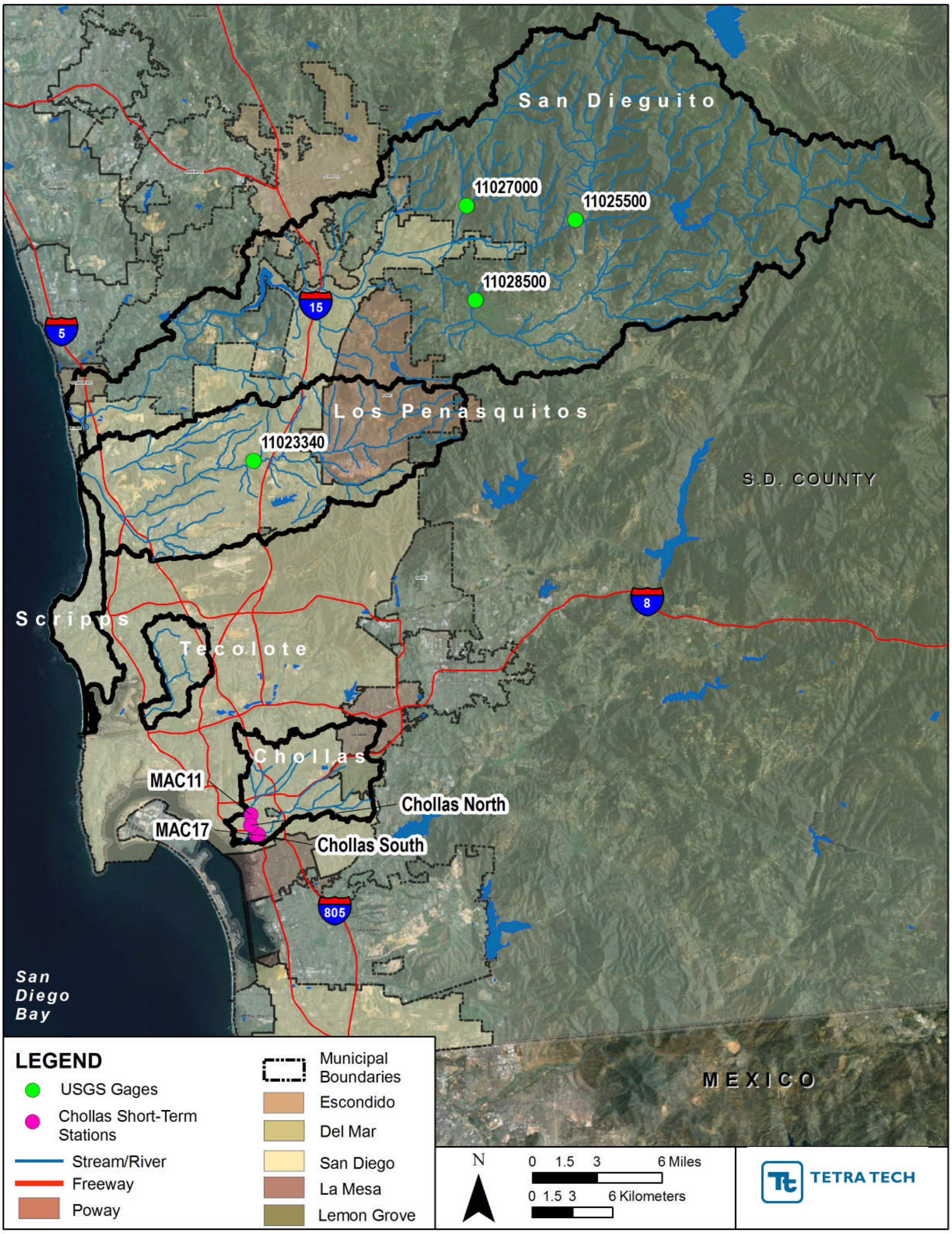



**Figure B-1. Flow Monitoring Stations**

## Water Quality Data

This section provides a summary of the water quality data that were reviewed, screened, and used for evaluating the San Diego County CLRP watershed models. The targeted water quality constituents in the CLRP watershed modeling were as follows:

- Sediment in all watersheds
- Bacteria in all watersheds (fecal coliform, total coliform, enterococcus)
- Trace metals in Chollas, Tecolote, and Scripps watersheds[1] (total copper, total lead, total zinc)
- Nutrients in all watersheds (total nitrogen, total phosphorous)

Water quality monitoring in the watersheds has focused on episodic dry weather sampling, compliance wet weather monitoring and some special study wet weather studies. There are numerous data sets that have been supplied as a part of this study; however, only a subset was used in the model development and testing. The following data were reviewed:

- **NPDES Receiving Waters from Ecolayers.** Wet and dry weather sampling took place between 2001 and 2008 in four of the five CLRP watersheds (no locations were available in the Scripps watershed). Of the available stations, four (one in each watershed) had sufficient periods of record to characterize water quality on a long term basis. These data were used as the primary source for in-stream water quality calibration.
- **Scripps Bacteria Data.** Bacteria samples from flowing storm drains and coastal receiving waters were collected in the Scripps watershed between 2007 and 2011. Since land use upstream of the storm drains was not provided, it was not possible to draw a correlation between bacteria concentrations and contributing land uses.
- **AMEC Monitoring.** Several parameters were monitored during two storm events in 2011. However, the model meteorology does not extend past 2010, so the data could not be used.
- **Dry and Wet Weather Storm Drain Data.** The storm drain data obtained from Ecolayers contains a large amount of data on dry weather storm drain water quality.
- **San Diego CoastKeepers.** Collected between 2009 and 2011. Inorganic nutrientsand dissolved metals were reported. Bacteria monitoring was limited.
- **Chollas Monitoring.** Stormwater pollutographs were sampled in two different studies, first in 2006, and later in 2009-2010. The studies are discussed below.

The Chollas stormwater pollutograph monitoring was used to calibrate the previous Chollas Creek LSPC models. The data incorporated both watershed and land use scaled monitoring, and included a wide range of constituents. Storm water monitoring data for Chollas, Paleta, and Switzer Creeks were collected in two separate studies. The first study, in early 2006, monitored three events in February and March on North Chollas Creek, South Chollas Creek, Paleta Creek, and Switzer Creek (Schiff and Carter 2007). The second study in late 2009 through early 2010 had a larger scope and monitored storm water runoff from twelve land use sites and eleven larger catchment-scale sites (City of San Diego, 2010b; City of San Diego, 2010c).

[1] Trace Metals were modeled in Chollas, Tecolote, and Scripps only. No impairments of copper, lead, or zinc were present in San Dieguito or Los Peñasquitos, and a review of monitoring data showed that total metals concentrations in both San Dieguito and Los Peñasquitos were typically one-half to one orders of magnitude lower than concentrations in Chollas and Tecolote.

LSPC parameters from the previous Chollas work were used for initializing land use-based values in the current effort. Ecolayers receiving waters data, most of which were flow-weighted samples, were used as the primary source for in-stream water quality calibration. This sampling set captured a relatively wide range of wet-weather conditions as needed to characterize pollutant loads. Instream data collected by San Diego Coastkeepers were a secondary source of information. The monitoring stations were georeferenced with both the subwatershed boundaries and reach layers to identify the associated model outflow points for comparison. Upstream drainage area characteristics, such as contributing land use distribution, were also summarized for each station. The NPDES and San Diego Coastkeepers station locations are shown in Figure B-2.

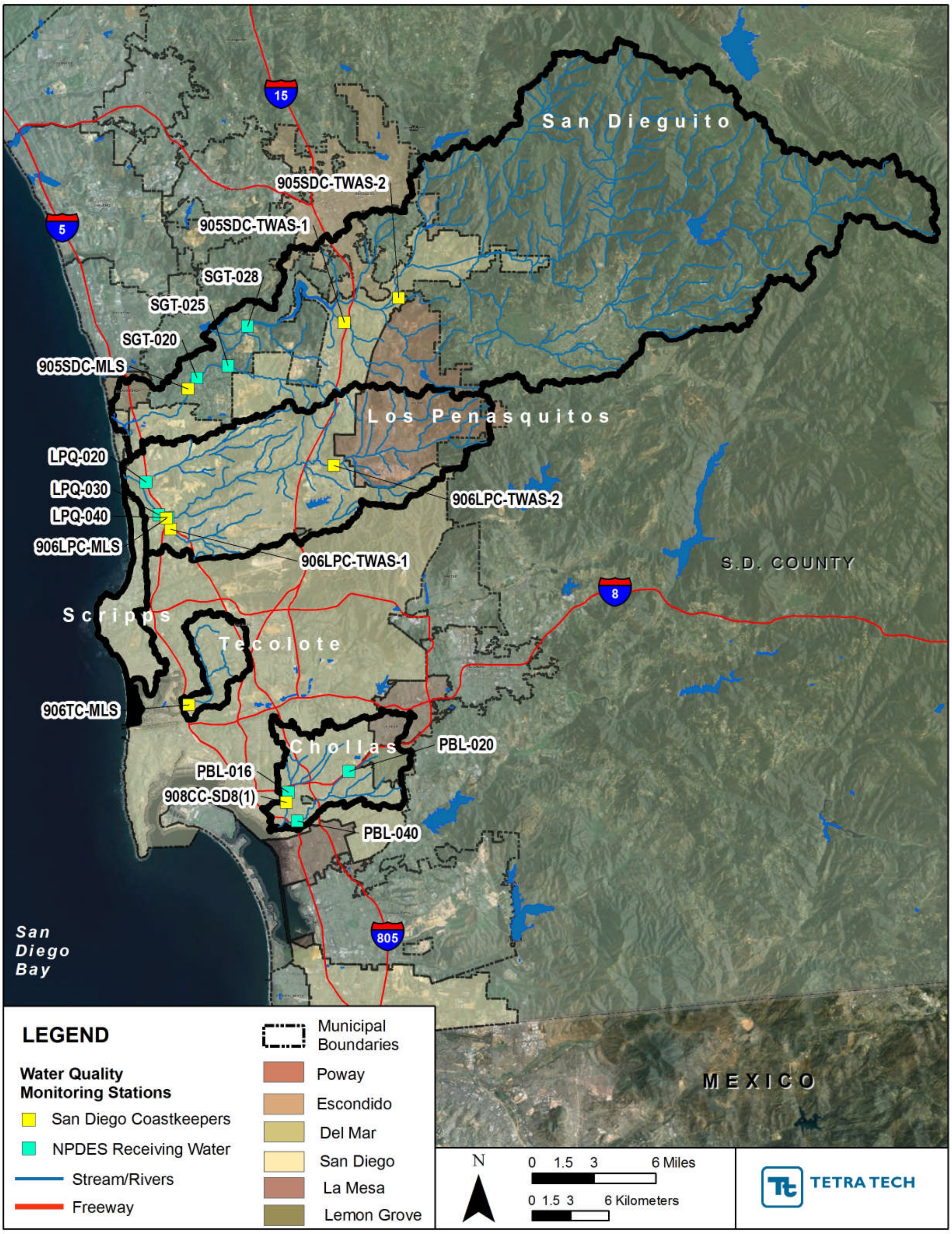



**Figure B-2. Receiving Waters - Water Quality Monitoring Stations**

## Model Configuration

This section of the appendix provides a description of LSPC model configuration used for the San Diego County CLRP watersheds. A long term simulation was developed spanning the period 1/1/1988 - 12/31/2010. Two years were used for model spin-up (allowing primarily for stabilization of soil moisture). Development and application of the models to address the project objectives involved the following important steps:

- Watershed segmentation (subbasins, reaches, and reservoirs)
- Development of meteorological data
- Land use and cover representation
- Point Sources

The goal of model configuration relative to the previous models was to incorporate the most recent, highest resolution data available, and to incorporate a regional approach that favors consistency among model configuration and subsequent parameterization during the calibration process.

### Watershed Segmentation

Watershed segmentation refers to the subdivision of the entire model area into smaller, discrete subwatersheds and reaches for modeling and analysis. This subdivision was primarily based on existing hydrologic boundaries and engineered storm drain networks, and secondarily on topography and the locations of flow and water quality monitoring stations. A combination of 3-meter and 10-meter resolution digital elevation models from the National Elevation Dataset (NED) were merged and then used to define the elevation throughout the watershed and assist with determining subbasin boundaries. Streams were defined primarily using National Hydrography Dataset (NHD) high resolution GIS data. Where available, local storm drain networks augmented or replaced NHD data. Each subwatershed was configured with a single associated stream reach, with reach connectivity from headwaters to outlets.

Based on some of the previous work and the intended use of the CLRP models, the target for average subbasin size was set at ~300 acres. This size tended to increase in the more rural, less developed areas. The subbasin sizing was deemed appropriate for characterizing existing pollutant loading and facilitating the analysis of management strategies in future phases of the CLRP project. The previous Chollas TMDL model subbasins and reaches were preserved with minor modification. The final delineations are shown in Figure B-3 through Figure B-7.

Model reaches were derived via the watershed delineation process. Many of the reaches were defined using storm drain network GIS data from the City of San Diego (obtained from http://www.sangis.org) where available. Additional GIS coverages from other municipalities (San Diego County, City of La Mesa, City of Solana Beach, City of Poway, and City of Escondido) augmented those data. Within the LSPC models, reaches were aggregated in cases where a reach length was less than 1,000 meters, to prevent the possibility of short travel times (relative to the one hour time step used in the modeling) leading to numeric instability.

Because of potential hydromodification impacts in the watersheds, the substrate of each reach was identified. The model reaches were defined as natural channel, concrete channel, or reinforced concrete pipe based on storm drain attributes from the GIS data, supplemented by visual investigation of model reaches as needed. Where storm drain networks were not available, natural reaches were assumed.

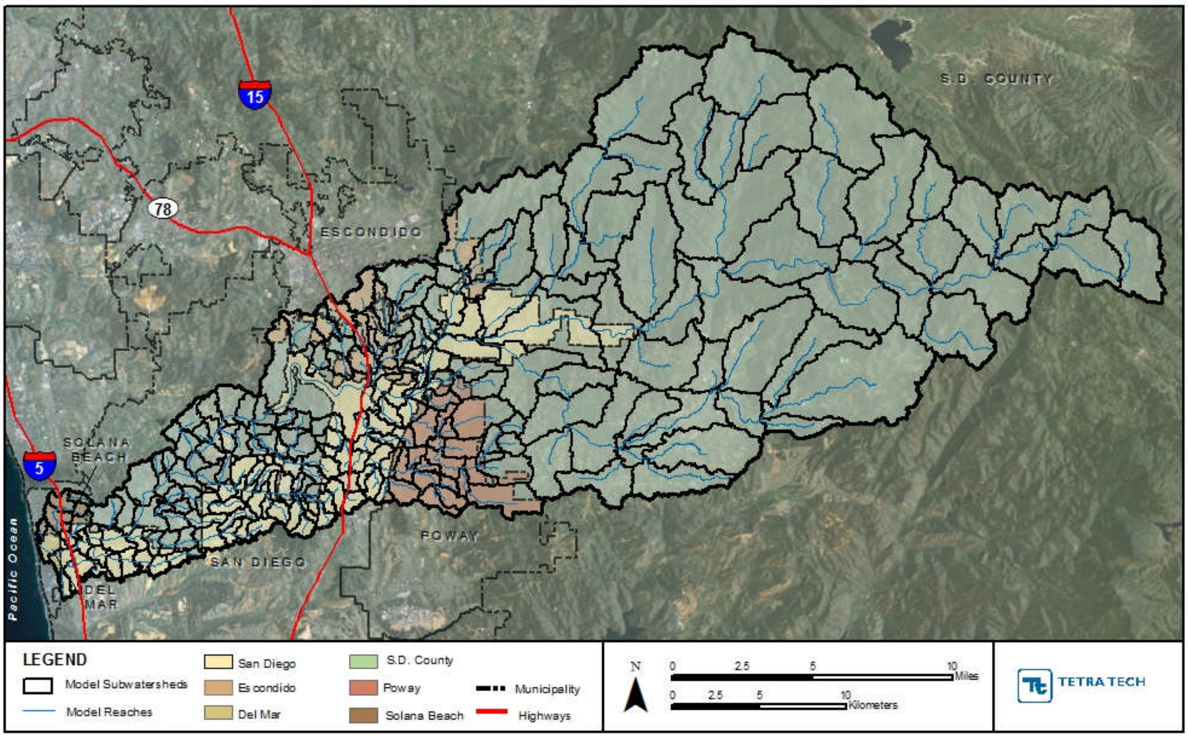



Figure B-3. San Dieguito LSPC Subbasins

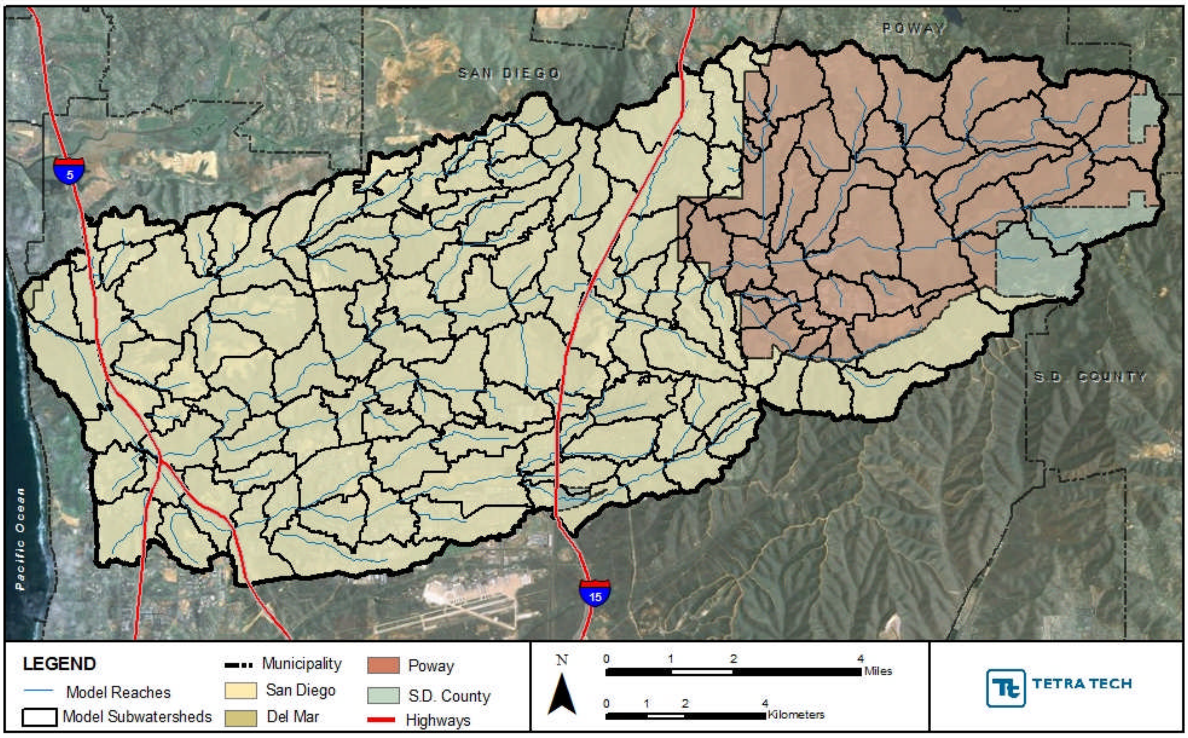



Figure B-4. Los Peñasquitos LSPC Subbasins

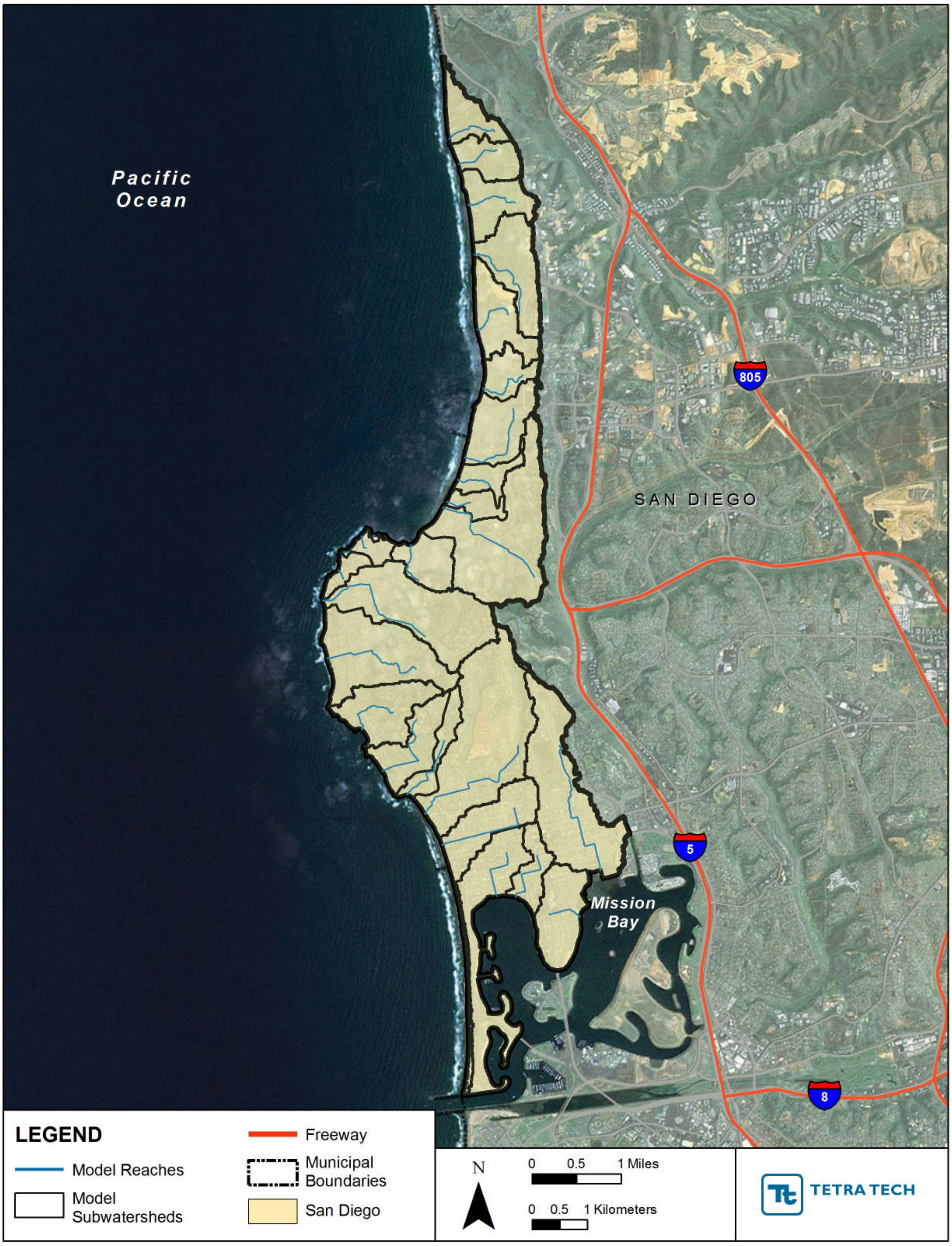



**Figure B-5. Scripps LSPC Subbasins**

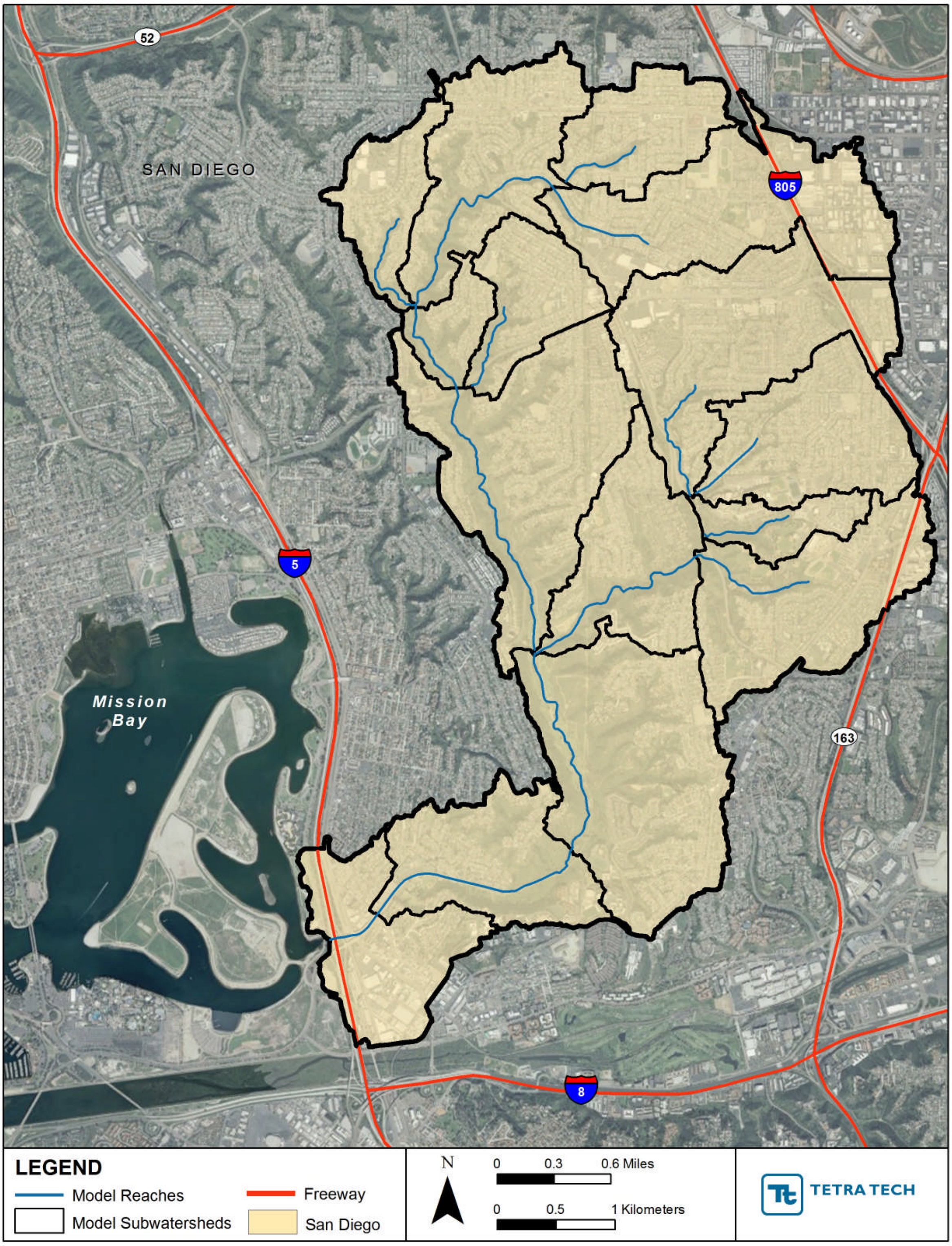



**Figure B-6. Tecolote LSPC Subbasins**

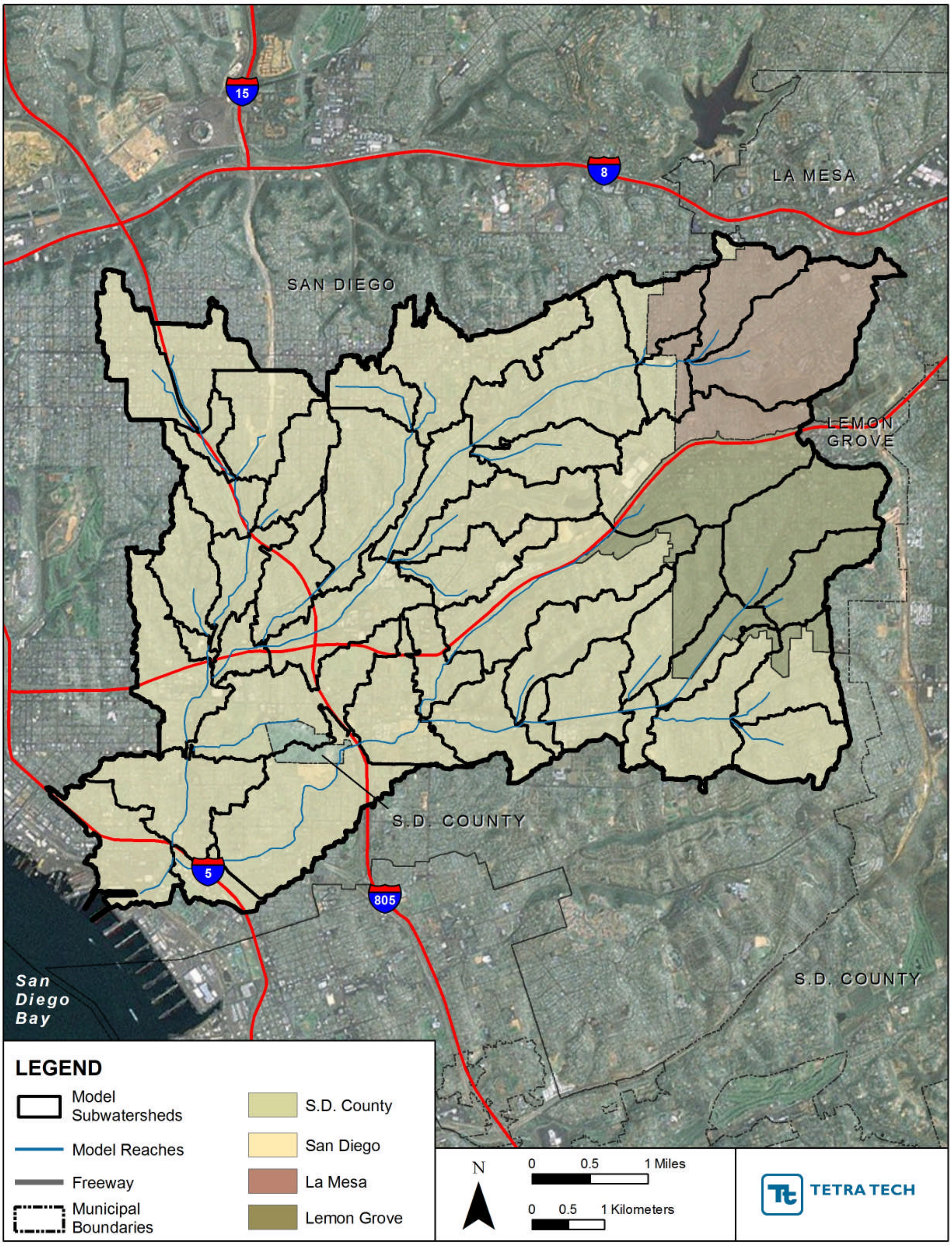



**Figure B-7. Chollas LSPC Subbasins**

Two significant reservoirs are included in the CLRP watersheds. Lake Hodges and Sutherland Reservoir are both explicitly represented in the San Dieguito model, using information supplied by the City of San Diego. Other reservoirs are found in the watersheds, but they have relatively small drainages compared to Lake Hodges and Sutherland Reservoir and therefore have much less influence on flow.

This included relationships between reservoir depth/volume and area, and spillway elevation. The information was synthesized into model Ftables, which characterize the relationship between volume, flow, stage, and surface area. Monthly information detailing the water balance of each reservoir was also supplied. Monthly water flows from leaks, the spillway, the outlet pipes, unaccounted losses, and imported flows were defined, The information was used to define flows from the reservoirs to the downstream reach (outlet pipes + spillway) and an overall loss/addition to the reservoirs (excluding rain on the surface and evaporation). The time series were incorporated in the model to balance the reservoir flows and provide an upstream boundary for the lower watershed. The average daily outflows for each reservoir are shown in Figure B-8 and Figure B-9.

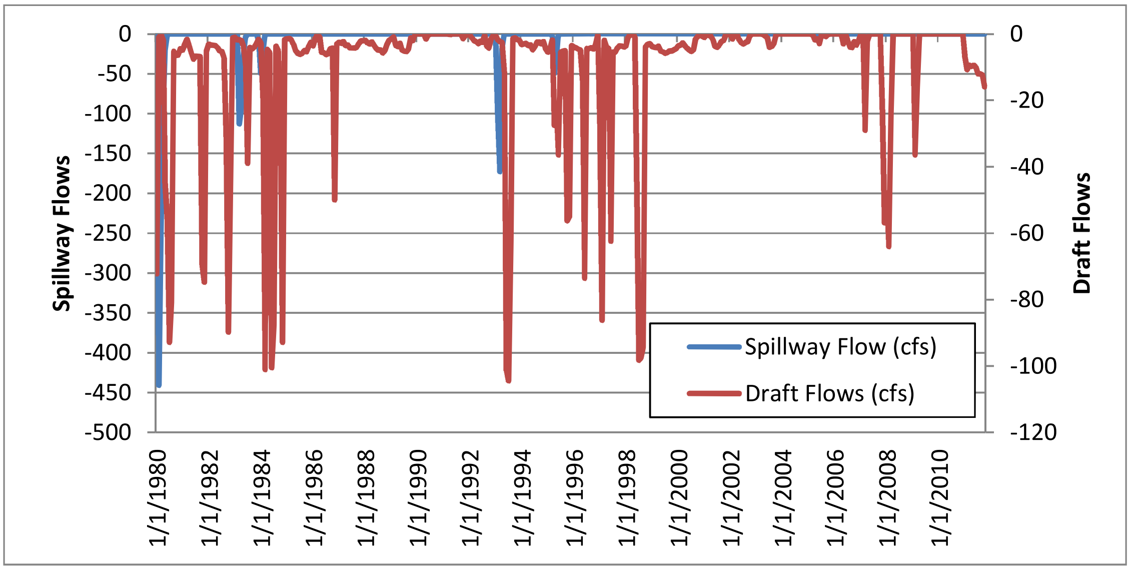



**Figure B-8. Sutherland Reservoir Outflows**

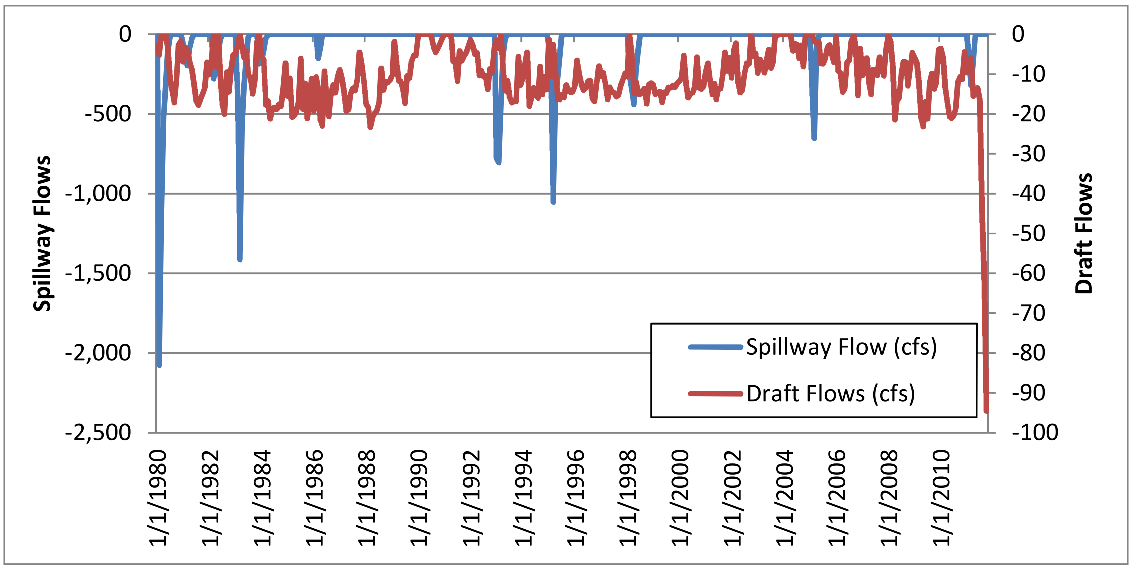



**Figure B-9. Lake Hodges Outflows**

## Meteorology

Meteorological data are a critical component of the watershed model. Models require appropriate representation of precipitation and potential evapotranspiration (PET). In general, hourly precipitation (or finer resolution) data are recommended for nonpoint source modeling and therefore are preferred, since daily flows tend to average out high peaks during storm events. Rainfall-runoff processes for each subwatershed were driven by precipitation data from the most representative station. Those data provide necessary input to LSPC algorithms for hydrologic and water quality representation.

Successful hydrologic modeling depends on an accurate representation of the overall water balance. The two largest terms in the water balance are typically precipitation input and actual evapotranspiration (ET) output. Precipitation is specified from direct observations, while PET is either derived as a function of observed pan evaporation, or computed as a function of other weather data such as wind speed, air temperature, dew point temperature, and solar radiation. Together, these constitute the external meteorological time series needed to drive the model. This section focuses on the precipitation and evaporation/ET data, which were rigorously evaluated and processed for modeling purposes.

The accuracy of a hydrologic model is dependent on the accuracy of the meteorological time series. In most cases, precipitation and evaporation data are the most hydrologically sensitive and spatially variable data sets used in watershed modeling; therefore, having a complete quality-controlled continuous set of the data benefits the modeling effort. A major and crucial early effort for model development is thus assembly and processing of meteorology. That presents several challenges. First, precipitation data has historically been available as point-in-space measurements, rather than integrated totals over subwatershed areas. Second, precipitation, temperature, and other meteorological series typically show strong spatial gradients in response to elevation (orographic effects) and aspect.

### *Precipitation*

Precipitation data from previous modeling efforts in the vicinity of the CLRP watersheds were screened for their utility in advancing the work of the current project. However, the periods of record were variable and of shorter duration than needed, and the level of effort for their development was localized to the immediate watersheds. Given the broader geographic area of the CLRP models, and an emphasis on using state-of-the-art approaches to filling missing data that incorporates both station proximity and elevation, precipitation data from previous models were not used directly.

Multiple sources of precipitation data were pursued and evaluated, including National Climatic Data Center (NCDC) hourly precipitation and surface airways stations, NCDC Summary of Day (SOD) precipitation stations, San Diego County ALERT hourly rainfall gages, and California Irrigation Management Information System (CIMIS) stations. Data were screened for two purposes:

- Best representation of daily total precipitation
- Best representation of hourly precipitation, used as a pattern to disaggregate daily totals into hourly values

Tetra Tech's experience has repeatedly demonstrated that precipitation collected on a daily basis from SOD stations provides a more accurate measure of total rainfall volume than accumulated volume from stations that monitor hourly. However, the spatial coverage was not adequate to capture rainfall variability, especially given the strong orographic influence along the coast. As a result, ALERT stations were used to address the gaps. CIMIS stations were initially included as well, but were removed after a quality review revealed large annual discrepancies in rainfall total compared to nearby locations. A few ALERT stations were excluded as well for similar reasons.

To address gaps, the accumulated, missing, and impaired data records were repaired based on rainfall patterns at other proximal stations with unimpaired data using the normal ratio method (Dunne and Leopold, 1978), which estimates a missing rainfall record with a weighted average from surrounding index stations (assigned based both on proximity and similar elevation). Once gaps in daily totals were patched for all the SOD and ALERT stations in the study area, annual and monthly rainfall totals were screened according to an increasing gradient of elevation. Thirteen stations were selected as providing the best spatial coverage, unimpaired period of record, and consistency across yearly totals - five SOD stations, and eight ALERT stations. ALERT hourly values were aggregated to daily totals due to quality issues in hourly rainfall reporting - there were numerous instances where a large rainfall value (in excess of one inch) was reported for a single hour, and no rainfall was reported during the remaining hours of the day. Daily SOD and ALERT totals were then disaggregated to hourly using Surface Airways (SA) and Hourly Precipitation Data sites.

Model subbasins were assigned to precipitation stations based on a combination of proximity, elevation, and annual average precipitation reported by San Diego County (Figure B-10). During hydrology calibration, precipitation assignment to subbasins in the upper half of the San Dieguito watershed was modified to use distance weighting factors from up to three precipitation stations. The station network was sparse in this area, and the adjustment improved hydrology performance.

### *Potential Evapotranspiration*

Evaporation in southern CA is typically limited by supply, rather than being capped by the potential. Observed pan evaporation data from the City of San Diego (from reservoir sites) could not be utilized for a variety of reasons - notably, the data begin in 2004, and the data contain numerous gaps during the periods of record. On the other hand, CIMIS reference crop evaporation (ETo) data are available for a handful of locations in or near the study area, with a nearly complete period of record for the 22 year simulation (Figure B-11). CIMIS stations provide an FAO-standard estimate of ETo using the Penman-Monteith energy balance method, which is equivalent to actual ET from a standardized alfalfa crop without water limitation. As a result, CIMIS ETo was used to develop model PET.

However, the CIMIS data are not without gaps, both spatially and temporally. Based on the location of usable data, the following approach was adopted. Two CIMIS stations (184 and 153) had minor gaps in their period of record. PET was extracted from the EPA BASINS meteorological data for two nearby NCDC Surface Airways stations. The BASINS daily PET (calculated using the Hamon method) was scaled to match the CIMIS ETo during periods of coincident data using fitted monthly adjustment factors. The monthly factors were in turn used to scale Hamon PET to fill the temporal gaps in the CIMIS data.

CIMIS 173 (at the coast) began reporting in 2000, and was deemed critical to retain to capture known differences in PET in the coastal fog zone. Using a similar procedure as performed for patching CIMIS in the previous step, the coincident data from 173 was fitted to 184 using monthly factors. The monthly factors were in turn used to back-calculate the missing 12 years for 173 using 184 as the template.

The previous steps provided three patched PET data sets; however, the study area spans five CIMIS ETo zones, as seen in Figure B-11. The stations provide coverage for Zones 1, 4, and 9. Published CIMIS ETo Zone monthly coefficients show measurable differences in seasonal ETo, especially for the high elevation Zone 16. To address the gaps, the difference in monthly ETo coefficients between zones was used to calculate daily values from station 153 (Zone 9) and apply to the lower elevation Zone 6 and the higher elevation Zone 16.

The five PET series were then assigned to each of the thirteen rain stations, using the CIMIS ETo zones as guidance, but allowing variation based on elevation. The CIMIS ETo zones were developed and interpolated at a larger statewide scale, and do not appear to account for local topography.

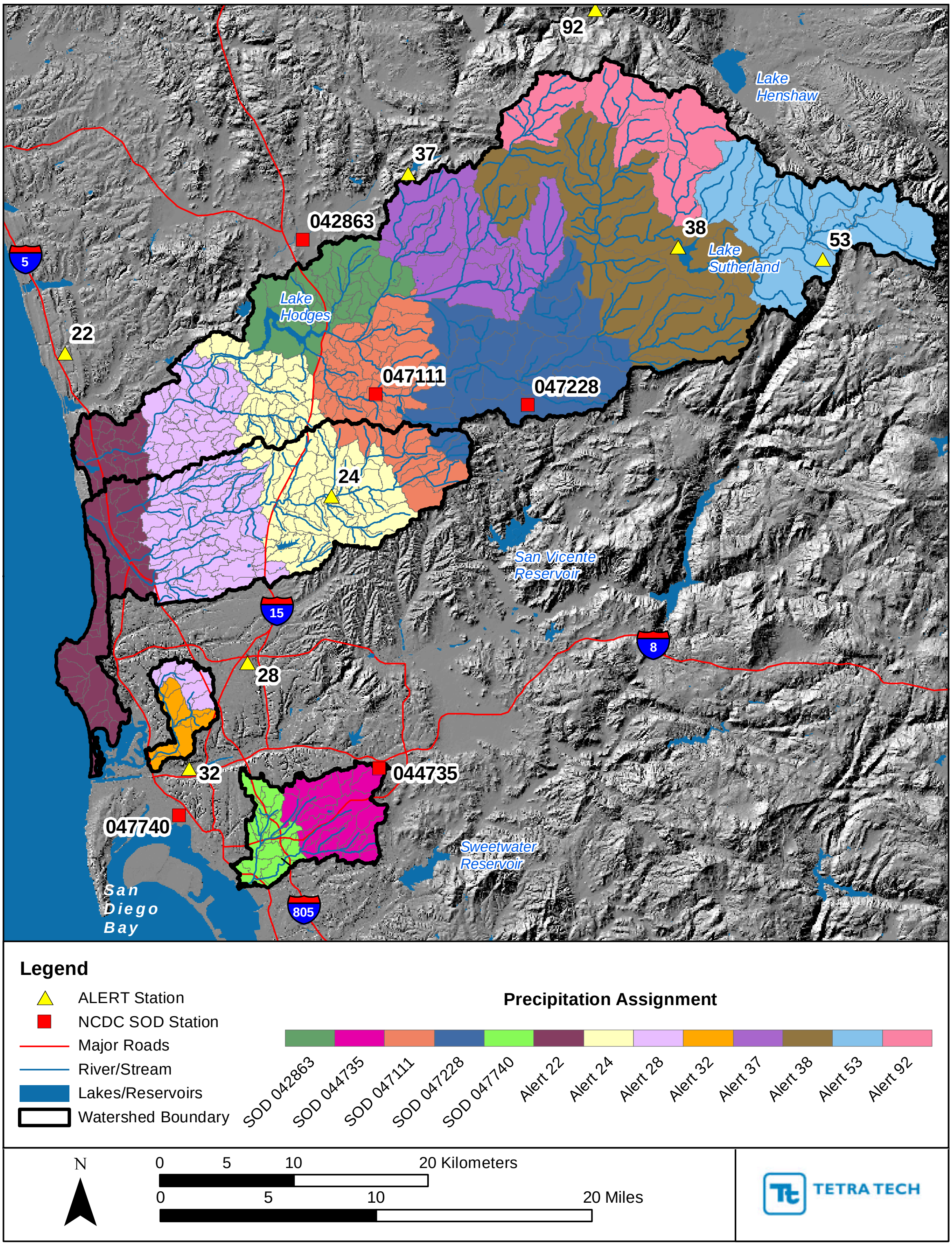



Figure B-10. Final Precipitation Stations Used in LSPC Models

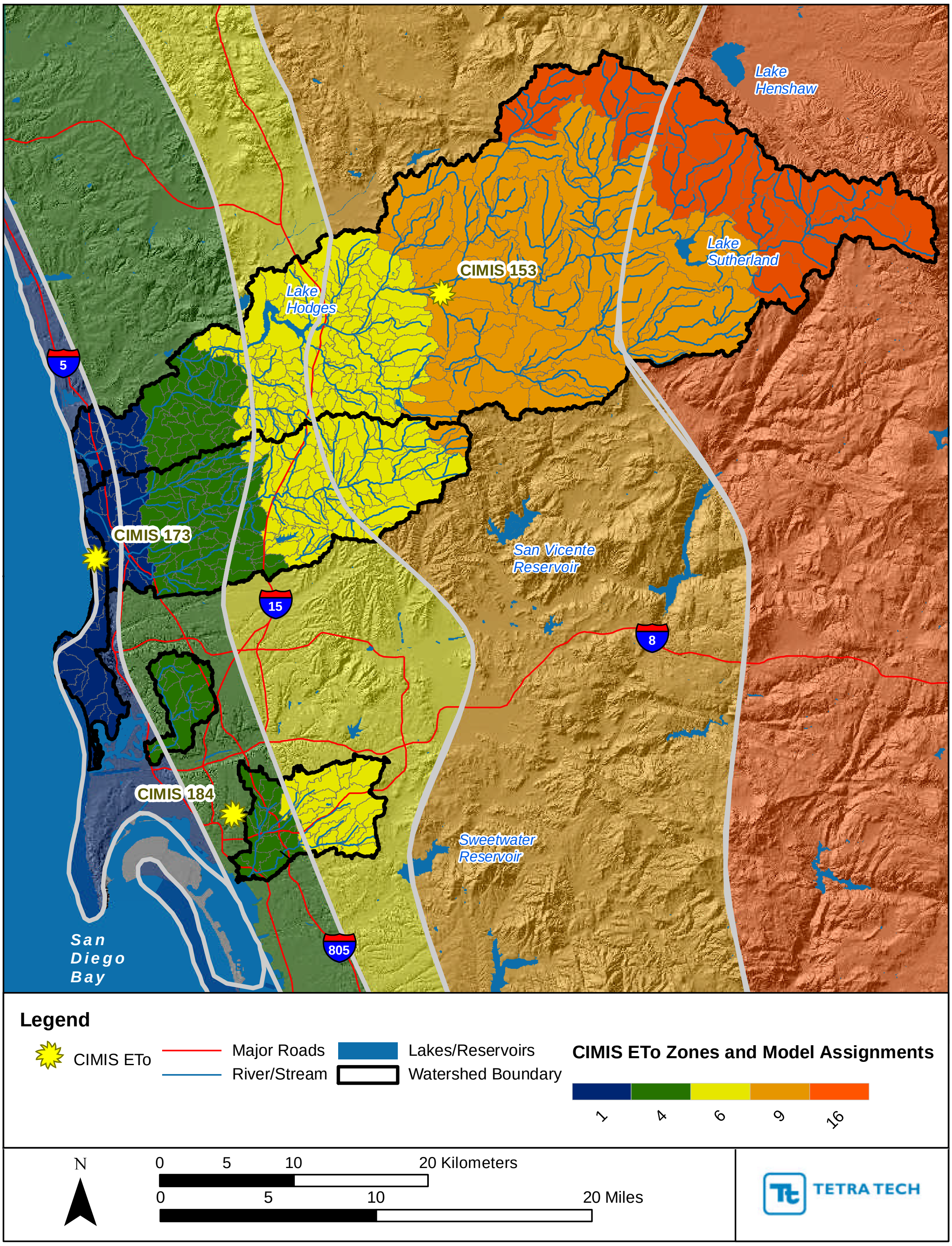



Figure B-11. PET Stations and Model PET Zone Assignment

## Land Use/Land Cover Representation (Hydrologic Response Units and Impervious Area)

In a watershed model, land unit representation should be sensitive to the features of the landscape that most affect hydrology and pollutant transport, including land use (including impervious assumptions), soils, and slope. In urban areas, it is important to estimate the division of land use into pervious and impervious components. In rural areas, vegetative cover is more important. Depending on the goals of the model, if soil hydrologic groups are not homogenous in a watershed, it might be important to further divide pervious land cover by soil hydrologic group so that infiltration processes are better represented. Slope might also be an important factor, especially if steep slopes are prevalent; high slopes influence runoff and moisture-storage processes. The combination of land use, soil hydrologic group, and slope were used to define the hydrologic response units (HRUs) for the San Diego County CLRP models. The HRU approach provides certain advantages and efficiencies for model parameterization because it compartmentalizes the way process variables are assigned and insulates that exercise from spatially variable influences like meteorology, which will naturally manifest itself differently for the same HRU located in different parts of the watershed. While there are many similarities in the way HRUs in the current effort compare to previous work in the region, the current configuration utilizes the most recent and highest resolution data sources available.

The main objectives for developing representative HRUs were:

- To support current objectives of representing hydrology and pollutant loading processes generated from land areas for source characterization;
- To support any potential future objectives of providing unit area hydrology and pollutographs in support of BMP optimization;
- To capture sufficient variability in hydrology and pollutant loading as related to land uses and land covers; and
- To balance the need for capturing landscape variability with a goal of reducing model complexity.

The following summarizes the HRU development approach. A detailed discussion of each step follows.

1. Land use in urban areas was represented with a polygon layer developed by a regional planning authority, with polygon boundaries largely determined using parcel data.
2. The planning land use categories were simplified into broader model land use categories, as well as disaggregation of Single Family Residential (SFR) planning categories into housing density groups.
3. Land cover in unmanaged land areas was represented with a grid data product based primarily on interpreted satellite imagery.
4. Unique percent impervious values were assigned to each urban area polygon, using best available data.
5. Each urban land use and unmanaged land cover (LULC) was classified by Hydrologic Soil Group (HSG).
6. Each LULC-HSG was further distinguished as a low or high slope class (SC).
7. The resulting over 100 potential HRU combinations of LULC-HSG-SC were simplified into a manageable number of model HRUs, using aggregation of classes with low contributing area or low importance to those with larger area and/or importance.
8. Irrigation assumptions were developed for urban land.

### 1. *Urban Land Use Coverage*

The San Diego Association of Governments (SANDAG) 2009 land use polygon coverage was obtained and intersected with the CLRP study area boundaries. Unique SANDAG classes and contributing land area within the CLRP watershed boundaries are shown in Table B-2.

**Table B-2. CLRP Land Uses**

| | CLRP Land Use | Notes |
|---|---|---|
| Residential | Unmanaged Land | Lot size > 10 ac |
| | Rural Residential | Lot size 2.0 - 10.0 acres (ac) |
| | LDR (Low Density Residential) | Lot size 0.5 - 2.0 ac |
| | MDR (Medium Density Residential) | Lot size 0.17 - 0.5 ac |
| | HDR (High Density Residential) | Lot size 0.07 - 0.17 ac |
| | Multifamily Residential | Includes SFR lot size <0.07 ac |
| | Office/Institutional | Lower vehicle/foot traffic |
| | Commercial | Higher vehicle/foot traffic |
| | Industrial | Manufacturing, warehouses, storage |
| | Transportation | streets, roads, and right-of-way |
| | Freeway | Limited-access highway corridors |
| | Barren | Construction sites and quarries/mines |
| | Park Land (irrigated) | Developed, higher intensity parks |
| | Open Water | Lakes, ponds |
| | Unmanaged Land | Undeveloped, low intensity park/recreation, agriculture |

### 2. *Assignment of SANDAG Classes to Model Land Uses*

CLRP urban model land uses (Table B-2) were selected to achieve a balance between those found most useful in a recent, previous effort outside of the watersheds (i.e. LA County), and previous San Diego region LSPC urban land use parameter aggregations. A critical goal was to capture types of use that are known to generate differential pollutant loads. For instance, Commercial use is distinguished from Office/Institutional use by intensity of vehicle and foot traffic; a higher intensity of use tends to result in more residues on impervious surfaces. Table B-3 provides the crosswalk between SANDAG categories and land uses in Table B-2. The Unmanaged Land category includes all land uses that have very low levels of developed use (open space and low intensity parkland, residential uses with parcel area in excess of 10 acres) or no developed use (undeveloped polygons and agricultural land). SANDAG classification of agricultural use was poor in comparison to high resolution aerial photos, and appeared to overestimate agricultural land. SANDAG documentation notes that the agricultural classification is a source of error, and is based on data from twenty years ago. It is important to note that the land use aggregation was performed in a manner to optimize land use groupings with similar hydrology and pollutant loading characteristics. An alternate land use grouping was utilized for CLRP planning work related to selection of appropriate treatment BMPs; it was guided by different goals.

SANDAG polygon boundaries typically follow parcel boundaries; however, areas with identical class assignment were aggregated into single polygons - notably the Residential uses with IDs 1000 - 1190. On the other hand, many larger parcels were split into multiple SANDAG use polygons. To allow for classification of SFR categories into housing density classes, a union coverage of current parcel boundaries (November 2011) and 2009 SANDAG land use was created. Polygon area was calculated to perform the CLRP residential land use assignment. Parcel boundary disagreements between the two datasets were present, though not common, which were rectified to the extent possible using automated geoprocessing techniques.

### Table B-3. SANDAG Land Uses and CLRP Land Use Class Assignment

| SANDAG code | SANDAG Land Use | Area in CLRP Watersheds (ac) | CLRP Land Use Class |
|---|---|---|---|
| 1000 | Spaced Rural Residential | 26,719 | SFR [1,3] |
| 1110 | Single Family Detached | 35,926 | SFR [1] |
| 1120 | Single Family Multiple-Units | 3,204 | SFR [1] |
| 1190 | Single Family Residential Without Units | 164 | SFR [1] |
| 1200 | Multi-Family Residential | 3,958 | Multifamily |
| 1290 | Multi-Family Residential Without Units | 14 | Multifamily |
| 1300 | Mobile Home Park | 404 | Multifamily |
| 1402 | Dormitory | 44 | Multifamily |
| 1403 | Military Barracks | 27 | Multifamily |
| 1409 | Other Group Quarters Facility | 157 | Multifamily |
| 1501 | Hotel/Motel (Low-Rise) | 130 | Commercial |
| 1502 | Hotel/Motel (High-Rise) | 9 | Commercial |
| 1503 | Resort | 159 | Commercial |
| 2001 | Heavy Industry | 19 | Industrial |
| 2101 | Industrial Park | 3,018 | Industrial |
| 2103 | Light Industry - General | 1,357 | Industrial |
| 2104 | Warehousing | 216 | Industrial |
| 2105 | Public Storage | 129 | Industrial |
| 2201 | Extractive Industry | 640 | Barren |
| 2301 | Junkyard/Dump/Landfill | 116 | Industrial |
| 4103 | General Aviation Airport | 254 | Commercial |
| 4111 | Rail Station/Transit Center | 13 | Transportation |

| SANDAG code | SANDAG Land Use | Area in CLRP Watersheds (ac) | CLRP Land Use Class |
|---|---|---|---|
| 4112 | Freeway | 3,242 | Freeway |
| 4113 | Communications and Utilities | 855 | Office/Institutional |
| 4114 | Parking Lot - Surface | 166 | Transportation |
| 4115 | Parking Lot - Structure | 23 | Transportation |
| 4116 | Park and Ride Lot | 16 | Transportation |
| 4117 | Railroad Right of Way | 256 | Transportation |
| 4118 | Road Right of Way | 17,839 | Transportation |
| 4119 | Other Transportation | 65 | Transportation |
| 5001 | Wholesale Trade | 16 | Commercial |
| 5002 | Regional Shopping Center | 136 | Commercial |
| 5003 | Community Shopping Center | 765 | Commercial |
| 5004 | Neighborhood Shopping Center | 727 | Commercial |
| 5005 | Specialty Commercial | 4 | Commercial |
| 5006 | Automobile Dealership | 74 | Commercial |
| 5007 | Arterial Commercial | 617 | Commercial |
| 5008 | Service Station | 86 | Commercial |
| 5009 | Other Retail Trade and Strip | 228 | Commercial |
| 6001 | Office (High-Rise) | 22 | Office/Institutional |
| 6002 | Office (Low-Rise) | 1,162 | Office/Institutional |
| 6003 | Government Office/Civic Center | 34 | Office/Institutional |
| 6101 | Cemetery | 437 | Park Land (irrigated) |
| 6102 | Religious Facility | 743 | Office/Institutional |
| 6103 | Library | 24 | Office/Institutional |
| 6104 | Post Office | 75 | Office/Institutional |
| 6105 | Fire/Police Station | 92 | Office/Institutional |
| 6109 | Other Public Services | 94 | Office/Institutional |

| SANDAG code | SANDAG Land Use | Area in CLRP Watersheds (ac) | CLRP Land Use Class |
|---|---|---|---|
| 6501 | UCSD/VA Hospital/Balboa Hospital | 5 | Office/Institutional |
| 6502 | Hospital - General | 110 | Office/Institutional |
| 6509 | Other Health Care | 104 | Office/Institutional |
| 6701 | Military Use | 67 | Office/Institutional |
| 6702 | Military Training | 5 | Office/Institutional |
| 6801 | SDSU/CSU San Marcos/UCSD | 419 | Office/Institutional |
| 6802 | Other University or College | 192 | Office/Institutional |
| 6803 | Junior College | 180 | Office/Institutional |
| 6804 | Senior High School | 862 | Office/Institutional |
| 6805 | Junior High School or Middle School | 486 | Office/Institutional |
| 6806 | Elementary School | 1,245 | Office/Institutional |
| 6807 | School District Office | 48 | Office/Institutional |
| 6809 | Other School | 142 | Office/Institutional |
| 7201 | Tourist Attraction | 646 | Park Land (irrigated) |
| 7203 | Racetrack | 88 | Commercial |
| 7204 | Golf Course | 3,758 | Park Land (irrigated) |
| 7205 | Golf Course Clubhouse | 143 | Commercial |
| 7207 | Marina | 6 | Commercial |
| 7210 | Other Recreation - High | 559 | Park Land (irrigated) |
| 7211 | Other Recreation - Low | 360 | Unmanaged Land [3] |
| 7601 | Park - Active | 1,679 | Park Land (irrigated) |
| 7603 | Open Space Park or Preserve | 68,833 | Unmanaged Land [3] |
| 7604 | Beach - Active | 155 | Unmanaged Land [3] |
| 7605 | Beach - Passive | 6 | Unmanaged Land [3] |
| 7606 | Landscape Open Space | 1,272 | Res Other [2] |
| 7607 | Residential Recreation | 184 | Park Land (irrigated) |

| SANDAG code | SANDAG Land Use | Area in CLRP Watersheds (ac) | CLRP Land Use Class |
|---|---|---|---|
| 8001 | Orchard or Vineyard | 5,686 | Unmanaged Land [3] |
| 8002 | Intensive Agriculture | 3,448 | Unmanaged Land [3] |
| 8003 | Field Crops | 21,922 | Unmanaged Land [3] |
| 9101 | Vacant and Undeveloped Land | 94,421 | Unmanaged Land [3] |
| 9200 | Water | 1 | Park Land (irrigated) |
| 9201 | Bay or Lagoon | 114 | Open Water |
| 9202 | Lake/Reservoir/Large Pond | 1,749 | Open Water |
| 9501 | Residential Under Construction | 393 | Barren |
| 9502 | Commercial Under Construction | 23 | Barren |
| 9503 | Industrial Under Construction | 41 | Barren |
| 9505 | School Under Construction | 71 | Barren |
| 9506 | Road Under Construction | 20 | Barren |

Note #1: All SFR categories were disaggregated to five residential densities, based on parcel area.

Note #2: In aerial photos, nearly all of these areas are fringes or easement areas in SFR developments. Many overlap impervious surfaces. These were disaggregated to residential pervious and impervious areas later in the HRU development process.

Note #3: Unmanaged Land was removed, and reclassified into Agriculture, Forest/Shrub, and Grassland using LANDFIRE EVT. SFR in excess of 10 acres was also classified as Unmanaged Land and reclassified with LANDFIRE.

### 3. Land Cover for Unmanaged Land Areas

Available land cover data were reviewed for providing the best representation of undeveloped land cover and vegetation type in areas assigned to the Unmanaged Land category. US Forest Service and Department of Interior (USFS/DOI) LANDFIRE, also known as the Landscape Fire and Resource Management Planning Tools Project, provides a high level of detail about vegetation for wildfire management, and consists of a series of raster-based data products including vegetation type, vegetation cover (percent canopy), vegetation height, and others. The Existing Vegetation Type (EVT) dataset provides details about plant communities, and some spatial information indicating areas of development and agricultural use, and was determined to be the best resource for characterizing land cover during a comparison to high resolution aerial photography. This finding is consistent with previous Tetra Tech experience in southern California. Agricultural land shown in LANDFIRE EVT was more consistent with aerial photography than SANDAG; error was fairly high at a close spatial scale (i.e., hundreds of feet), but the relative proportions at a subwatershed scale matched reasonably well.

Three categories were selected to represent undeveloped land cover, which were sufficient to capture variation in vegetation and land use germane to hydrology and pollutant loading processes - Forest, Grassland/Shrubland (or chaparral), and Agriculture. Given the relatively small area of agricultural land use within the watersheds as a whole, multiple agricultural categories (e.g., orchards, vegetable production) were not needed.

### 4. Impervious Area

The National Land Cover Dataset (NLCD) is developed under a national program overseen by the Multi-Resolution Land Characteristics Consortium, a group of federal agencies that cooperate to create a consistent land cover GIS grid-based product for the entire United States. The 2006 data is based on interpretation of multi-seasonal Landsat satellite images into 30-meter grid cells, and includes a grid with assignment of percent impervious cover. Spatial analysis and post-processing calculations were performed to assign unique percent impervious values to each SANDAG polygon (excluding polygons assigned to Unmanaged Land Area and Open Water).

### 5. HSG

EPA recommends classifying HSPF pervious land uses by hydrologic soil group or HSG (USEPA, 2000). Soil hydrologic group defines a soil's ability to infiltrate rainfall in four categories (A, B, C, D), ranging from A soils that support high infiltration rates to D soils that support low infiltration rates. County-level soil GIS data files were obtained (SSURGO) to develop an HSG GIS coverage. The HSG coverage was spatially intersected with the land use/land cover coverage to allow for specification of HSG.

### 6. Slope Class

Slope is also an important factor for HRU development, especially if steep slopes are prevalent; high slopes influence runoff and moisture storage processes. Percent slope was calculated from the 10-meter DEM from NED, and the slope values were classified as Low (< 10 percent), and High (> 10 percent). Slope classes were dichotomized at 10 percent because past experience has shown that this threshold value strongly influences land use patterns (i.e. most urban development occurs on land with slopes less than 10 percent). The Low/High slope grid was converted to a polygon coverage, and spatially intersected with the land use/land cover coverage to allow for specification of slope class.

### 7. Final HRU Selection

To reduce model complexity, the pool of potential discrete HRU types was simplified using the following observations of tabular HRU area, balanced by project goals:

- Developed polygon areas were split into impervious and developed pervious model HRUs, based on the assigned percent impervious value.
- In urbanized area, runoff response and pollutant loading is driven primarily by impervious surfaces; the urban land use designation was therefore retained and carried forward into the impervious HRU assignment.
- On the other hand, HSG and slope were considered more important for characterizing hydrology and pollutant loading for developed pervious land; therefore, HSG and slope class were retained.
- HSG A soils comprise less than 2.5 percent of the combined area of the five CLRP watersheds; to reduce model complexity, HSG A soils were lumped with HSG B soils.
- The majority of Forest and Grassland/Shrubland land covers were classified as having high slopes (87 percent and 76 percent, respectively); however, HSG classes were more evenly distributed. Low slope land was lumped with High slope land for both land covers.
- Agriculture and Barren land were evenly distributed by slope, but tended to be dominated by a single HSG. As a result, Low and High slopes only were used for both land covers.
- Both slope class and HSG were retained for developed pervious land, resulting in six separate classes.

### 8. *Irrigation Assumptions*

LSPC provides a module for simulating the impacts of irrigation, beginning with a dynamic estimation of irrigation volume based on PET and recent rainfall depth, followed by application of irrigation to the vegetation, ground surface, or within the soil. Select model HRUs can be selected by the user for receiving irrigation, with appropriate application factors for the HRU. Irrigation input is lumped with precipitation, so the influence of irrigation on hydrology (i.e., wetter soils that promote more runoff during storm events, irrigation return flow via groundwater, etc.) and pollutant loading is carried through the entire model. However, not all developed land is irrigated, and degree of irrigation can vary spatially depending on many factors. A review was performed to characterize expected urban irrigation rates by urban land use, individually within each of the five CLRP watersheds. The review took into account open space requirements, zoning, lot size, landscaping requirements, review of aerial photos, and socioeconomic factors. Based on the results of the review, developed pervious land was split into irrigated and non-irrigated fractions according to the percentages shown in Table B-4. Final model HRUs are shown in Table B-5.

**Table B-4. Fraction of Developed Pervious HRU Area Subject to Irrigation**

| Land Use | Chollas | Los Peñasquitos | San Dieguito | Scripps | Tecolote |
|---|---|---|---|---|---|
| Rural Residential | 10% | 10% | 8% | 13% | 12% |
| LDR | 10% | 14% | 19% | 22% | 11% |
| MDR | 21% | 31% | 32% | 25% | 27% |
| HDR | 30% | 35% | 28% | 40% | 30% |
| Multifamily | 60% | 45% | 35% | 70% | 50% |
| Commercial | 70% | 50% | 11% | 60% | 60% |
| Industrial | 50% | 45% | 40% | 40% | 50% |
| Office/Institutional | 65% | 50% | 23% | 50% | 60% |
| Park Land (irrigated) | 50% | 50% | 45% | 50% | 50% |
| Transportation | 30% | 30% | 15% | 40% | 30% |

**Table B-5. Model HRUs**

| Land Use/Land Cover | HSG | Slope Class |
|---|---|---|
| Open Water | N/A | |
| Agriculture | | Low |
| | | High |
| Barren | | Low |
| | | High |
| Forest | B | |
| | C | |
| | D | |
| Grassland/Shrubland | B | |

| Land Use/Land Cover | HSG | Slope Class |
|---|---|---|
| | C | |
| | D | |
| Developed Pervious, No Irrigation | B | Low |
| | C | Low |
| | D | Low |
| | B | High |
| | C | High |
| | D | High |
| Developed Pervious, With Irrigation | B | Low |
| | C | Low |
| | D | Low |
| | B | High |
| | C | High |
| | D | High |
| Low Intensity Residential | Impervious | |
| High Intensity Residential | | |
| Office/Institutional | | |
| Commercial | | |
| Industrial | | |
| Transportation | | |
| Freeway | | |

## Point Sources

As authorized by the Clean Water Act (CWA), the National Pollutant Discharge Elimination System (NPDES) Permit Program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches.

Tetra Tech obtained a listing of facilities regulated by the San Diego Regional Water Quality Control Board under a NPDES permit for non-stormwater point source discharge to surface water (Bob Morris, San Diego Regional Water Quality Control Board, personal communication with Catherine Carter, Tetra Tech, November 17, 2011). All major dischargers on this list were found to discharge directly to the Pacific Ocean and no major perennial dischargers to modeled streams were found within the CLRP study area.

Additionally, Tetra Tech performed a query for all point source dischargers regulated by NPDES in San Diego County, California using EPA's Enforcement & Compliance History Online (ECHO; http://www.epa-echo.gov/echo/index.html). Clean Water Act data shown in ECHO come from the Permit Compliance System (PCS) or from the modernized system, Integrated Compliance Information System - National Pollutant Discharge Elimination System (ICIS-NPDES). Results from the query returned 38 permitted dischargers for San Diego County, none of which were identified as major active dischargers discharging to waters within the CLRP study area.

Point sources also include storm water that is regulated through the NPDES program. Municipal storm water, regulated by the MS4 permit, considers loading associated with various sources and activities. Storm water outfalls are point sources of storm water runoff into receiving waterbodies and are regulated by the MS4 permit. The location and density of these outfalls can serve as a general indicator of the significance of storm water-based sources in the drainage area. Many outfalls are located throughout the entire CLRP study area.

## Calibration Approach

As noted previously, an important goal of model configuration was to incorporate a regional approach that favors consistency among model configuration and subsequent parameterization during the calibration process. However, the upper half of San Dieguito is in a different climatological, geological, and land use context from the rest of the CLRP watersheds. Precipitation is much greater due to orographic effects from the sharp elevation increase, and PET is much higher as well. The terrain has greater relief, and little significant development is present. As a result, hydrology and water quality parameters were allowed to vary in the upper portion of San Dieguito relative to the other watershed areas.

### Hydrology

As discussed in the *Data Summary* section, the flow monitoring station on Los Peñasquitos Creek represents the only recent continuous flow monitoring for an extended period of time downstream of an urbanized area. As a result, emphasis was placed on achieving a high quality hydrology calibration at this location, allowing for the parameterization of hydrology in the urban areas of the remaining watersheds. The primary basis for initializing model hydrology parameterization was derived from the recent Los Peñasquitos watershed modeling to support sediment TMDL development (City of San Diego, 2010).

Hydrology calibration used a regional approach. For the CLRP modeling, hydrology was calibrated and validated for Los Peñasquitos using flow monitoring data from 1990 to 2010. Los Peñasquitos calibrated hydrology parameters were then applied to Chollas, Scripps, Tecolote, and the bottom half of San Dieguito. Additional validation was provided by a visual assessment of performance for the short term flow monitoring in Chollas.

For the upper half of San Dieguito, hydrology was calibrated to aggregate performance at the three USGS gages on Guejito Creek, Santa Ysabel Creek, Santa Maria Creek.

Calibration and validation periods for the USGS long term stations are shown in Table B-6.

#### Table B-6. Model Calibration and Validation Periods

| Location | USGS Gage No. | Calibration | Validation |
|---|---|---|---|
| Los Peñasquitos | 11023340 | 2000-2010 | 1990-1999 |
| Guejito Creek | 11027000 | 2005-2010 | |
| Santa Ysabel Creek | 11025500 | 2000-2010 | 1990-1999 |
| Santa Maria Creek | 11028500 | 2000-2010 | 1990-1999 |

Hydrologic calibration followed the standard operating procedures for the model described in Donigian et al. (1984) and Lumb et al. (1994). Daily, monthly, seasonal, and total modeled flows were compared to observed data, and error statistics were calculated for the percent difference. The percent errors were then compared to recommended tolerance targets from Donigian et al. (1984) and Lumb et al. (1994). Targets are show in Table B-7 and represent long term averages for relative error. In general, meeting these targets indicates that a model calibration can be rated as "very good". In contrast, failure to achieve these targets does not indicate that the model is unusable, but rather indicates a need to consider the impacts of model uncertainty on decisions. Values for hydrologic parameters were set in accordance with the ranges recommended in USEPA (2000) and adjusted during calibration.

Model results were also visually compared to observed data using time series plots, and additional graphical and tabular monthly comparisons were performed. Less credence was placed in the seasonal summer and storm event summer statistics since runoff volumes are low (or non-existent) during the dry seasons, and storms are rare.

### Table B-7. Criteria for the Hydrology Calibration

| Category | Recommended Criteria (%) |
|---|---|
| Error in total volume: | ±10 |
| Error in 50% lowest flows: | ±10 |
| Error in 10% highest flows: | ±15 |
| Seasonal volume error - Summer: | ±30 |
| Seasonal volume error - Fall: | ±30 |
| Seasonal volume error - Winter: | ±30 |
| Seasonal volume error - Spring: | ±30 |
| Error in storm volumes: | ±20 |
| Error in summer storm volumes: | ±50 |

Modified from Lumb et al., 1994 and Donigian et al., 1984

## Water Quality

A regionalized approach was implemented for water quality calibration as well. The models simulate pollutant generation and accumulation on surfaces, and resulting pollutant runoff and delivery to receiving waterbodies. Delivery of pollutants through subsurface pathways (i.e., interflow and groundwater) is also represented. Water quality parameters were determined to adequately represent the loading generation capabilities for the different modeled HRUs for a wide range of storm intensities and base flows. Initial water quality parameterization was taken from the previous models developed in the region and refined where appropriate to optimize the fit of simulated to observed concentration and load. The previous models and water quality constituents modeled by each are shown in Table B-8.

### Table B-8. Previous LSPC Models Developed for CLRP Watersheds

| Models | Bacteria | Trace Metals | Sediment | Nutrients |
|---|---|---|---|---|
| Chollas | • | • | • | |
| Los Peñasquitos | | | • | |
| Bacteria Project I & II | • | | | • |
| San Diego Region Lagoons | • | | • | • |

After reviewing the available data sets following the screening discussed in the *Data Summary* section, four locations were identified as having a sufficient number of observations to characterize water quality across a range of seasons and flow conditions (Table B-9). These stations received the most focus during the course of the calibration. The remaining identified stations had fewer than ten observations, with the majority of those having five or fewer observations.

### Table B-9. Water Quality Calibration Stations with Observation Counts

| Station | Watershed | Years | Bacteria | Metals | TSS | Nutrients |
|---|---|---|---|---|---|---|
| 905SDC-MLS | San Dieguito | 2001 – 2008 | 69 | (n/a) | 23 | 44 |
| 906LPC-MLS | Los Peñasquitos | 2001 – 2008 | 72 | (n/a) | 24 | 46 |
| 906TC-MLS | Tecolote | 2001 – 2008 | 57 | 19 | 19 | 38 |
| 908CC-SD8 | Chollas | 2001 – 2008 | 69 | 26 | 23 | 44 |

Given the limited monitoring data, an approach for assessing model performance was adopted that addressed the strengths of the available monitoring data using a combination of visual plots highlighting concentration and load comparisons, as well as a quantitative measure of simulated versus estimated observed long-term loading:

- The **ratio of simulated loads to estimated observed load** is presented for each watershed. Estimated observed load was calculated by interpolation from the flow-pollutant relationship in the limited available monitoring data. This comparison on a load basis is essentially equivalent to using flow-weighting to evaluate the fit of the simulated and observed concentrations.
- **A time series of simulated and observed concentrations**. The time series plots are useful for making a general comparison of order-of-magnitude between observed and simulated values.
- **Simulated versus observed load scatterplots**. The load scatter plot provides away to observe the load response across a range of load values.
- **Simulated and observed load duration plots**. The load-duration curve provides a way to determine whether monitoring data are unbiased with respect to flow, or are concentrated in wet or dry periods.

Due to the limited number of observations and available locations, monitoring data were used for model calibration only, with no separate validation period. The specific approach taken for each CLRP water quality parameter is discussed below.

#### *Sediment*

Parameters developed for the Los Peñasquitos Lagoon sediment TMDL (City of San Diego, 2010) for upland sediment generation were used as the starting point for parameterizing upland sediment in the CLRP models. Any additional load needed to achieve balance in the calibration was then attributed to bank erosion (using the LSPC option of simulating bank erosion as a function of flow.)

Comprehensive and continuous flow gaging is not available for the water quality monitoring stations. Therefore, the flow-weighting for load comparisons is based on the simulated flow.

The upland sediment parameters were retained with only minor modifications. As necessary, the bank erosion component was turned on for natural, unhardened channels to approximate observed data (also implicitly accounting for gully loads). LSPC allows specification of a critical flow to initiate bank erosion, but this would require accurate reach-specific information. Therefore, the option of allowing LSPC to initiate bank erosion at internally estimated bankfull flows was used. The major calibration parameter was KBER, which is the bank erosion coefficient in LSPC. Other channel scour and deposition processes for cohesive sediments (i.e., silt and clay) were turned off as these are highly dependent on the geometry of individual channel segments, which were not specified in the model. An exception was made for the two impoundments in San Dieguito, for which all sand was assumed to be trapped, and silt and clay were allowed to settle.

For Los Peñasquitos an adequate fit was obtained without additional bank erosion. (Given lack of data, this was also assumed for the Scripps watershed.) Bank erosion factors were required for the remaining watersheds; the following KBER values were used: Tecolote – 6; San Dieguito – 0.4; Chollas – 2.5.

#### *Trace Metals*

Total copper, total lead, and total zinc were modeled in support of the TMDLs developed for Chollas (City of San Diego, 2012). All four metals were modeled as sediment-associated, with separate potency factors for each HRU. Initial values were used from the Chollas TMDL model. Interflow and groundwater concentrations were specified based on the instream monitoring data during low flow conditions; it was noted during calibration that there were large differences in observed low flow concentrations between the watersheds, but little relative difference in contributing land use. Potency factors were also assigned to sediment derived from bank erosion, which was modeled in Tecolote, San Dieguito, and Chollas. Bank sediment potency factors were used to account for differences seen in storm event loads between the watersheds, but were constrained to be reasonably close to the developed pervious upland sediment potency factors.

#### *Nutrients*

The LSPC models from the San Diego Region Lagoon TMDLs (Tetra Tech, 2008) were used to initialize values including buildup rate, maximum storage, and washoff depth, first order decay rates, and interflow/groundwater concentrations.

Nutrient calibration focused on adjusting parameters for dominate HRUs for the portions of the watersheds draining to the monitoring stations, with an eye on achieving an overall balance in model performance between all the watersheds. The primary factors adjusted were buildup rate, maximum storage, and interflow/groundwater concentrations.

#### *Bacteria*

The LSPC models developed recently for the Chollas watershed (SCCWRP and Tetra Tech, 2007; SDRWQCB, 2007b; City of San Diego, 2012) were used to initialize buildup rate, maximum storage, and washoff depth for fecal coliform bacteria for each model HRU, notably the impervious HRUs. No previous modeling of total coliform bacteria and Enterococcus was identified; however, both were monitored in the Chollas storm drain catchments used to characterize model land use parameters during the recent Chollas modeling. The same methodology used to estimate land use-based parameters for fecal coliform bacteria was applied to total coliform bacteria and *enterococcus*, resulting in a separate set of initial parameters for each. During calibration, adjustments were made primarily to buildup rate, maximum storage, and interflow/groundwater concentrations to better match the monitoring data.

## Calibration Results

### Hydrology

#### *Los Peñasquitos*

For Los Peñasquitos, calibration results are discussed, and are then followed by a presentation of validation results.

As discussed in the *Calibration Approach* section, the flow monitoring station on Los Peñasquitos Creek represents the only recent continuous flow monitoring for an extended period of time downstream of an urbanized area. As a result, emphasis was placed on achieving a high quality hydrology calibration at this location.

Statistics for the hydrologic calibration on Los Peñasquitos Creek are shown in Figure B-12 and compared to the targets discussed in the *Calibration Approach* section. All measures are within the pre-specified target tolerance ranges (with the exception of summer storm volumes, for which the percent error is large primarily because the observed volume is near zero). Overall, the model performs very well, across a range of flow conditions and seasons.

| LSPC Simulated Flow | | Observed Flow Gage | | |
|---|---|---|---|---|
| REACH OUTFLOW FROM SUBBASIN 1146<br><br>11-Year Analysis Period: 1/1/2000 - 12/31/2010<br>Flow volumes are (inches/year) for upstream drainage area | | USGS 11023340 LOS PENASQUITOS C NR POWAY CA<br><br>Hydrologic Unit Code: 18070304<br>Latitude: 32.9431013<br>Longitude: -117.1216999<br>Drainage Area (sq-mi): 42.1 | | |
| Total Simulated In-stream Flow: | **4.27** | Total Observed In-stream Flow: | | **4.49** |
| | | | | |
| Total of simulated highest 10% flows: | **3.40** | Total of Observed highest 10% flows: | | **3.50** |
| Total of Simulated lowest 50% flows: | **0.36** | Total of Observed Lowest 50% flows: | | **0.34** |
| | | | | |
| Simulated Summer Flow Volume (months 7-9): | **0.23** | Observed Summer Flow Volume (7-9): | | **0.18** |
| Simulated Fall Flow Volume (months 10-12): | **1.36** | Observed Fall Flow Volume (10-12): | | **1.54** |
| Simulated Winter Flow Volume (months 1-3): | **2.22** | Observed Winter Flow Volume (1-3): | | **2.28** |
| Simulated Spring Flow Volume (months 4-6): | **0.46** | Observed Spring Flow Volume (4-6): | | **0.49** |
| | | | | |
| Total Simulated Storm Volume: | **2.99** | Total Observed Storm Volume: | | **3.10** |
| Simulated Summer Storm Volume (7-9): | **0.01** | Observed Summer Storm Volume (7-9): | | **0.03** |
| *Errors (Simulated-Observed)* | *Error Statistics* | *Recommended Criteria* | | |
| Error in total volume: | -4.78 | 10 | | |
| Error in 50% lowest flows: | 8.43 | 10 | | |
| Error in 10% highest flows: | -2.83 | 15 | | |
| Seasonal volume error - Summer: | 28.17 | 30 | | |
| Seasonal volume error - Fall: | -11.56 | 30 | | |
| Seasonal volume error - Winter: | -2.73 | 30 | | |
| Seasonal volume error - Spring: | -5.31 | 30 | | |
| Error in storm volumes: | -3.45 | 20 | | |
| Error in summer storm volumes: | -74.86 | 50 | | |
| Nash-Sutcliffe Coefficient of Efficiency, E: | 0.825 | Model accuracy increases | | |
| Baseline adjusted coefficient (Garrick), E': | 0.695 | as E or E' approaches 1.0 | | |

**Figure B-12. Hydrologic Calibration of Daily Flows, Los Peñasquitos Creek, 2000 – 2010**

A flow-duration plot (plot of flow versus percent of time exceeded, Figure B-13) shows excellent agreement for the highest flows, and overall good agreement for the rest of the flows. Mid-range flows are slightly over-predicted, and low flows slightly under-predicted (note that the use of a logarithmic scale exaggerates the differences at low flows). A plot of flow accumulation (Figure B-14) shows that the model tracks observed flow volume well over time, with little deviation.

Monthly observed and modeled flows at Los Peñasquitos Creek for the calibration period are plotted along with reported monthly rainfall (Figure B-15), and also show good agreement. When months are aggregated across the entire calibration period, both a scatterplot and time series show very little difference between simulated and observed average monthly values (Figure B-16).

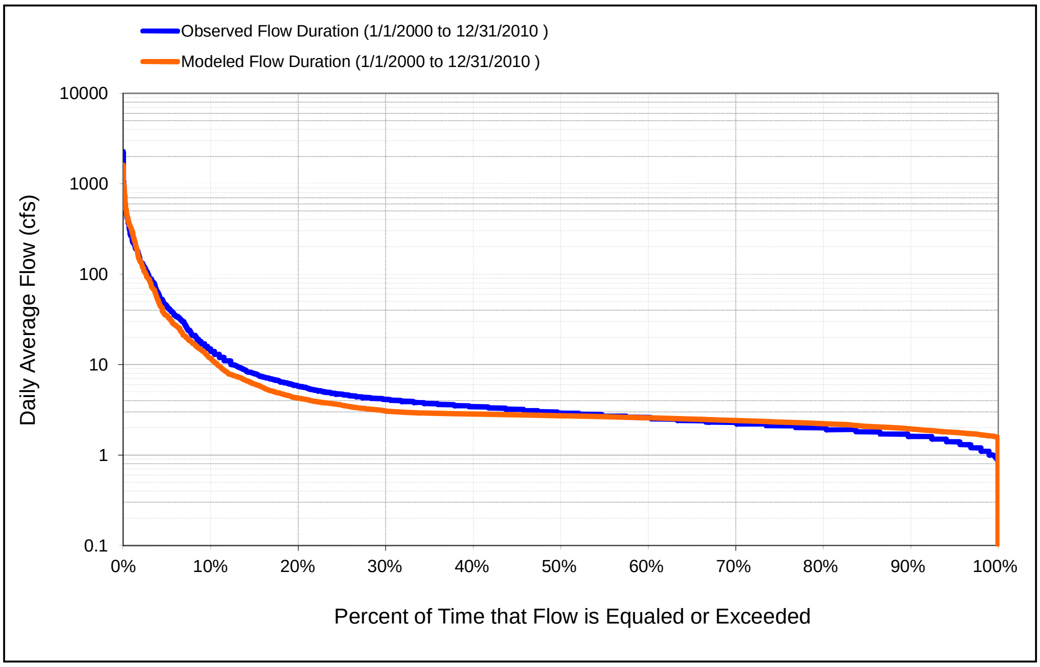



**Figure B-13. Flow-Duration Plot, Los Peñasquitos Creek, 2000 – 2010**

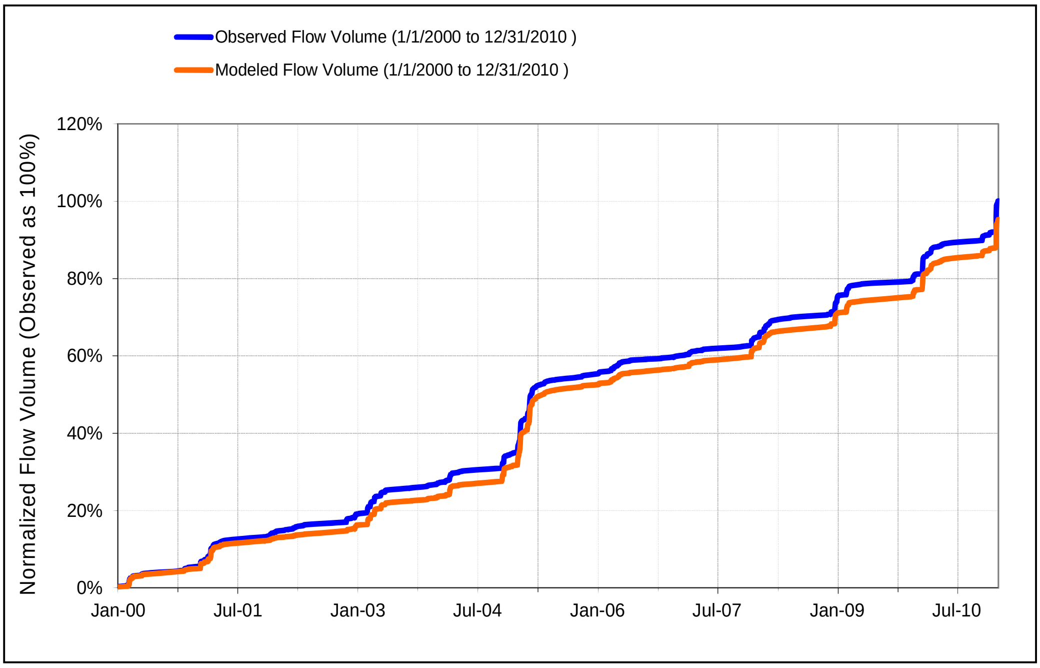



**Figure B-14. Cumulative Observed and Modeled Flows, Los Peñasquitos Creek, 2000 – 2010**

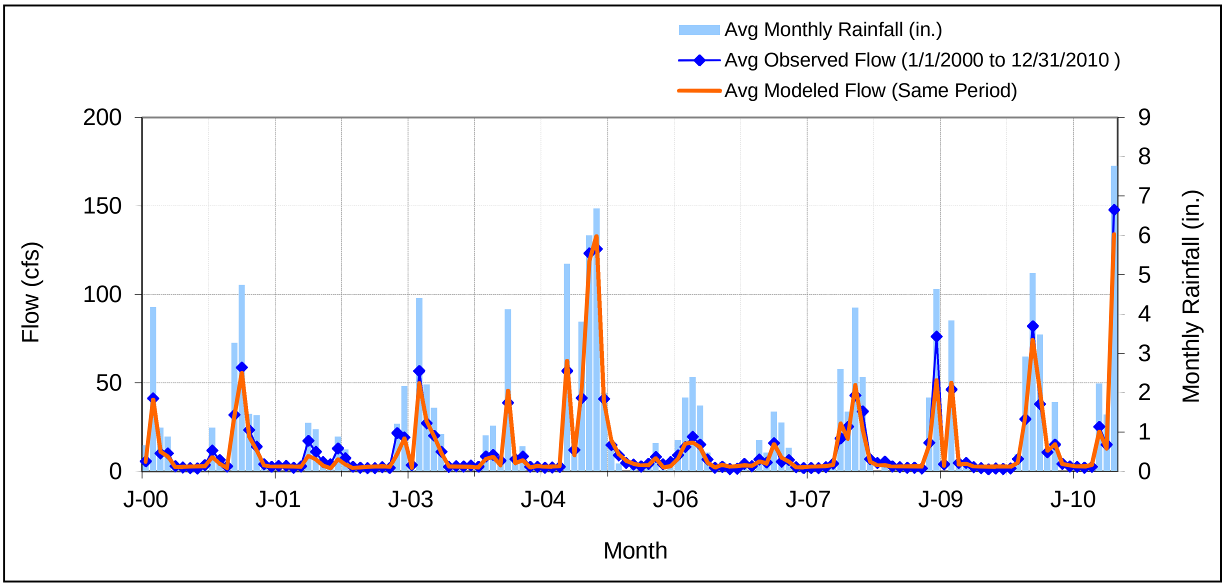



**Figure B-15. Time Series of Observed and Modeled Monthly Flows and Monthly Rainfall, Los Peñasquitos Creek, 2000 – 2010**

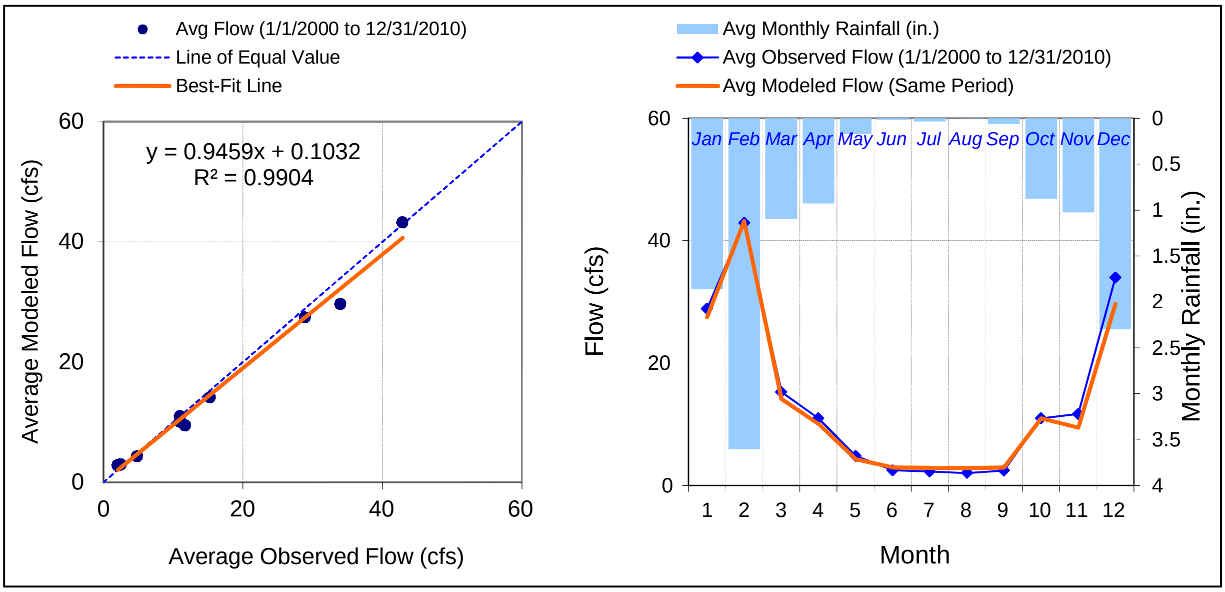



**Figure B-16. Observed and Modeled Monthly Average Flow, Los Peñasquitos Creek, 2000 – 2010**

Validation results are presented in Figure B-17 through Figure B-21. The model shows good agreement to observed conditions, although low flow is overpredicted, leading to an overestimate of the 50 percent lowest flows, and summer seasonal volume.

Validation for Los Peñasquitos reflects the model simulation using meteorology data from an earlier time period, 1990 – 1999. No changes were made to the model to account for different conditions that might be present in the watershed. If the development in the watershed was active during the past twenty years, it is possible that different land use and land cover existing during an earlier time period. Since irrigation return flow in the model is the primary source of low flows, it is possible that the model land use overestimates irrigation use if development density was lower during the 1990's.

| LSPC Simulated Flow | | Observed Flow Gage | | |
|---|---|---|---|---|
| REACH OUTFLOW FROM SUBBASIN 1146<br><br>11-Year Analysis Period: 1/1/1990 - 12/31/2000<br>Flow volumes are (inches/year) for upstream drainage area | | USGS 11023340 LOS PENASQUITOS C NR POWAY CA<br><br>Hydrologic Unit Code: 18070304<br>Latitude: 32.9431013<br>Longitude: -117.1216999<br>Drainage Area (sq-mi): 42.1 | | |
| Total Simulated In-stream Flow: | **5.16** | Total Observed In-stream Flow: | | **5.28** |
| | | | | |
| Total of simulated highest 10% flows: | **4.03** | Total of Observed highest 10% flows: | | **4.26** |
| Total of Simulated lowest 50% flows: | **0.38** | Total of Observed Lowest 50% flows: | | **0.28** |
| | | | | |
| Simulated Summer Flow Volume (months 7-9): | **0.31** | Observed Summer Flow Volume (7-9): | | **0.20** |
| Simulated Fall Flow Volume (months 10-12): | **0.56** | Observed Fall Flow Volume (10-12): | | **0.53** |
| Simulated Winter Flow Volume (months 1-3): | **3.60** | Observed Winter Flow Volume (1-3): | | **3.92** |
| Simulated Spring Flow Volume (months 4-6): | **0.69** | Observed Spring Flow Volume (4-6): | | **0.62** |
| | | | | |
| Total Simulated Storm Volume: | **3.51** | Total Observed Storm Volume: | | **3.54** |
| Simulated Summer Storm Volume (7-9): | **0.05** | Observed Summer Storm Volume (7-9): | | **0.06** |
| *Errors (Simulated-Observed)* | *Error Statistics* | *Recommended Criteria* | | |
| Error in total volume: | -2.17 | 10 | | |
| Error in 50% lowest flows: | 35.39 | 10 | | |
| Error in 10% highest flows: | -5.33 | 15 | | |
| Seasonal volume error - Summer: | 56.02 | 30 | | |
| Seasonal volume error - Fall: | 5.01 | 30 | | |
| Seasonal volume error - Winter: | -8.13 | 30 | | |
| Seasonal volume error - Spring: | 10.79 | 30 | | |
| Error in storm volumes: | -0.80 | 20 | | |
| Error in summer storm volumes: | -18.55 | 50 | | |
| Nash-Sutcliffe Coefficient of Efficiency, E: | 0.450 | Model accuracy increases | | |
| Baseline adjusted coefficient (Garrick), E': | 0.636 | as E or E' approaches 1.0 | | |

**Figure B-17. Hydrologic Calibration of Daily Flows, Los Peñasquitos Creek, 1990 – 1999**

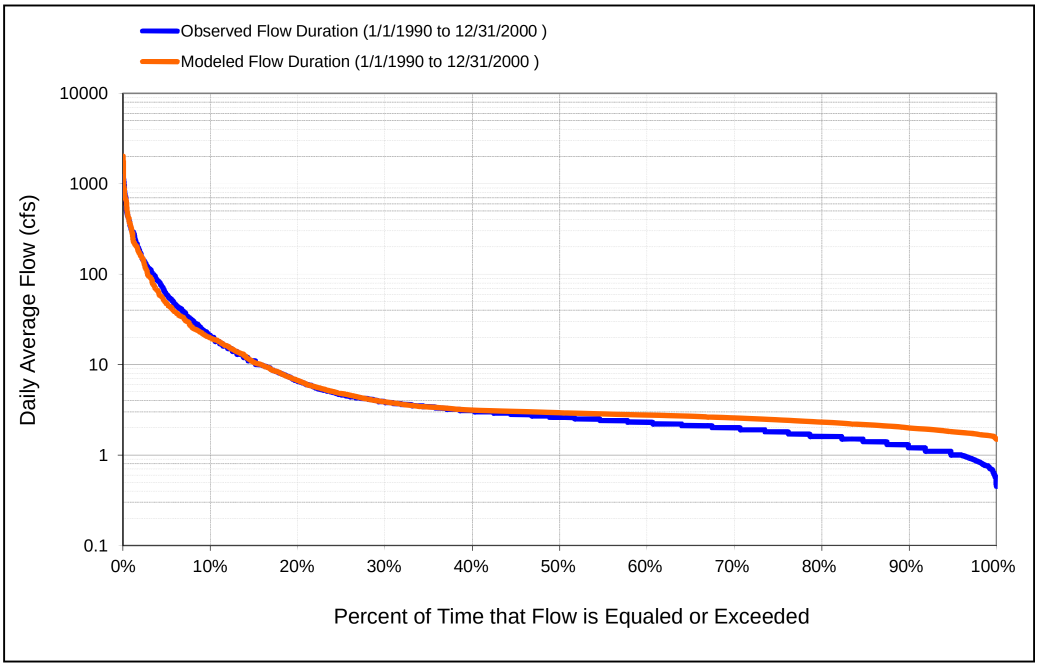



**Figure B-18. Flow-Duration Plot, Los Peñasquitos Creek, 1990 – 1999**

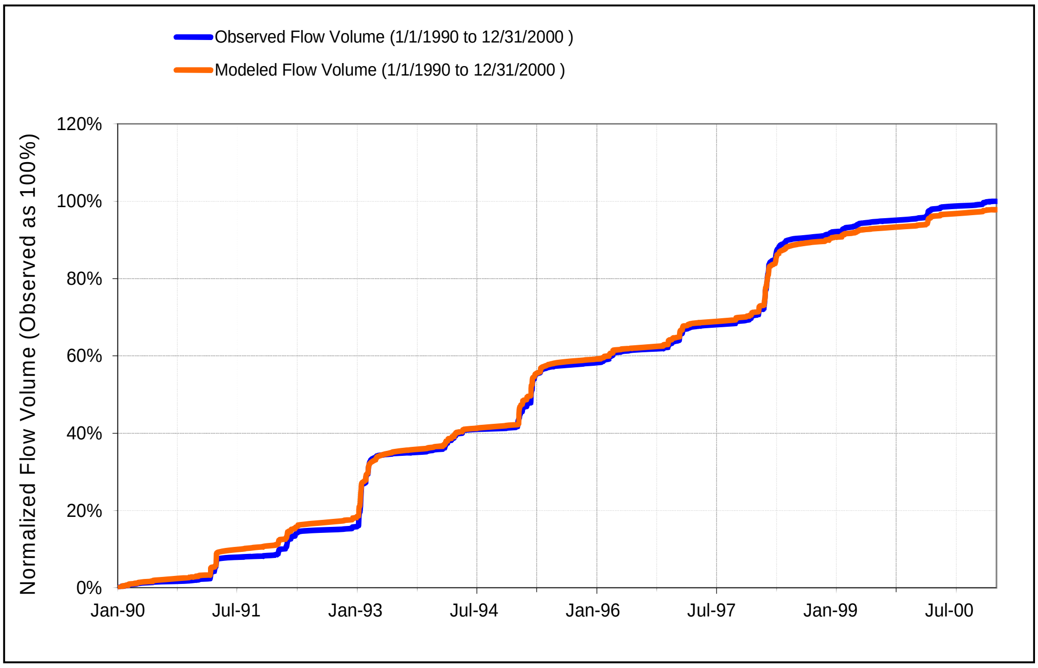



**Figure B-19. Cumulative Observed and Modeled Flows, Los Peñasquitos Creek, 1990 – 1999**

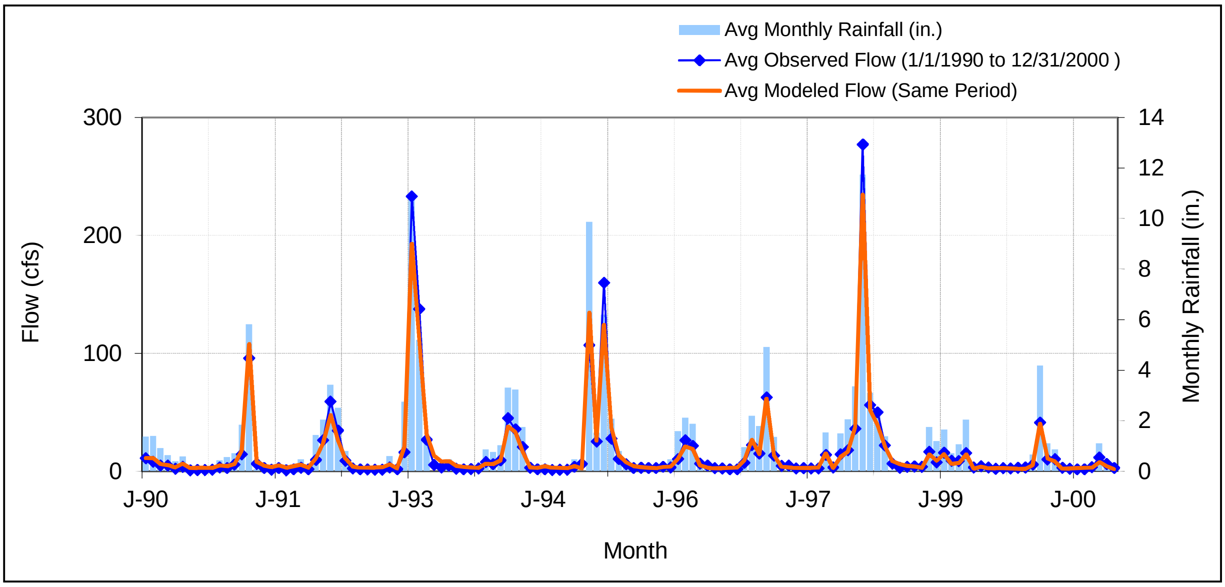



**Figure B-20. Time Series of Observed and Modeled Monthly Flows and Monthly Rainfall, Los Peñasquitos Creek, 1990 – 1999**

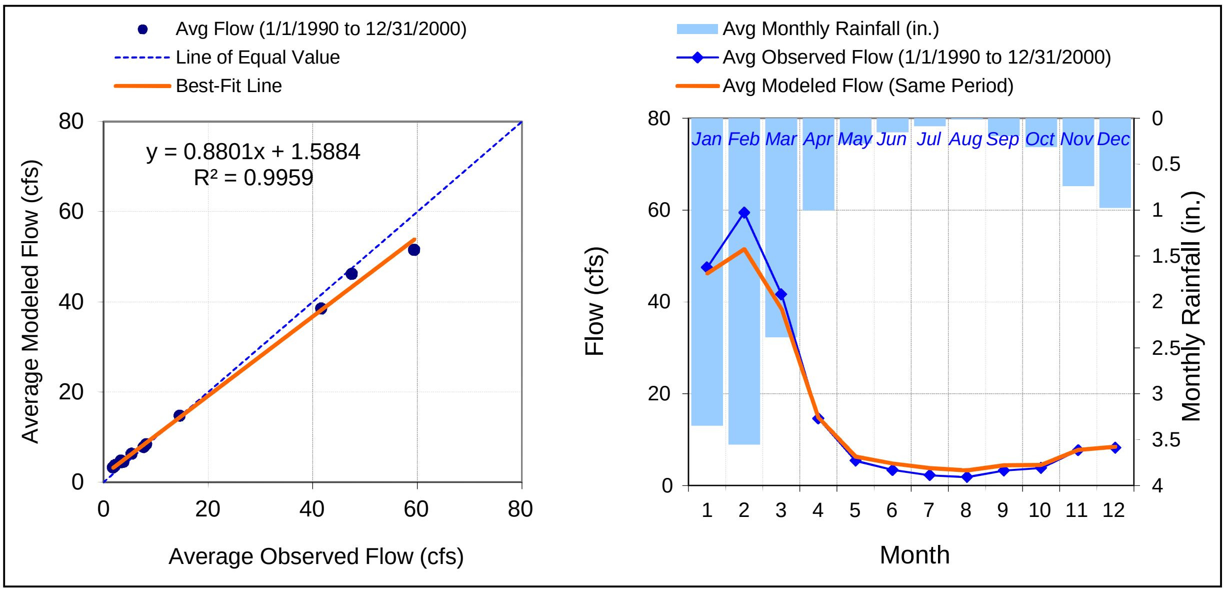



**Figure B-21. Observed and Modeled Monthly Average Flow, Los Peñasquitos Creek, 1990 – 1999**

### Chollas

Additional validation was provided by a visual assessment of performance for the short term flow monitoring in Chollas. Generally, the model predicts individual events well at both stations on North Chollas Creek, but overpredicts storm peaks and volumes at both of the South Chollas Creek stations. The North Chollas Creek and South Chollas Creek watersheds are very similar in configuration, land use, and impervious area, so the reason for the difference in observed response is not known. Alluvial aquifers are present in parts of the Chollas watershed, so it is possible that runoff is lost into the creek beds leading to lower observed flow.

### Upper San Dieguito

The monitored creeks in the upper high-elevation portion of San Dieguito presented a number of challenges for calibration. Model performance was fair to poor during both the calibration period and the validation period. Select graphs are shown highlighting the issues for each station.

All of the monitored creeks were dry during the majority of the year. The unit-area annual runoff in upper San Dieguito is a fraction of the unit area annual runoff in Los Peñasquitos, but Upper San Dieguito receives considerably more rainfall. On the other hand, there are only limited areas of impervious surfaces and irrigated land. Much of the infiltrated precipitation is lost to groundwater and ET; in addition, groundwater basins and alluvial aquifers are present in much of the area, notably in the area drained by Santa Maria Creek. Accounting for gain and loss occurring in reaches can be difficult, especially when consumptive use takes place via pumping from the local aquifers and no data are available to track time-varying consumptive use. Ultimately, the flow leaving the upper San Dieguito is low relative to the higher year-round flows present at lower elevations, and all the flow enters Lake Hodges which rarely discharges. As a result, uncertainty in hydrology modeling of the upper San Dieguito is unlikely to have much impact on results farther downstream, in the lower elevation urbanized part of the San Dieguito watershed.

### Guejito Creek

The upstream area is largely uninhabited, and the gage has a calibration period only. Higher flow is over predicted (Figure B-22), but much of the error can be attributed to a single wet season (2004 – 2005) as seen in Figure B-23. The discrepancy may be due to poorly measured rainfall at one or more of the ALERT gages used in the model. However, the monthly time series compare fairly well during the rest of the simulation (Figure B-24).

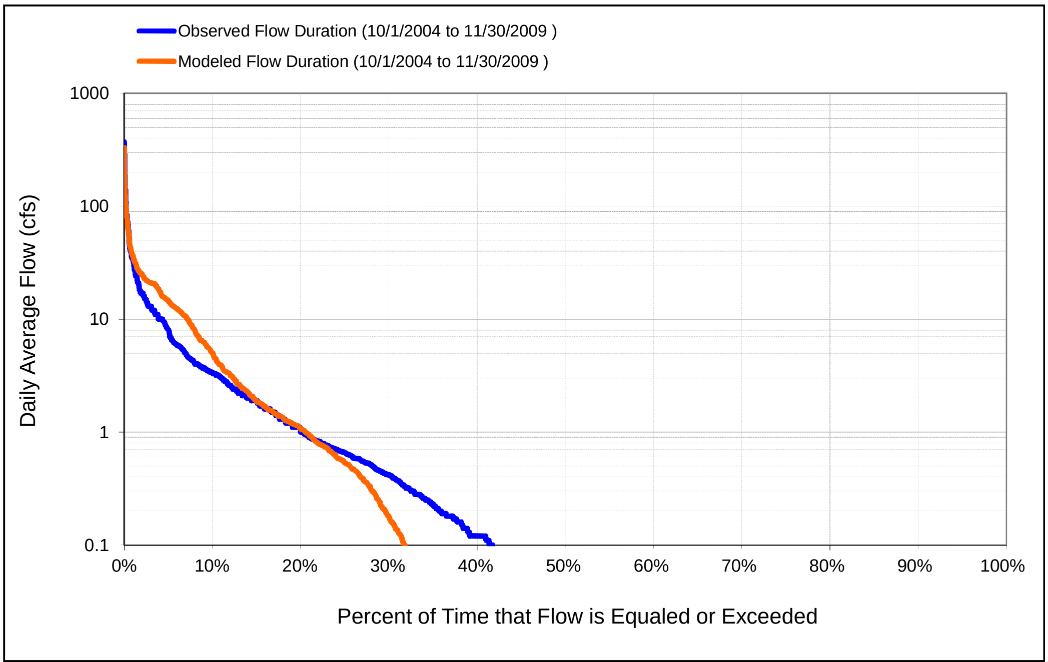



**Figure B-22. Flow-Duration Plot, Guejito Creek, 2004 – 2010**

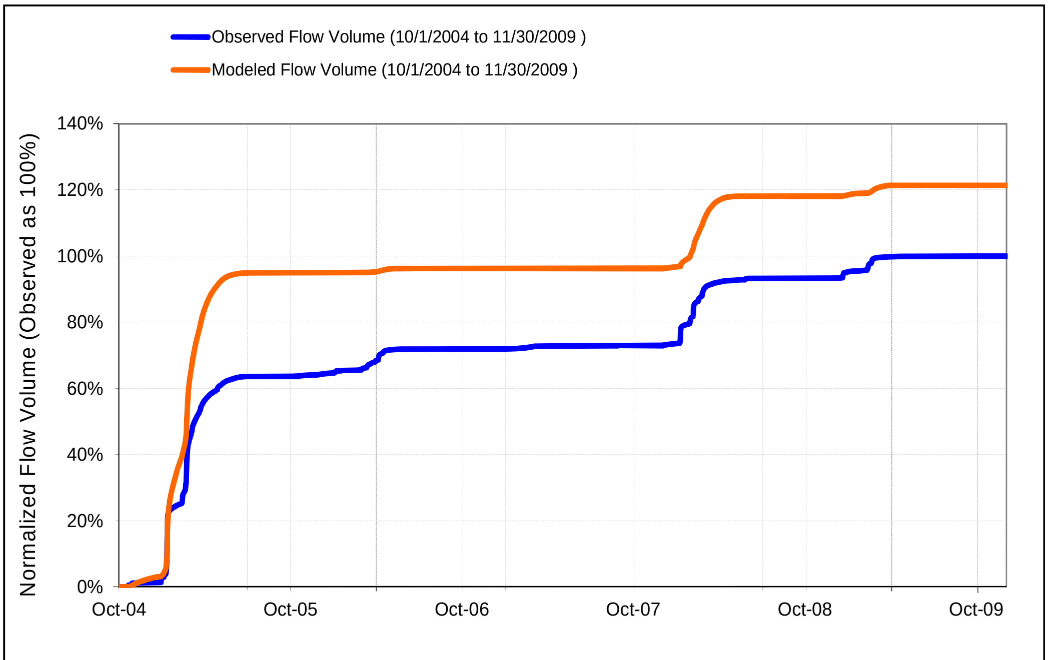



**Figure B-23. Cumulative Observed and Modeled Flows, Guejito Creek, 2004 – 2010**

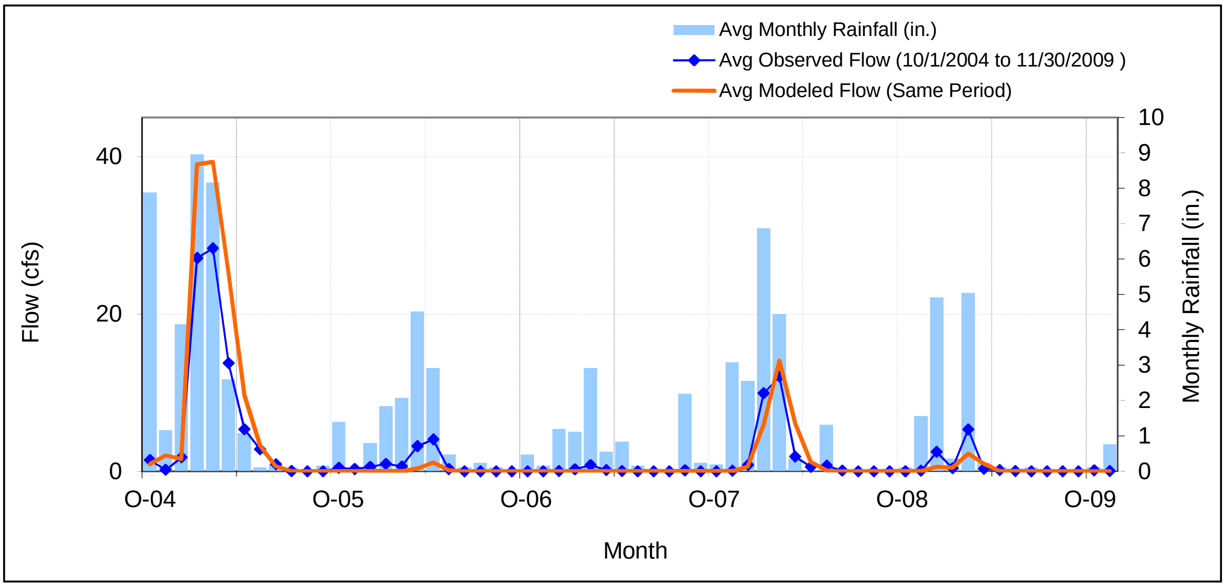



**Figure B-24. Time Series of Observed and Modeled Monthly Flows and Monthly Rainfall, Guejito Creek, 2004 – 2010**

### *Santa Ysabel Creek*

The area upstream is also largely uninhabited, and much of the watershed drains to Sutherland Reservoir which rarely discharges. As a result, the net contributing drainage area to the gage is much less than the total area. The flow duration curves are well matched during the calibration period (Figure B-25), and the monthly time series compare fairly well (Figure B-26). However, the flow duration from the validation period shows a sharp divergence where observed flow exceeds simulated flow much of the time (Figure B-27). A daily time series of flow (Figure B-28, using a log scale for emphasis) shows extended periods of observed flow, even during the dry season. The data suggest that discharge was occurring from Sutherland Reservoir during this time period, but the outflows are not represented in the model. The data used to create the outflow time series may have been inaccurate or incomplete during much of the 1990's.

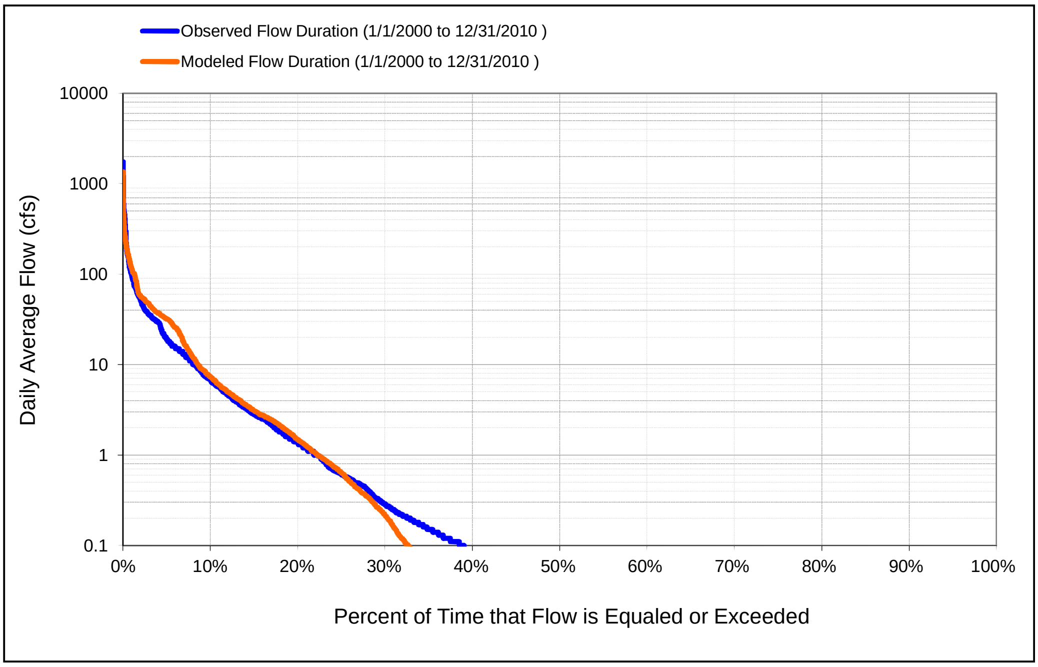



**Figure B-25. Flow-Duration Plot, Santa Ysabel Creek, 2000 – 2010**

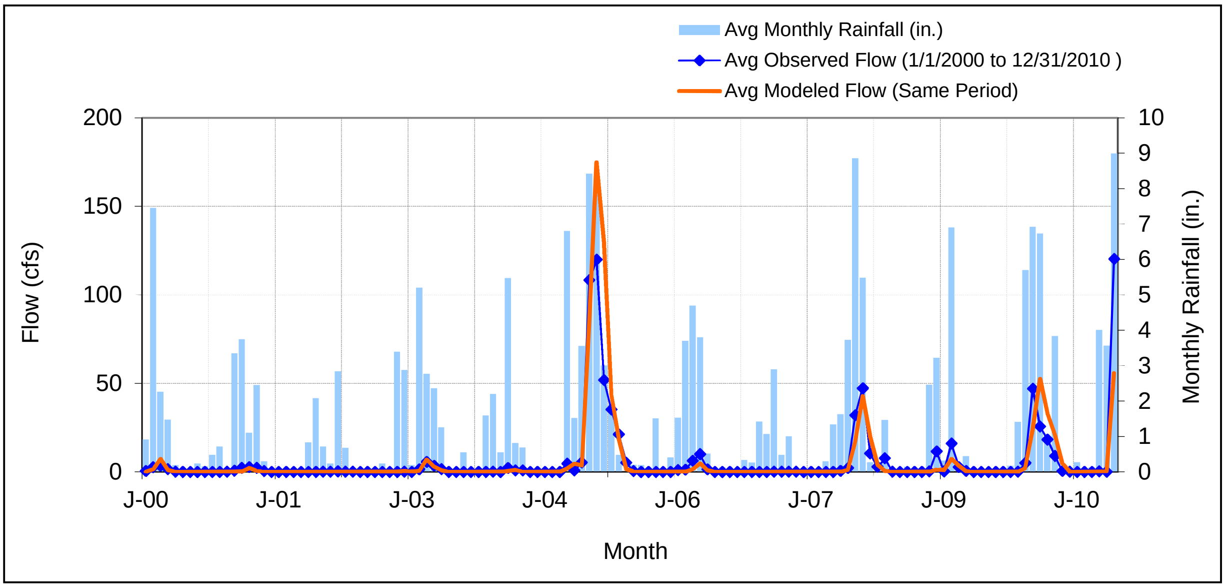



**Figure B-26. Time Series of Observed and Modeled Monthly Flows and Monthly Rainfall, Santa Ysabel Creek, 2000 – 2010**

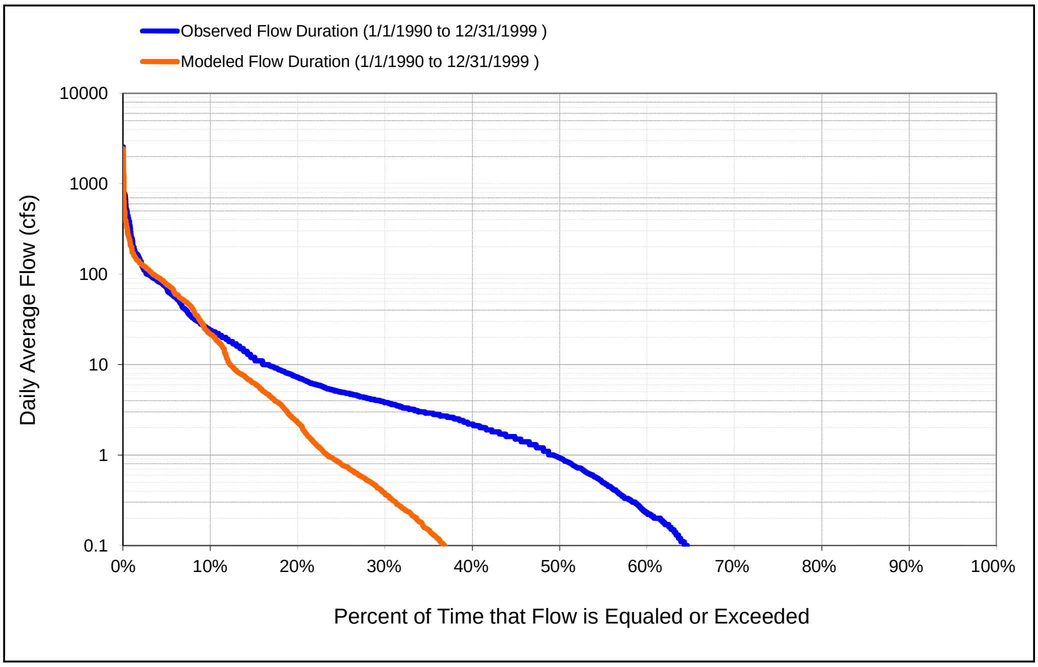



**Figure B-27. Flow-Duration Plot, Santa Ysabel Creek, 1990 – 1999**

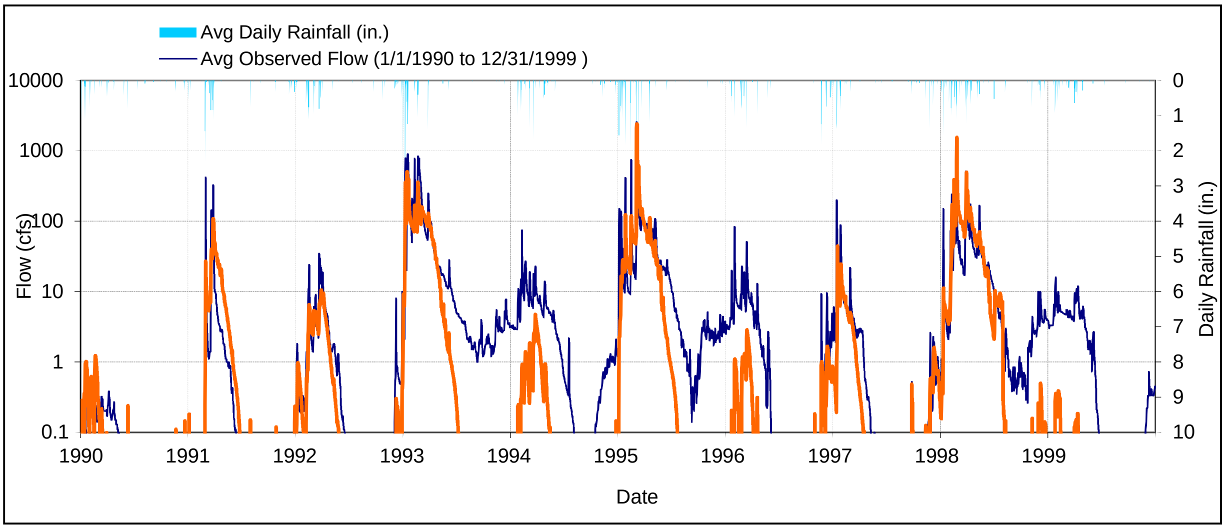



**Figure B-28. Time Series of Observed and Modeled Daily Flows and Monthly Rainfall, Santa Ysabel Creek, 1990 – 1999**

### Santa Maria Creek

Model representation of flow in Santa Maria Creek is poor; the Santa Maria groundwater basin underlies the area, and much of the aquifer is tapped for consumptive use. During calibration (Figure B-29), model flow is overpredicted; flows may be entering the alluvial aquifer thus reducing observed flow. Modeled flow is underpredicted during the validation period (Figure B-30), due in large part to the El Niño years of 1993 and 1995. ALERT gages may not be fully representing all of the rainfall from those periods.

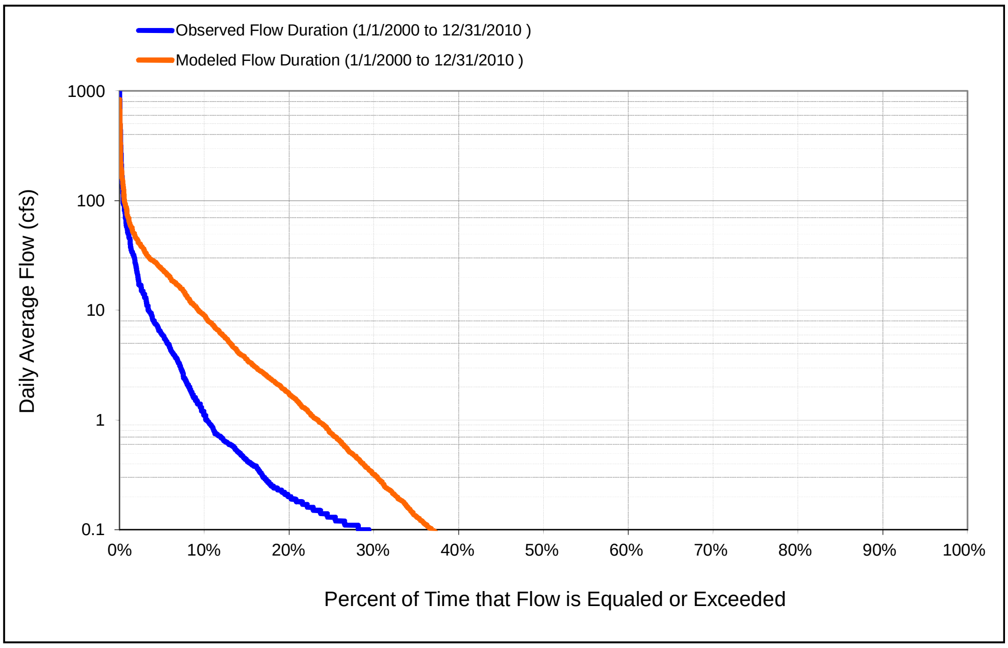



**Figure B-29. Flow-Duration Plot, Santa Maria Creek, 2000 – 2010**

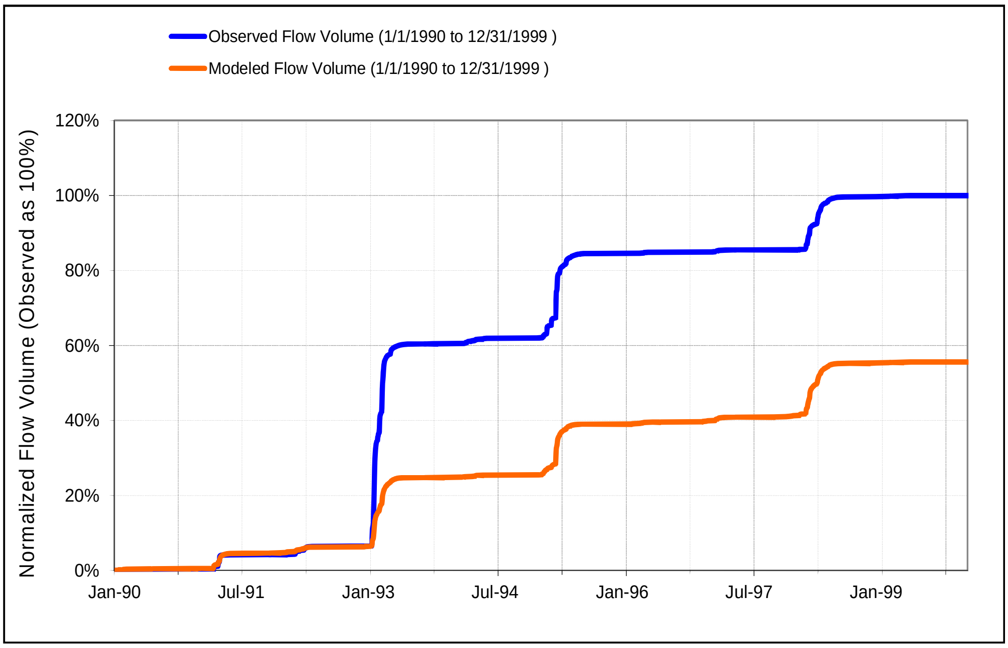



**Figure B-30. Cumulative Observed and Modeled Flows, Santa Maria Creek, 1990 – 1999**

## Sediment

Graphical comparisons are shown in Figure B-31 through Figure B- 34 respectively for Los Peñasquitos, Tecolote, Chollas, and San Dieguito. Observed and simulated concentrations have similar distributions in all four watersheds, as seen in the time series plots. Observed concentrations are sometimes higher than the simulated distribution, but most of those occur during smaller storm events that carry less sediment load than the larger events. Scatterplots of simulated versus observed show little or no bias across the range of loads. In the load duration curves, storm events are seen on the left side of the curves; observed loads follow the distribution of simulated loads. At low flows (the right side of the curves), observed loads are typically higher than simulated loads, indicating low flow concentrations may be underrepresented. Low flow discharge in urban areas of Southern California is largely driven by irrigation return flow; the overall load contribution of solids carried by low flows is minimal and represents a negligible fraction of watershed-scale annual sediment loading.

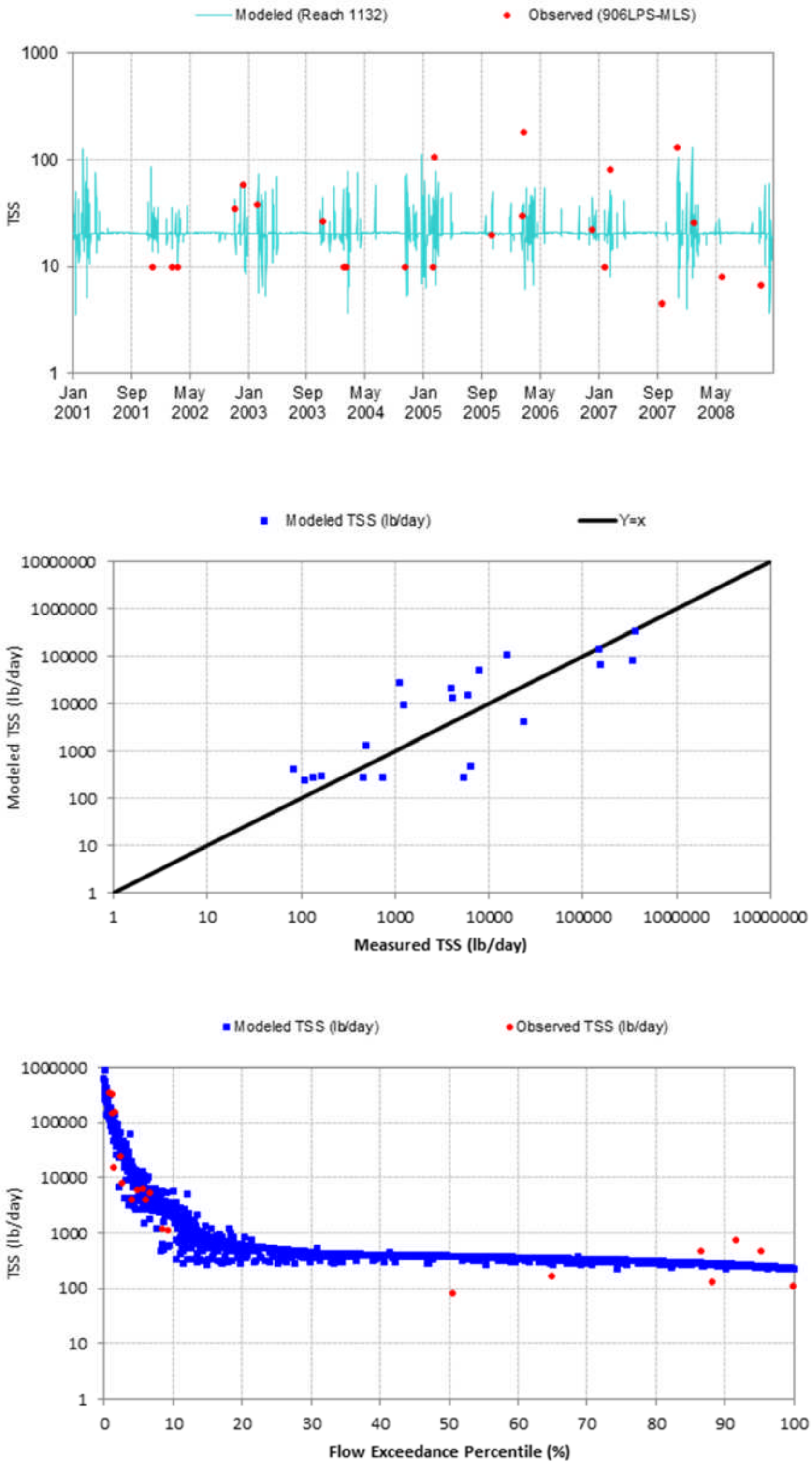



**Figure B-31. Sediment (TSS) at Los Peñasquitos Monitoring Site – Simulated and Observed Comparison**

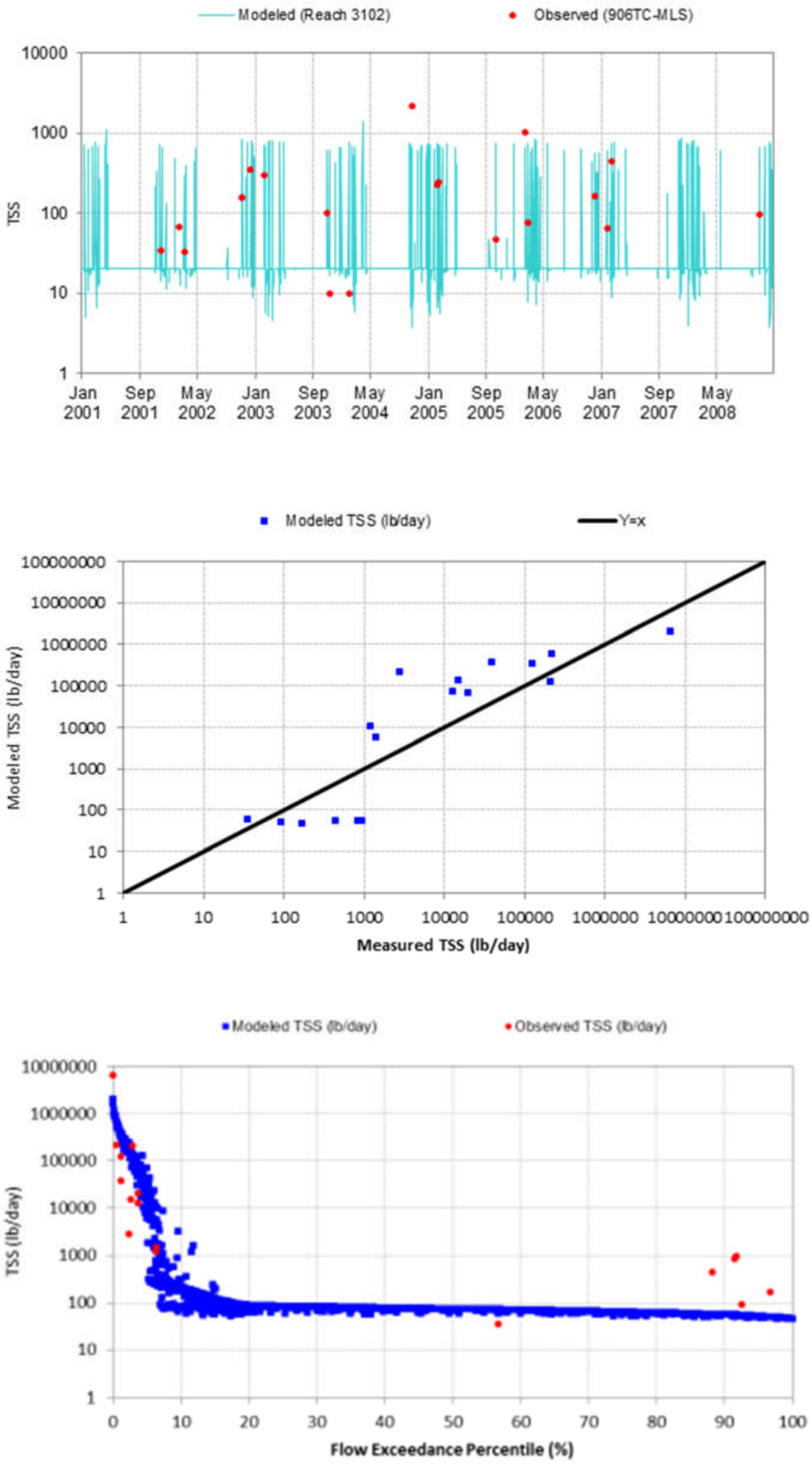



**Figure B-32. Sediment (TSS) at Tecolote Monitoring Site – Simulated and Observed Comparison**

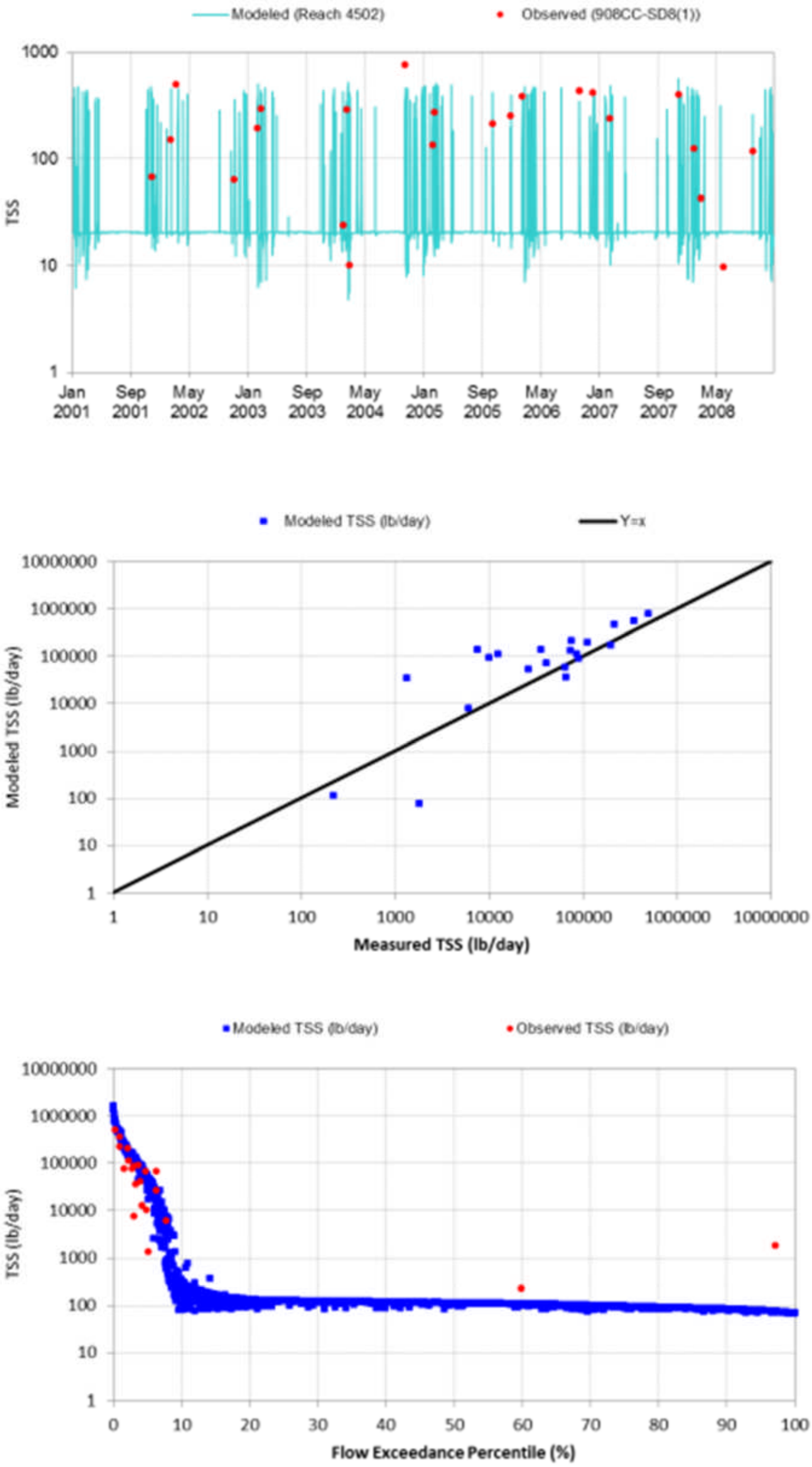



**Figure B-33. Sediment (TSS) at Chollas Monitoring Site – Simulated and Observed Comparison**

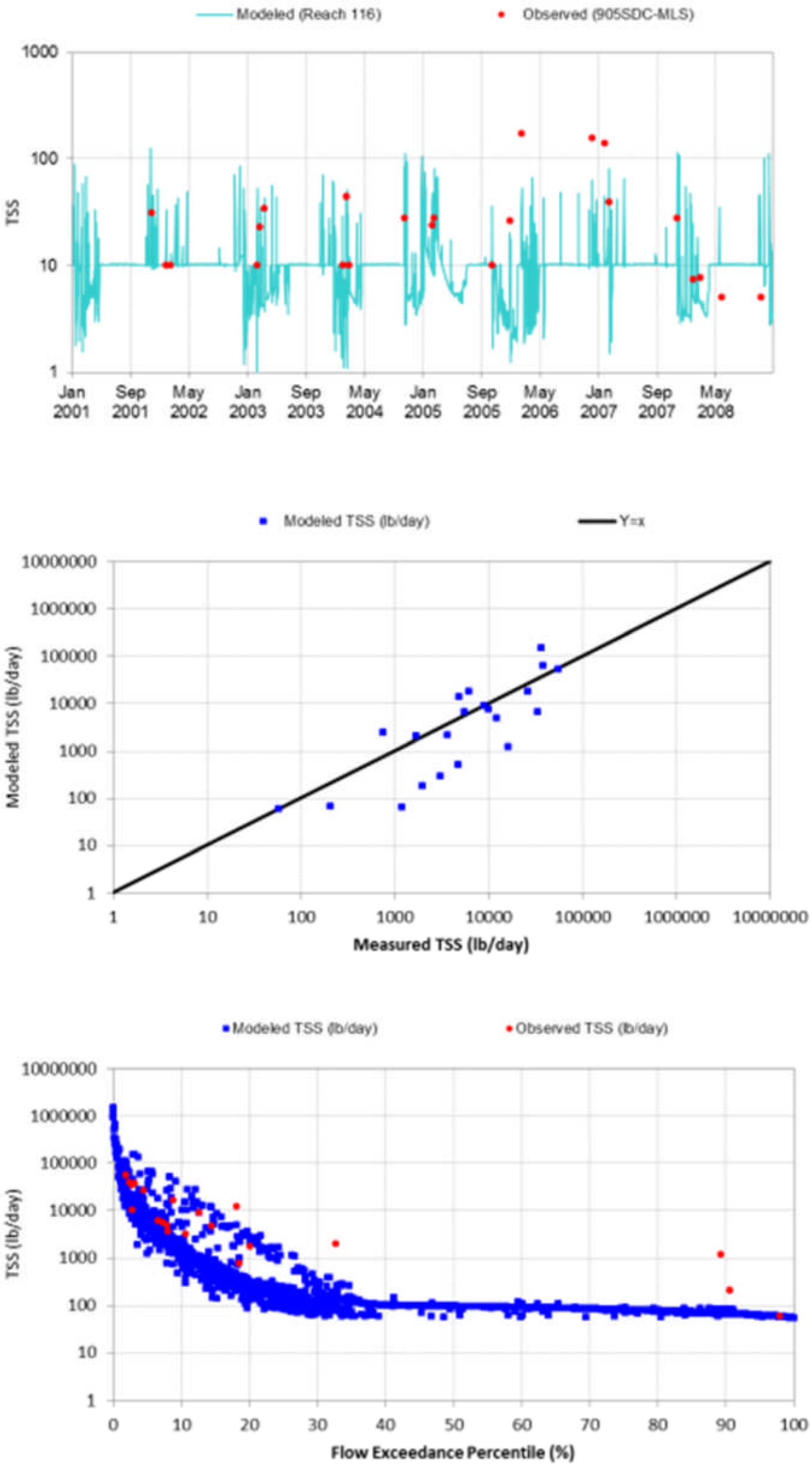



**Figure B- 34. Sediment (TSS) at San Dieguito Monitoring Site – Simulated and Observed Comparison**

## Trace Metals

As noted in the *Data Summary* section, trace metals were simulated in Scripps, Tecolote, and Chollas only; monitoring data were not available in Scripps for calibration.

Graphical comparisons are provided as follows:

- Figure B-35: Total copper, Tecolote
- Figure B-36: Total copper, Chollas
- Figure B-37: Total lead, Tecolote
- Figure B-38: Total lead, Chollas
- Figure B-39: Total zinc, Tecolote
- Figure B-40: Total zinc, Chollas

Simulated wet weather metals loads are higher than observed in Tecolote, and lower than observed in Chollas. Dry weather concentrations are well matched for all three metals in Tecolote, while in Chollas the observed dry weather concentrations are higher than simulated.

The source of the discrepancy between estimated metals loads in the two watersheds can be explained: dry weather and wet weather observed concentrations of metals are uniformly higher in Chollas than in Tecolote. The difference is especially pronounced for zinc; the highest observed concentration in Tecolote is about 400 ug/L, while more than half the observations in Chollas are *higher* than 400 ug/L.

However, the land use characteristics (in terms of proportions of contributing land area) are similar between the two watersheds. The regional modeling approach of using a consistent set of parameters did not provide a way to match what appears to be fundamental differences in background and storm event loading of metals in the two watersheds. As a result, the calibration focused on achieving a middle ground between the two watersheds for the characterization of metals loading. Results for Chollas suggest that there are additional sources of metals in this watershed, such as contaminated stream sediments, that should be further investigated in future implementation planning efforts.

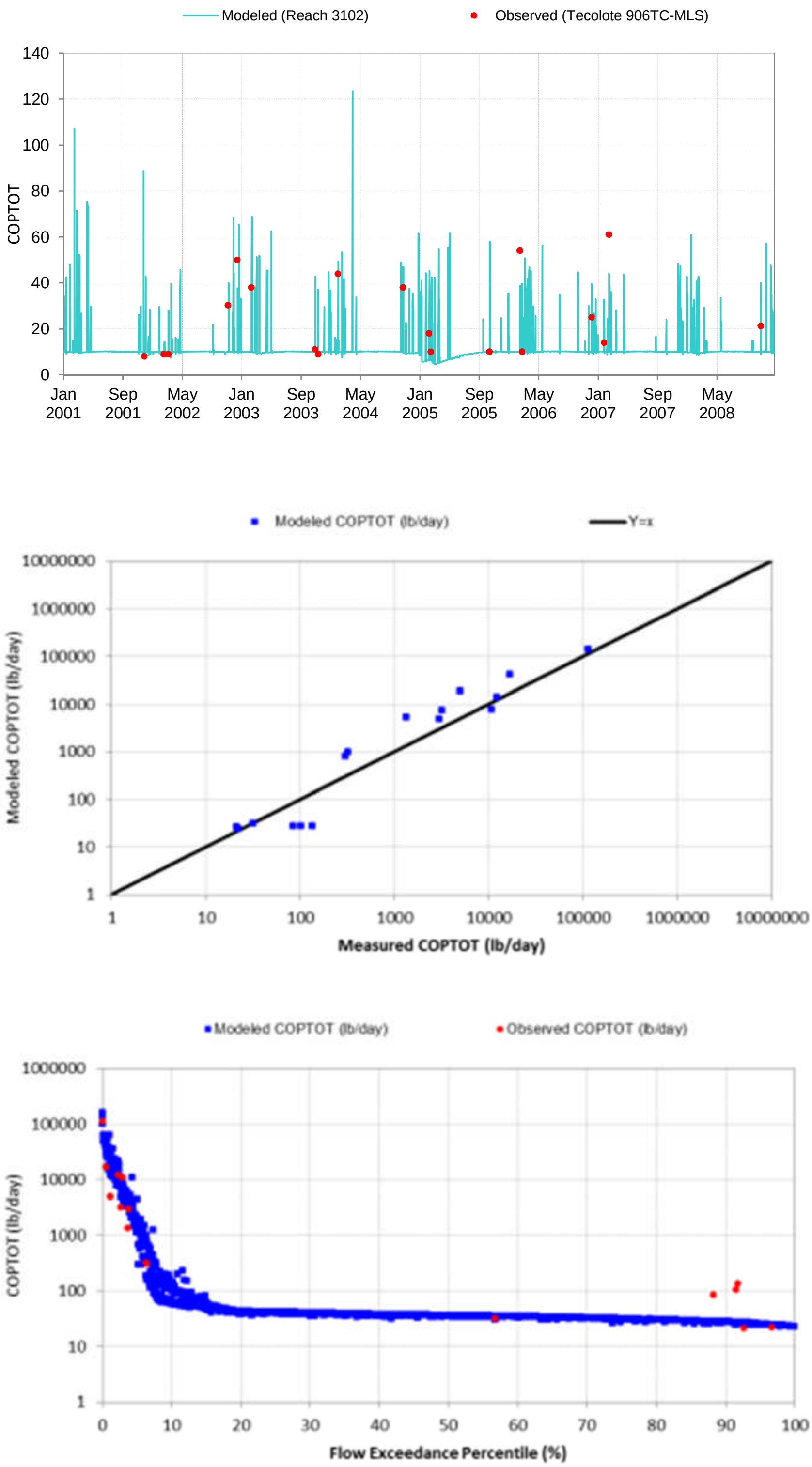



**Figure B-35. Total Copper at Tecolote Monitoring Site – Simulated and Observed Comparison**

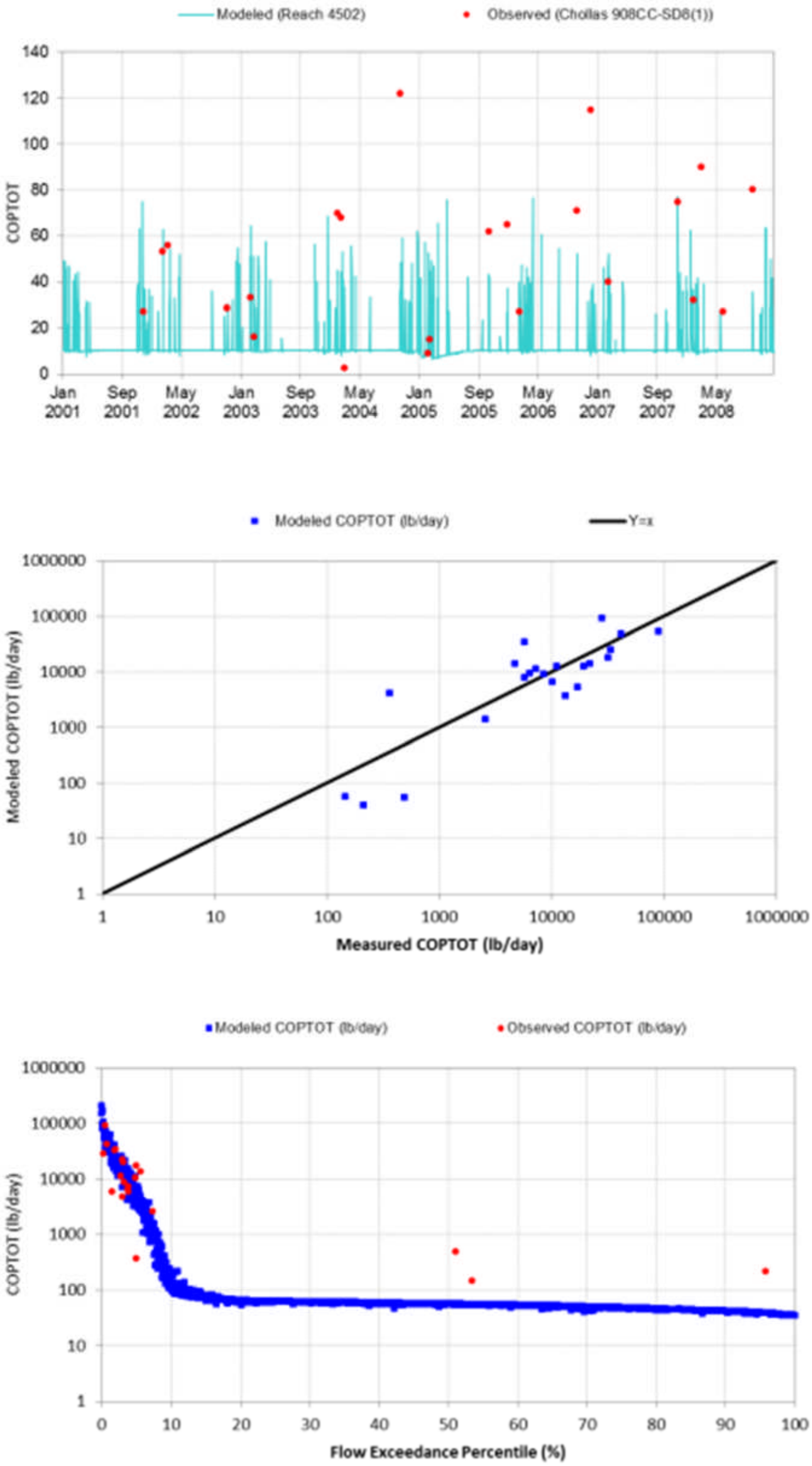
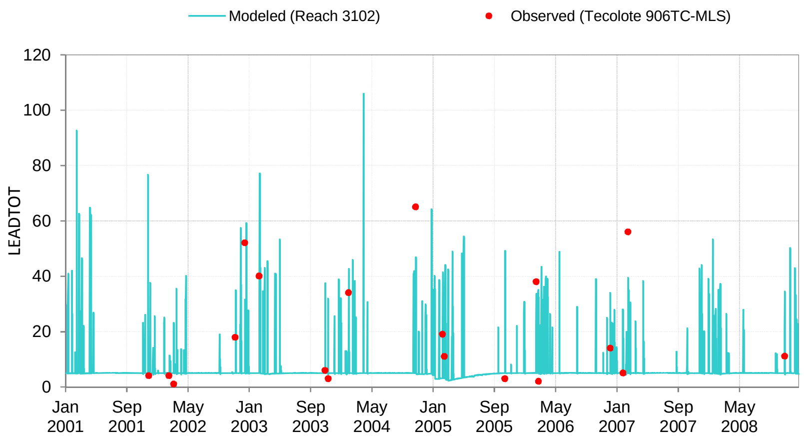
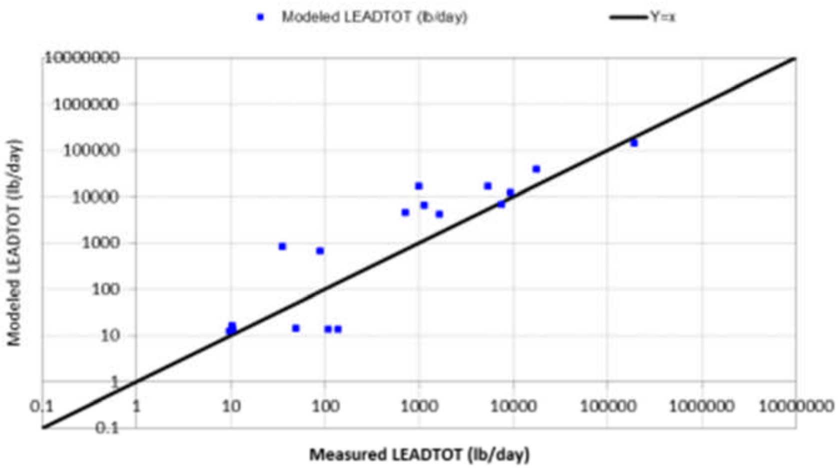



**Figure B-36. Total Copper at Chollas Monitoring Site – Simulated and Observed Comparison**



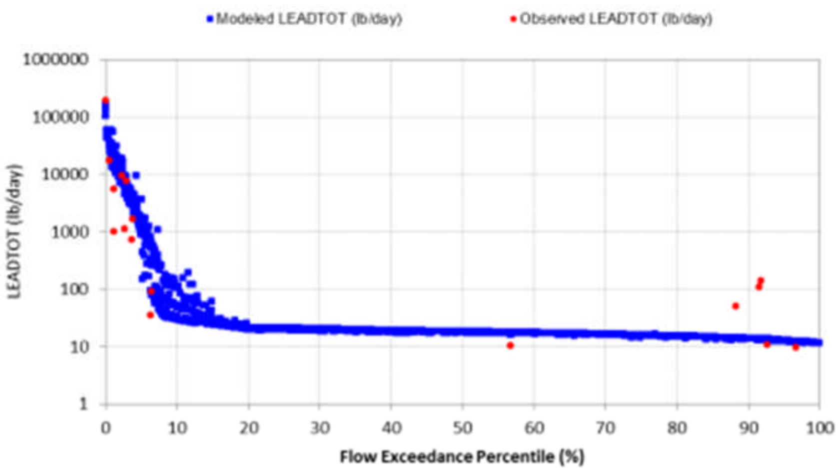




**Figure B-37. Total Lead at Tecolote Monitoring Site – Simulated and Observed Comparison**

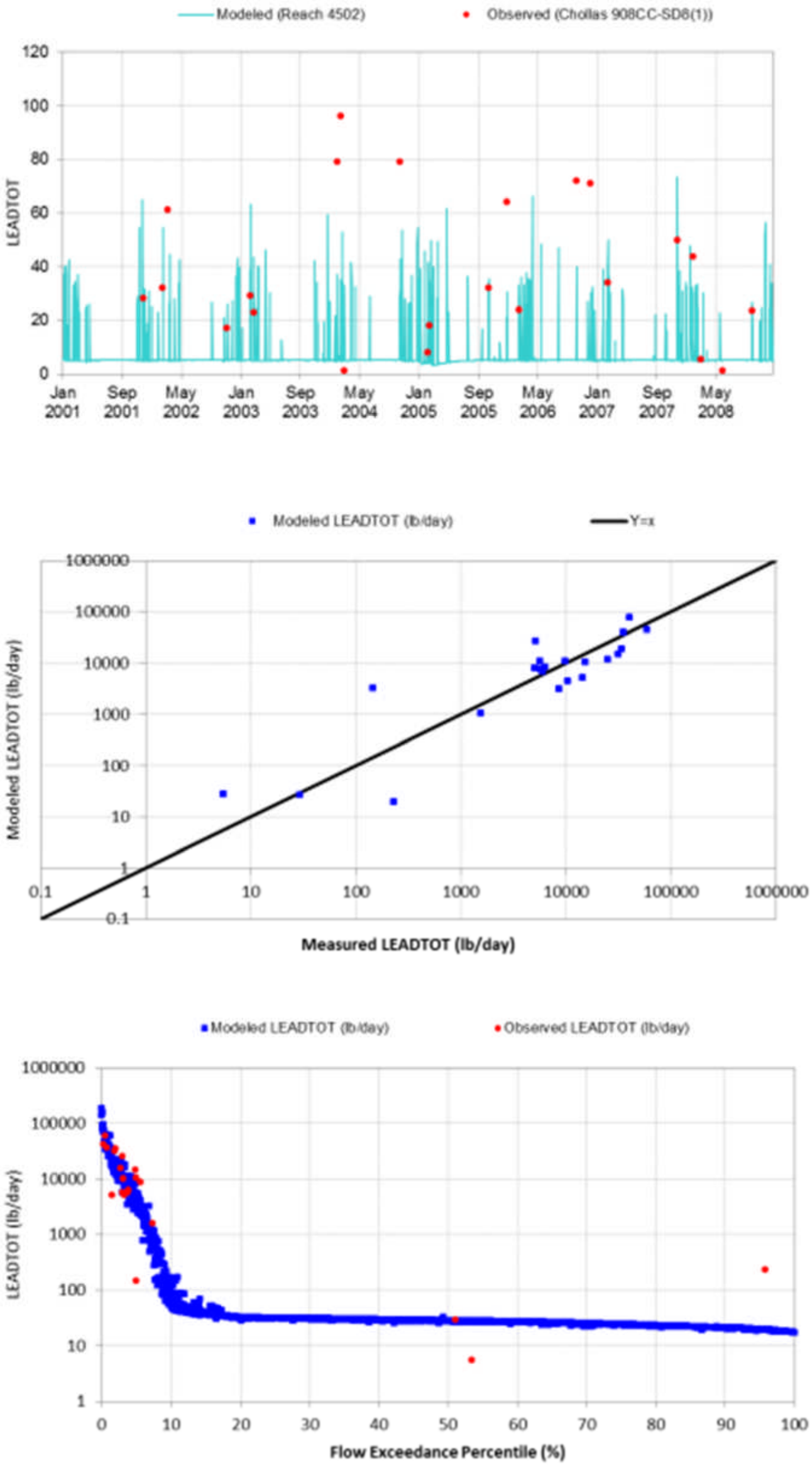
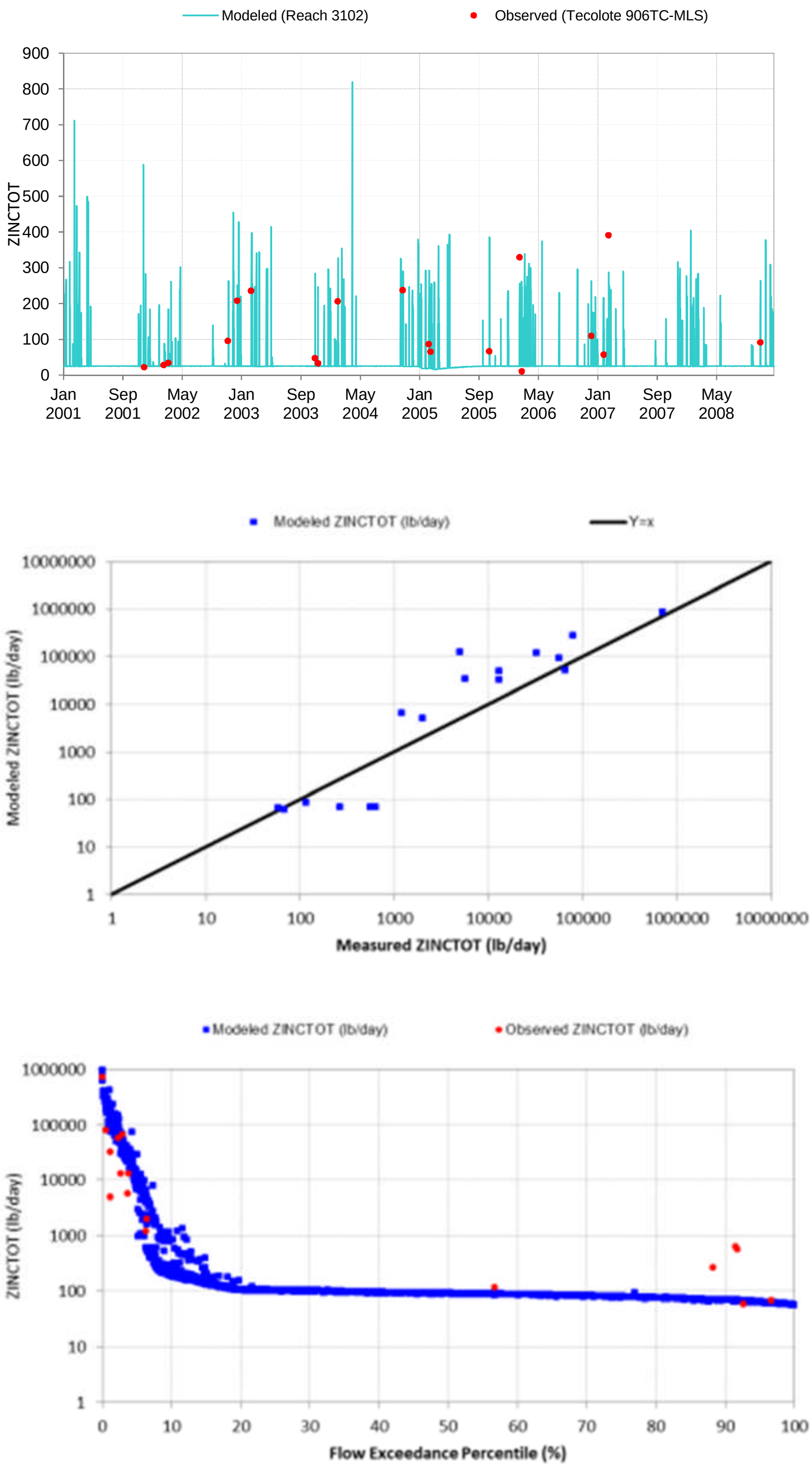



**Figure B-38. Total Lead at Chollas Monitoring Site – Simulated and Observed Comparison**




## Figure B-39. Total Zinc at Tecolote Monitoring Site – Simulated and Observed Comparison

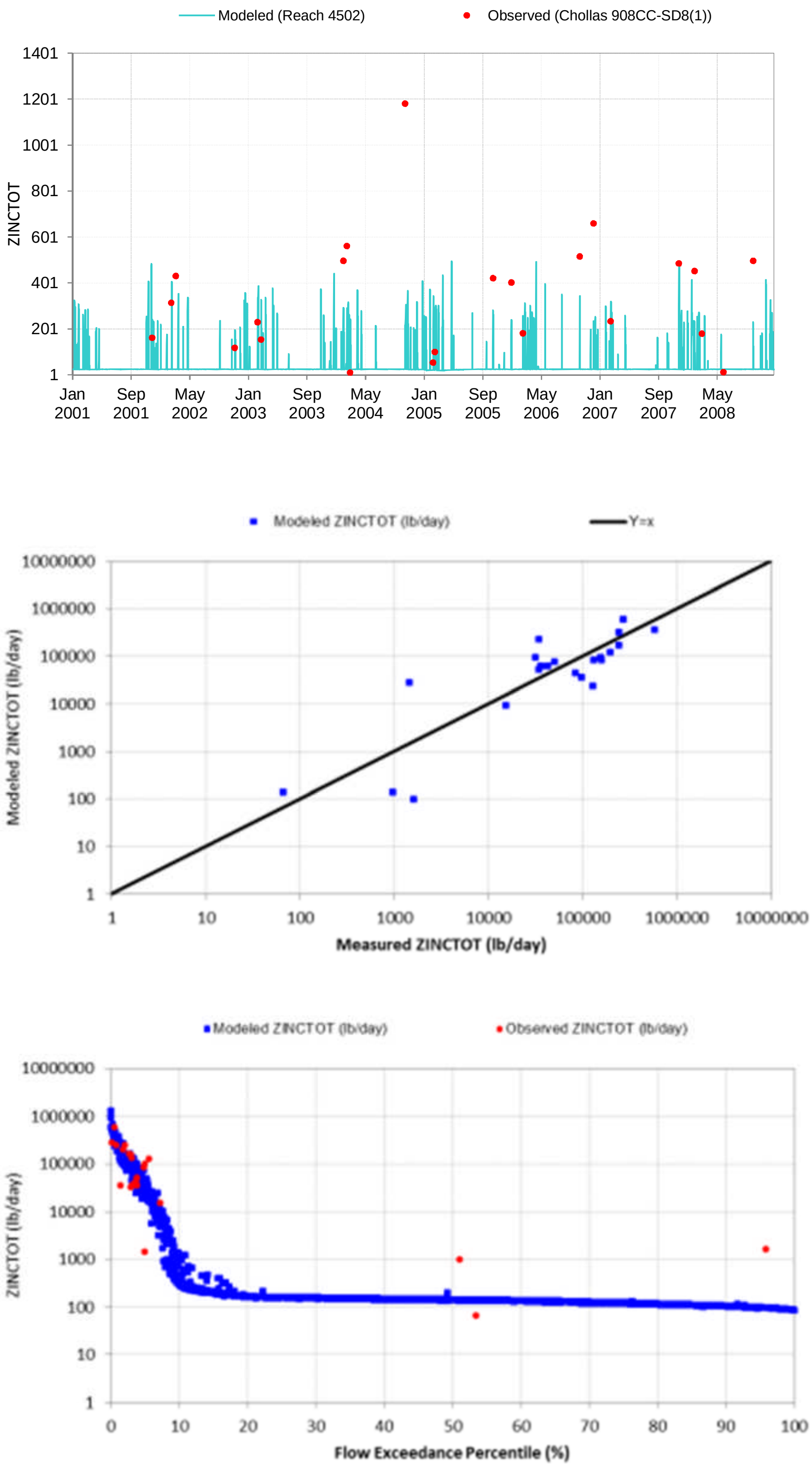
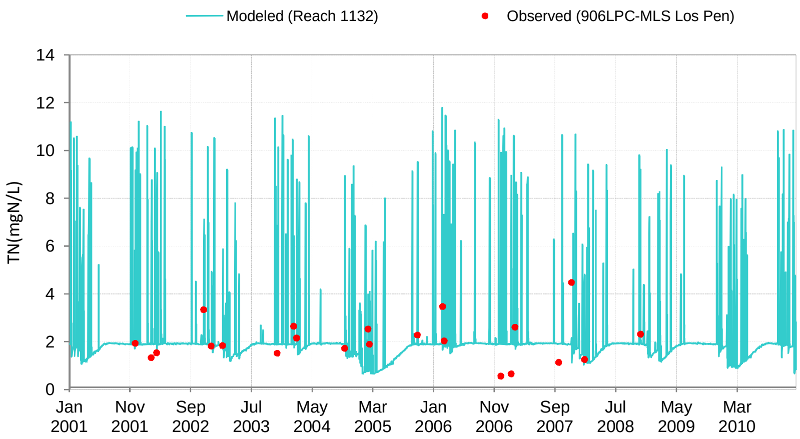


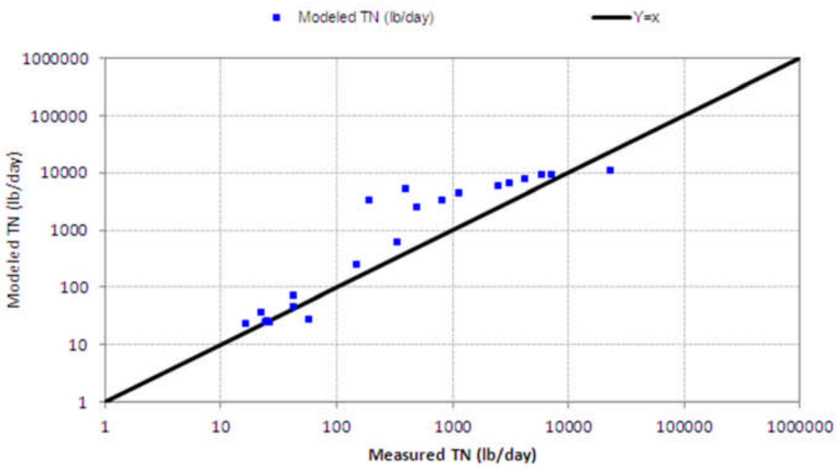

**Figure B-40. Total Zinc at Chollas Monitoring Site – Simulated and Observed Comparison**

## Nutrients

Although nutrient calibration was constrained by limited observed data, most of the time series and scatterplots of simulated versus observed show limited bias across the full range of loads. Los Peñasquitos tends to show the most deviation with generally consistent over simulation. Observed values tended higher in Chollas and Tecolote for both constituents.

In the load duration curves, storm events are seen on the left side of the curves; observed loads follow the distribution of simulated loads in most cases except as noted above. At low flows (the right side of the curves), observed loads are typically in the range of simulated loads for TN though there is only a single point in Chollas for comparison. Low flow results for TP show higher simulated values in Los Peñasquitos and San Dieguito with lower values in Chollas. Tecolote observed values appear to be approximately bisected by the simulated load series. Low flow discharge in urban areas of Southern California is largely driven by irrigation return flow; the overall load contribution carried by low flows is minimal and represents a negligible fraction of watershed-scale annual nutrient loading. Enhancements to the simulation may be explored in future implementation planning efforts.



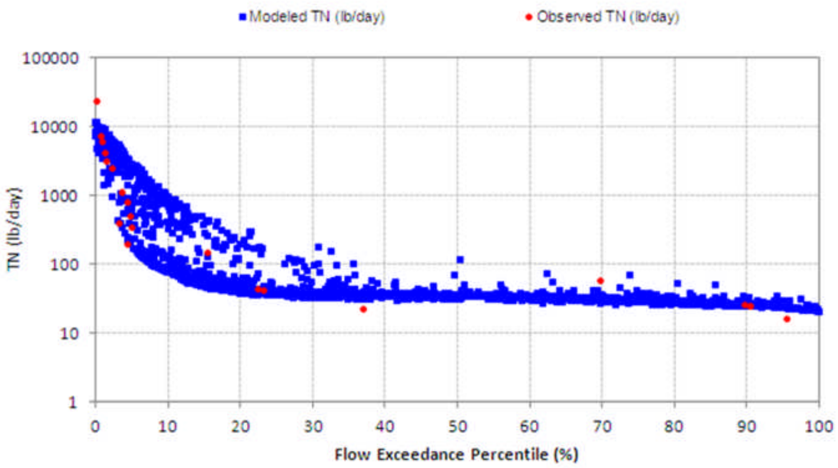




**Figure B-41. Total Nitrogen at Los Peñasquitos Monitoring Site – Simulated and Observed Comparison**

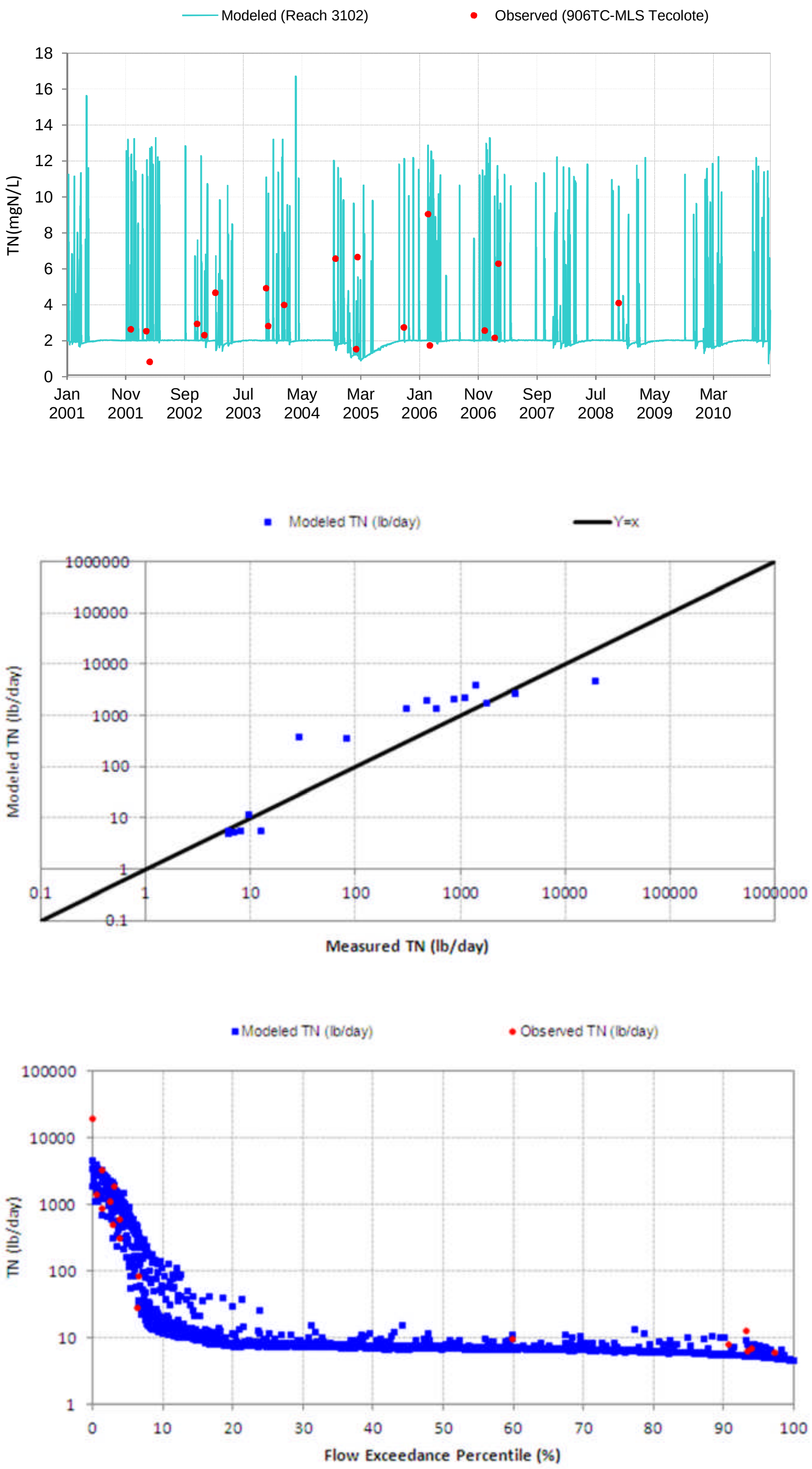
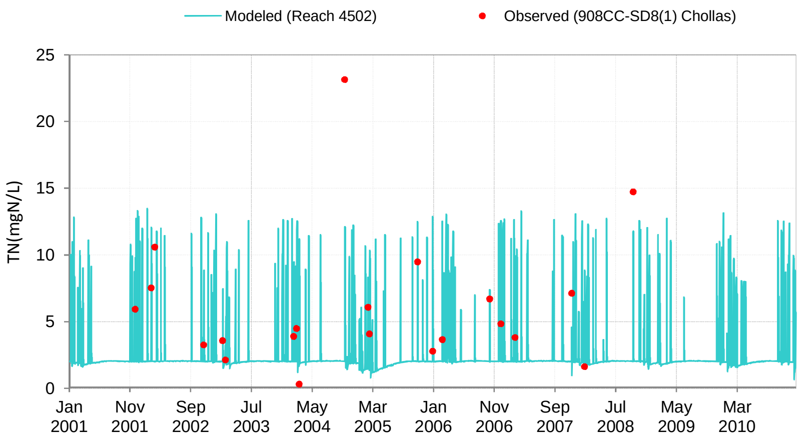
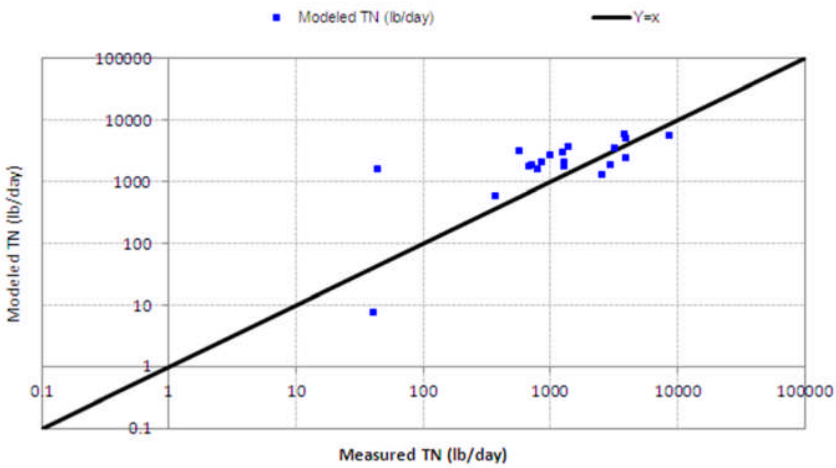



**Figure B-42. Total Nitrogen at Tecolote Monitoring Site – Simulated and Observed Comparison**



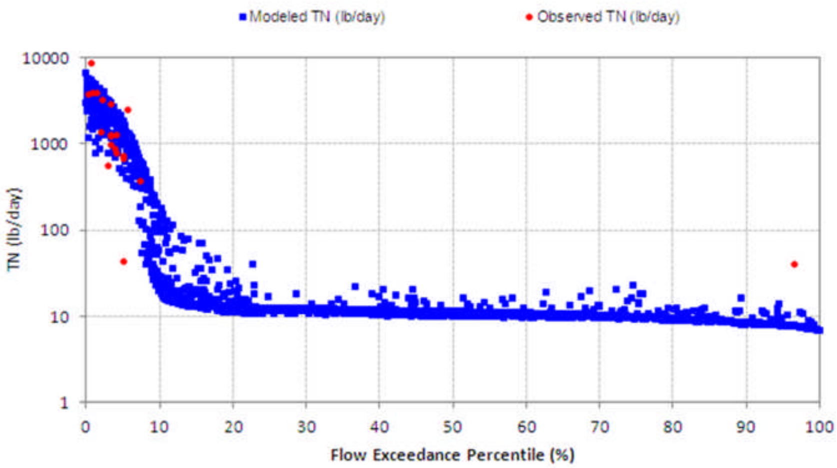




**Figure B-43. Total Nitrogen at Chollas Monitoring Site – Simulated and Observed Comparison**

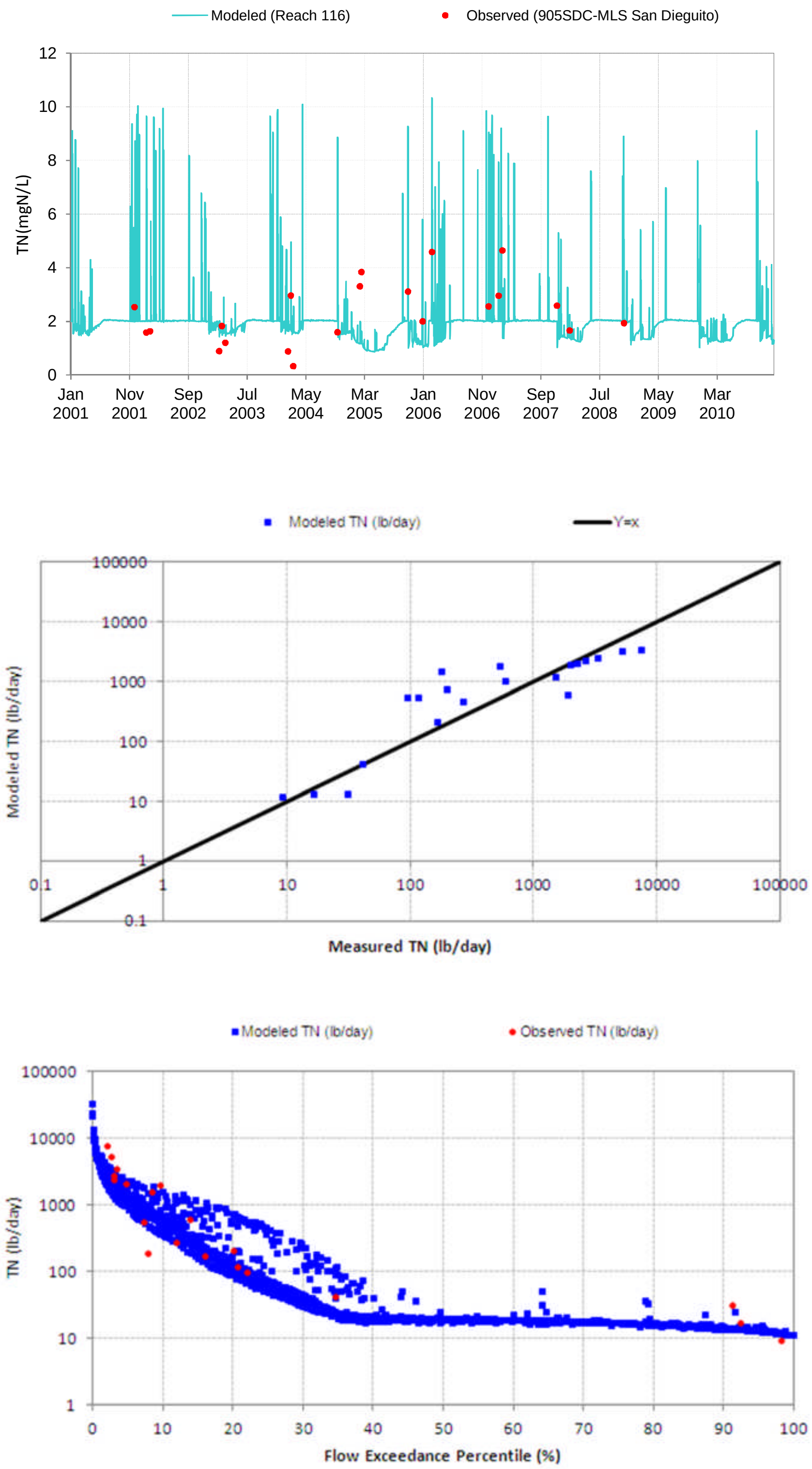



**Figure B-44. Total Nitrogen at San Dieguito Monitoring Site – Simulated and Observed Comparison**

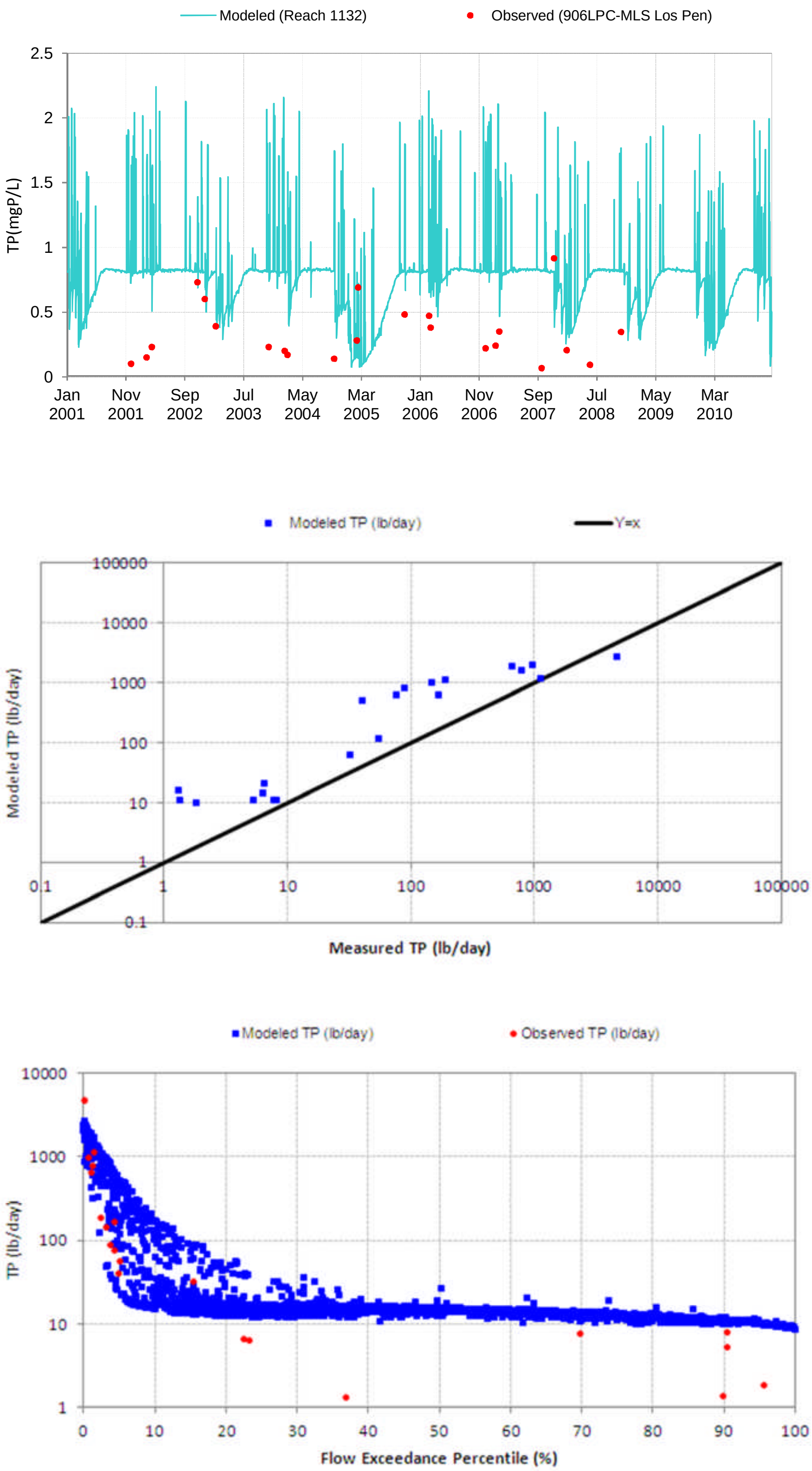
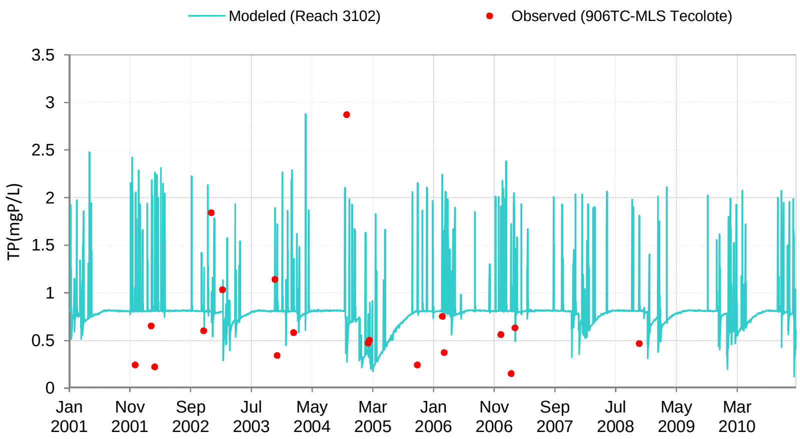
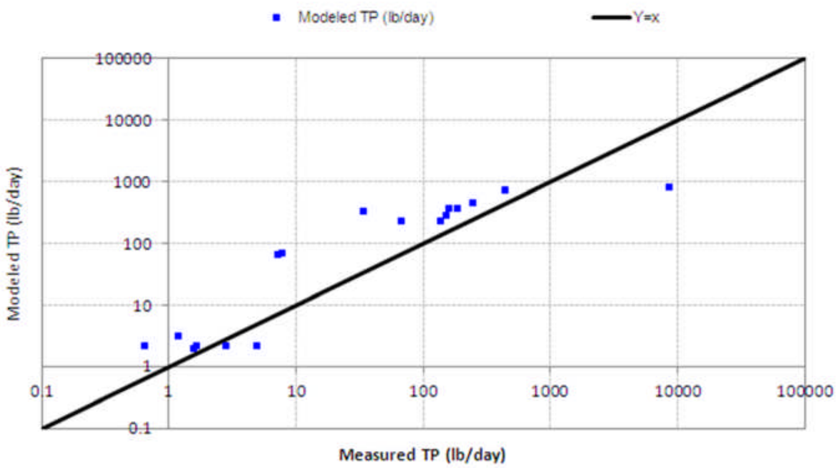



**Figure B-45. Total Phosphorus at Los Peñasquitos Monitoring Site – Simulated and Observed Comparison**



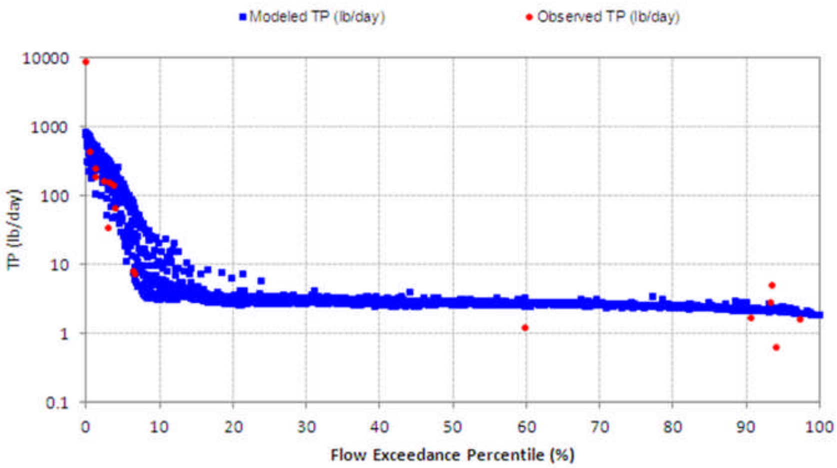
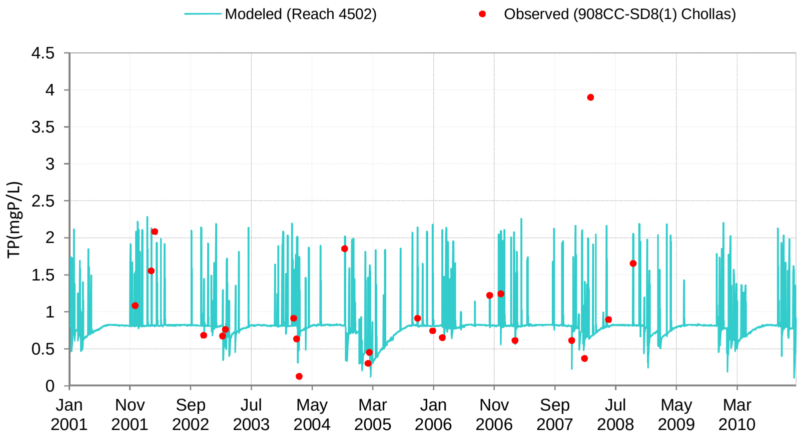
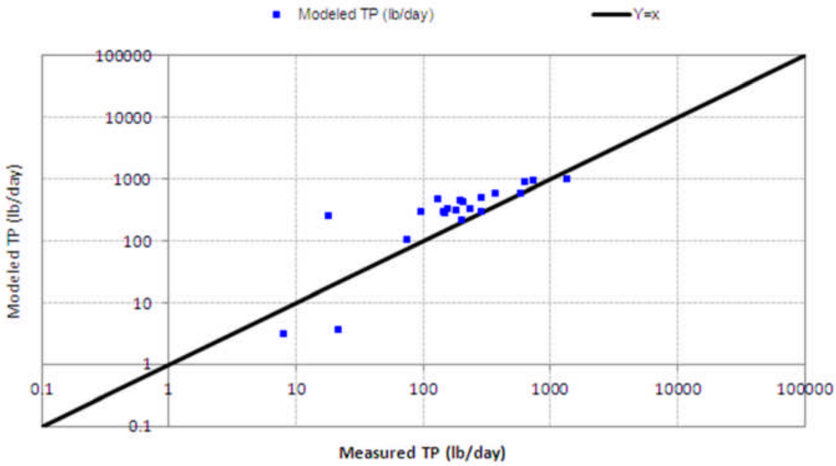




**Figure B-46. Total Phosphorus at Tecolote Monitoring Site – Simulated and Observed Comparison**



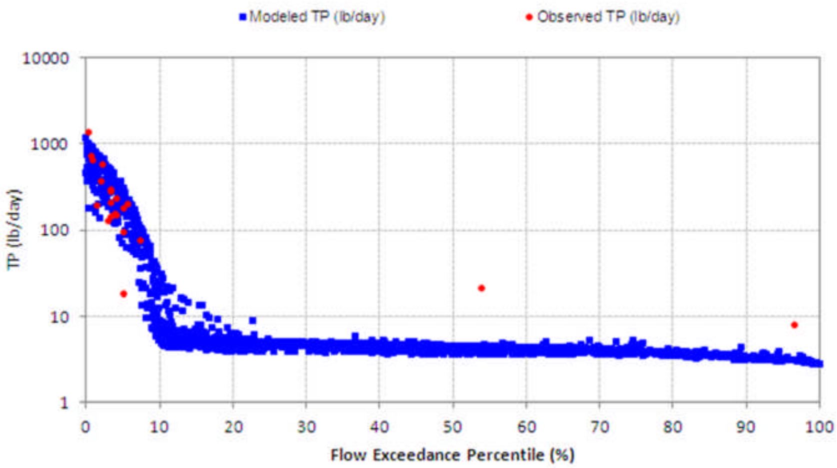




**Figure B- 47. Total Phosphorus at Chollas Monitoring Site – Simulated and Observed Comparison**

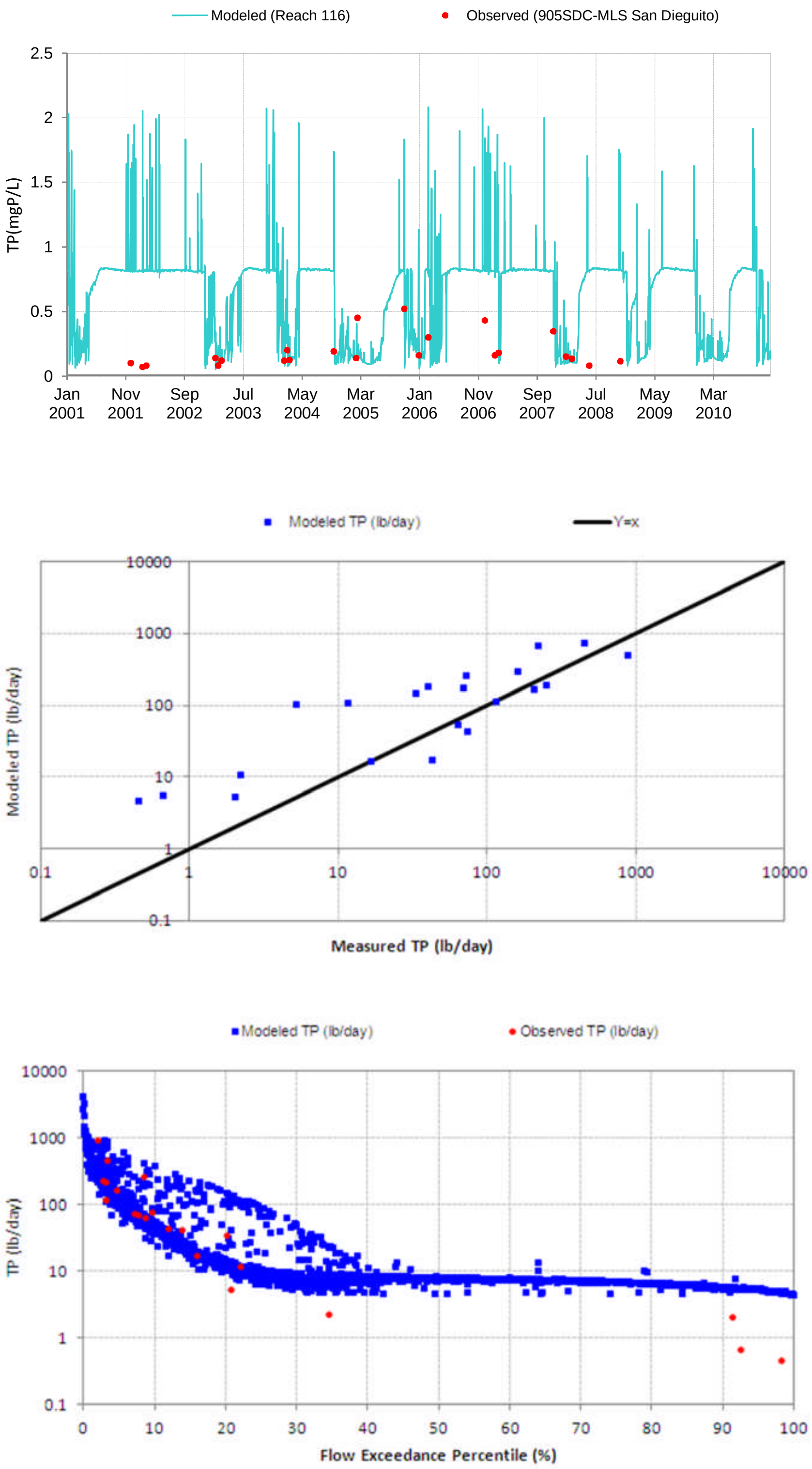


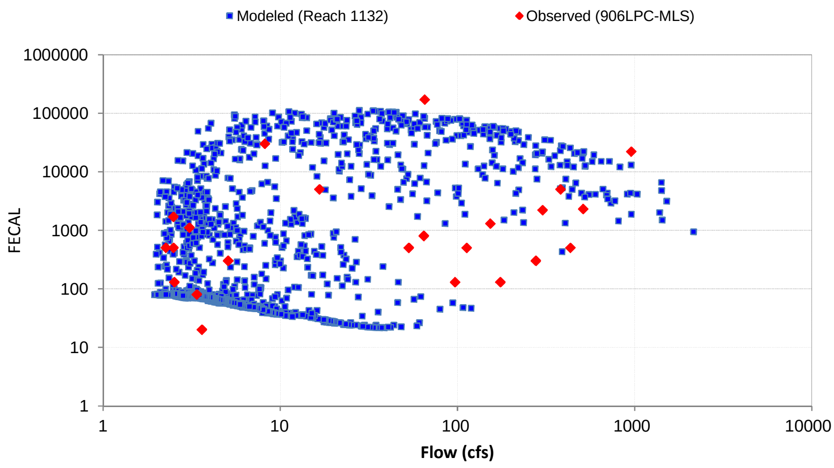

Figure B-48. Total Phosphorus at San Dieguito Monitoring Site – Simulated and Observed Comparison

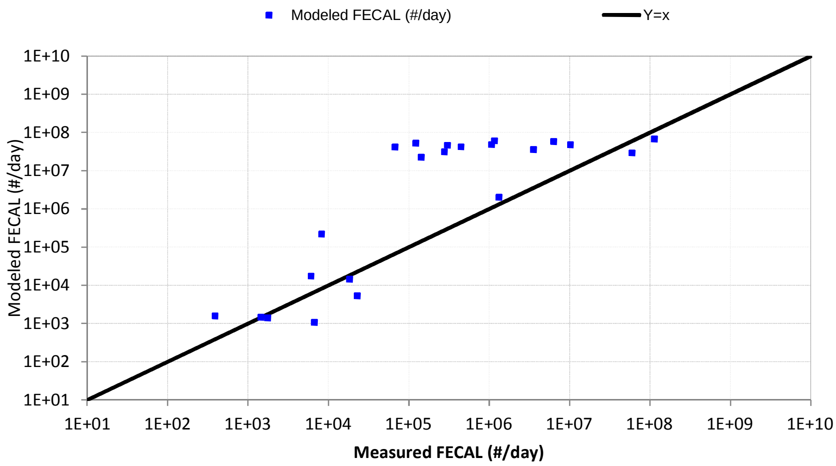
## Bacteria

Bacteria loads were difficult to replicate using the regional parameter approach; bacteria loading in the LSPC model was driven by upland storm event runoff processes, and did not take other sources of bacteria loading that are frequently present in urban watersheds, such as inflow and infiltration, leaking sanitary sewer lines, illicit and cross connections, and direct loading from rodents and wildlife within storm drains. It is also possible that large bacteria loads are mobilized from storm drains during wet weather events, which is a process more stochastic in nature than upland loading.

Figure B-49 through Figure B-60 present comparisons of simulated and observed bacteria for each of the three bacteria measures. Concentrations are well represented in Tecolote and Los Peñasquitos; concentrations appear to be overpredicted somewhat in San Dieguito, and underpredicted in Chollas.

Upland bacteria runoff processes (and the concentrations and loads produced as a result) are likely to be similar across the watersheds, so the calibration was conducted to obtain an overall balance between the watersheds for each bacteria measure. The results are therefore appropriate for characterizing upland sources and loads. However, the model does not include other urban sources of bacteria, so receiving stream results should be viewed in that context. Further updates and improvements to the bacteria simulation are planned in the next phase of modeling.



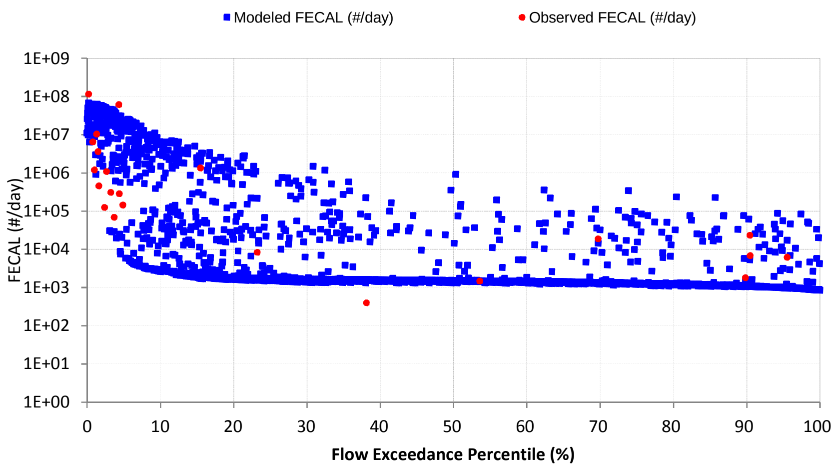




**Figure B-49. Fecal Coliform at Los Peñasquitos Monitoring Site – Simulated and Observed Comparison**

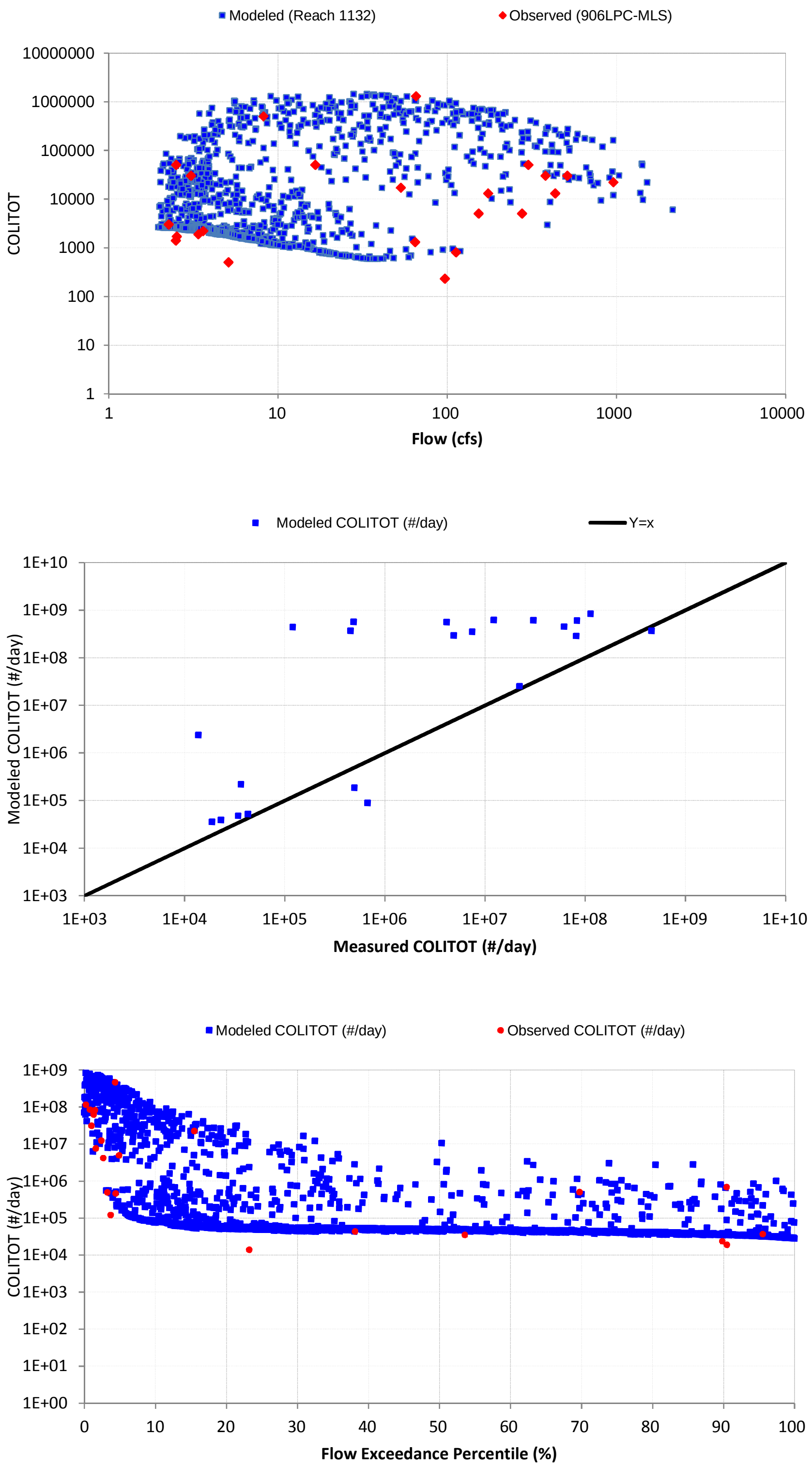



**Figure B-50. Total Coliform at Los Peñasquitos Monitoring Site – Simulated and Observed Comparison**

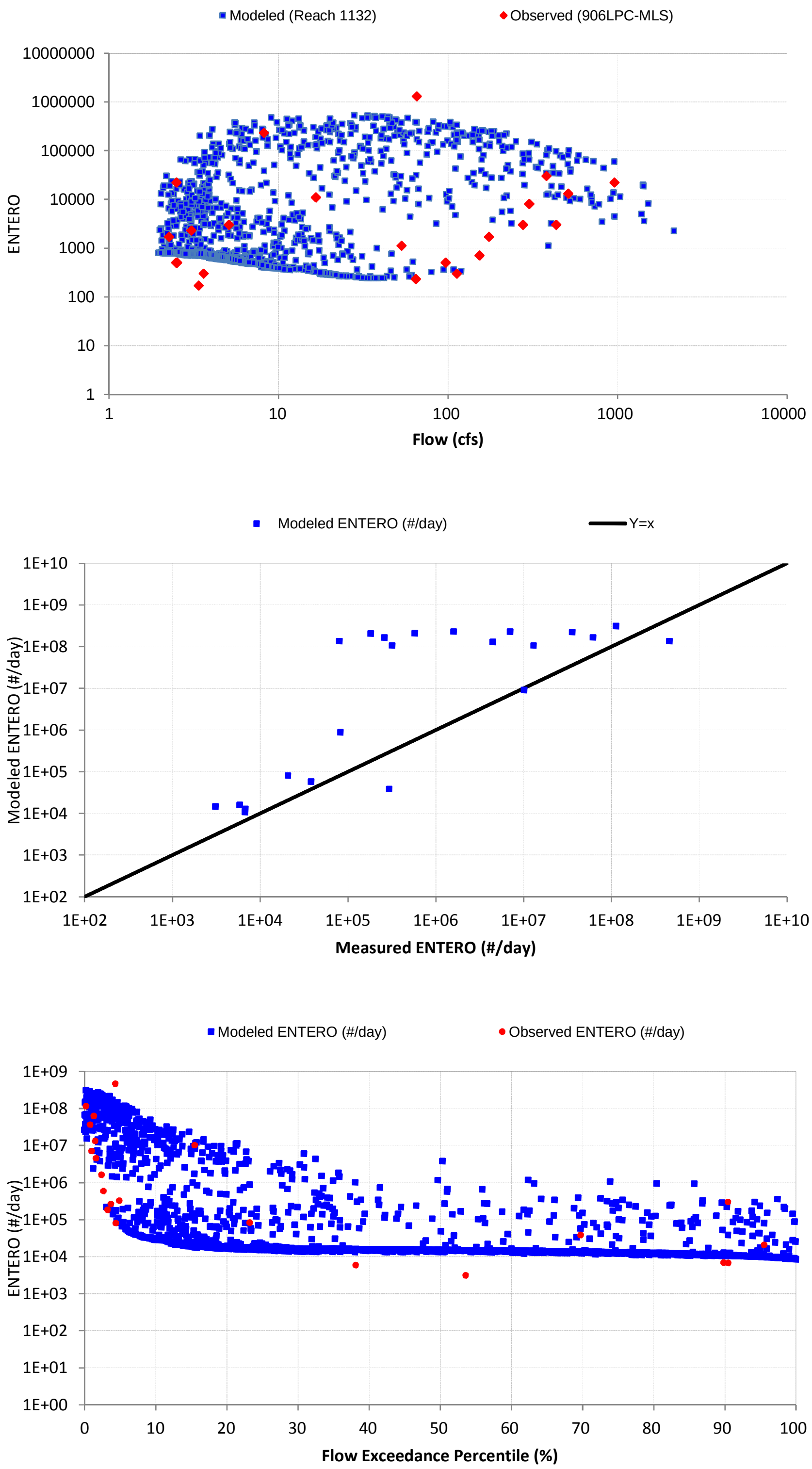



**Figure B-51. Enterococcus at Los Peñasquitos Monitoring Site – Simulated and Observed Comparison**

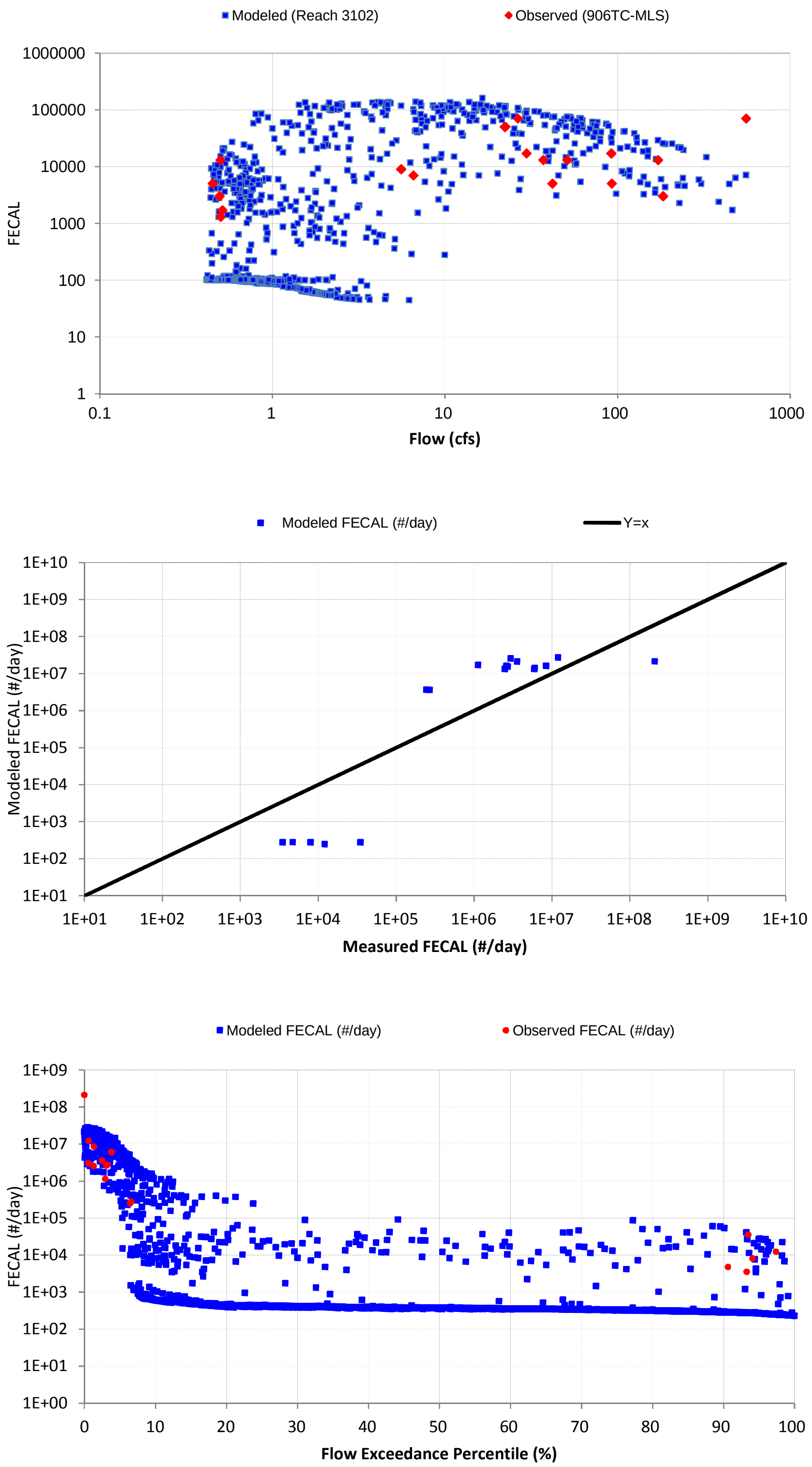



**Figure B-52. Fecal Coliform at Tecolote Monitoring Site – Simulated and Observed Comparison**

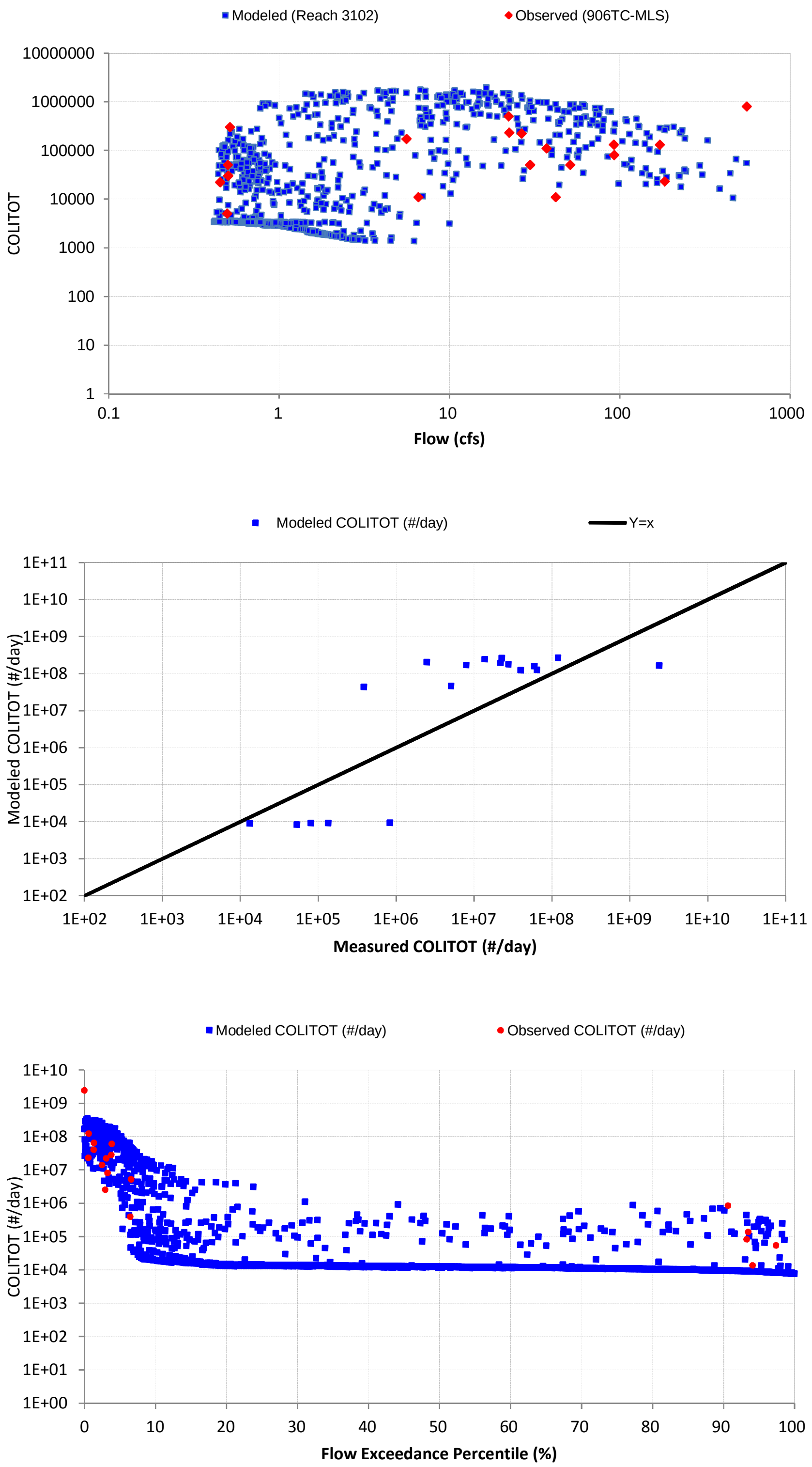
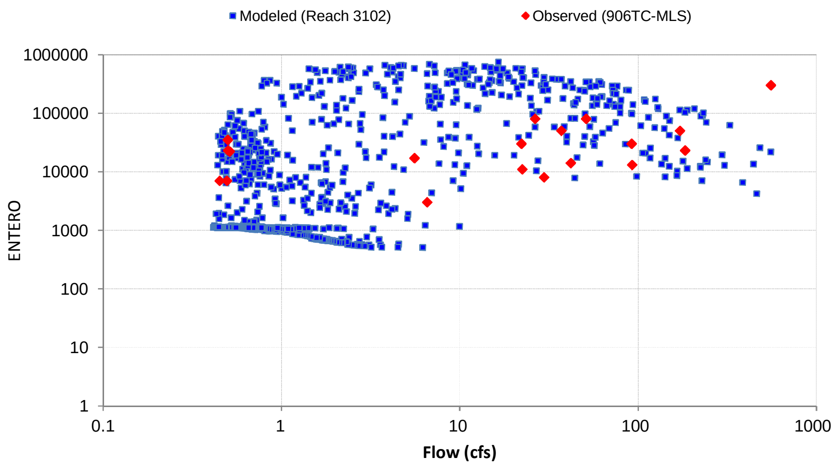
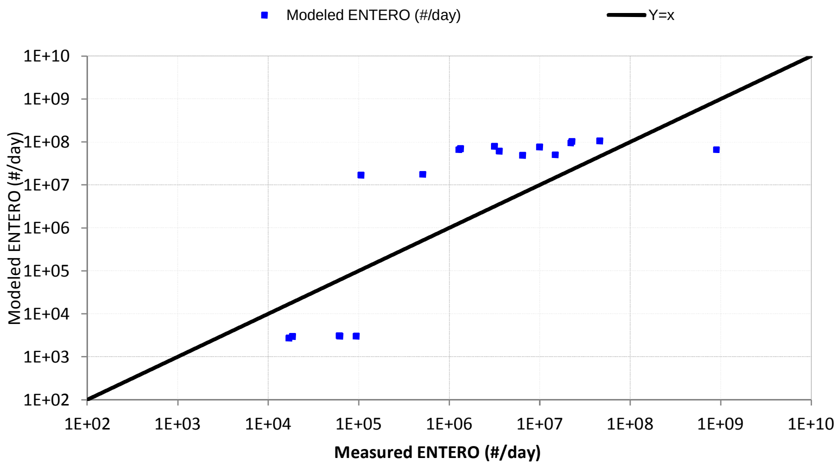



**Figure B-53. Total Coliform at Tecolote Monitoring Site – Simulated and Observed Comparison**



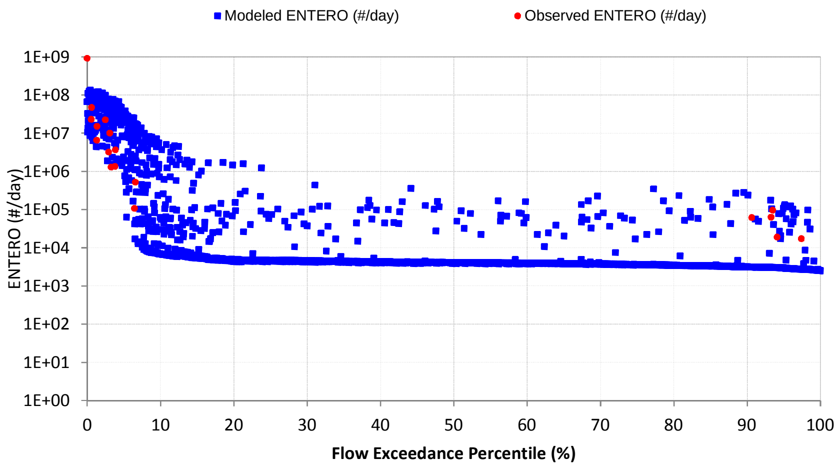




**Figure B-54. Enterococcus at Tecolote Monitoring Site – Simulated and Observed Comparison**

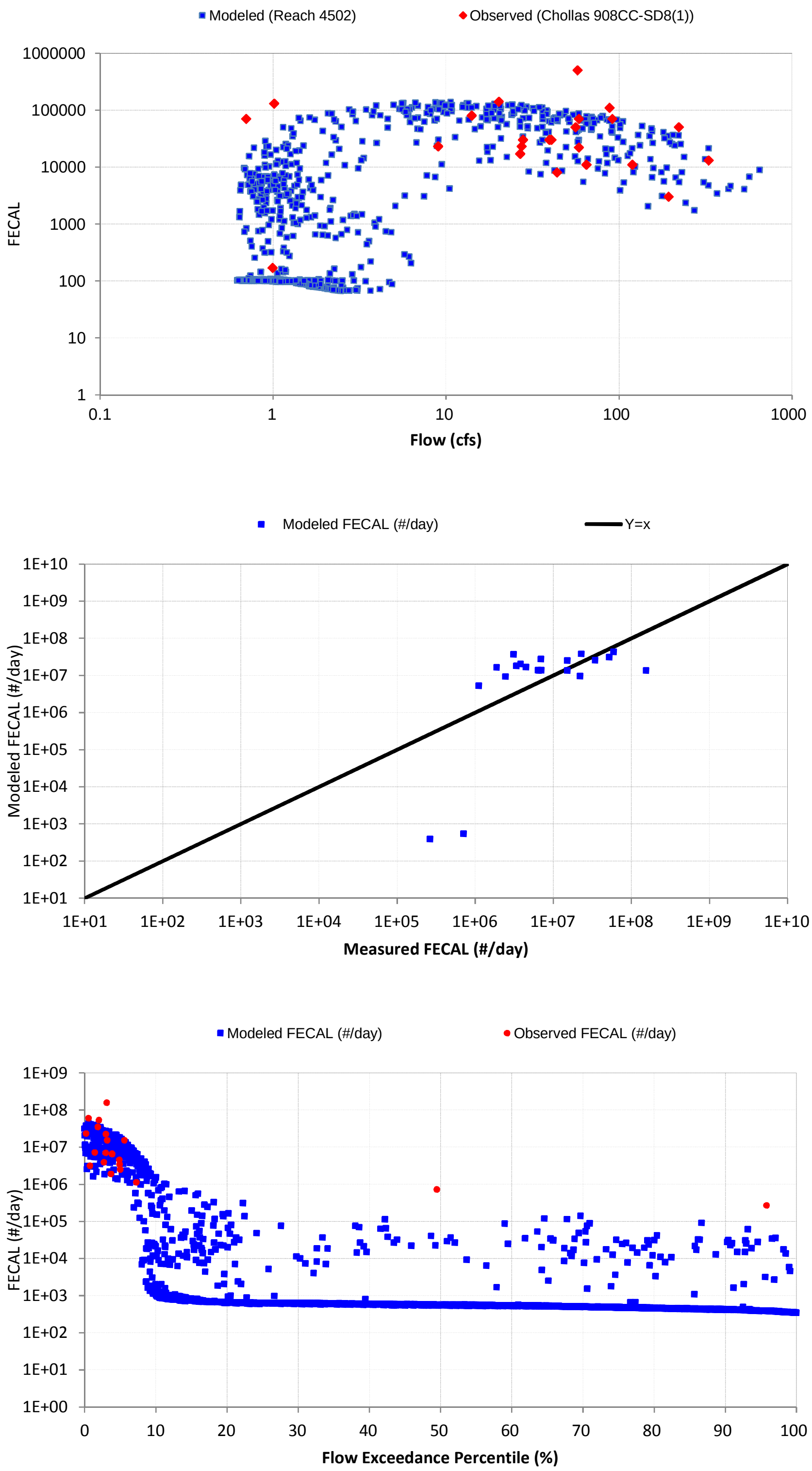



**Figure B-55. Fecal Coliform at Chollas Monitoring Site – Simulated and Observed Comparison**

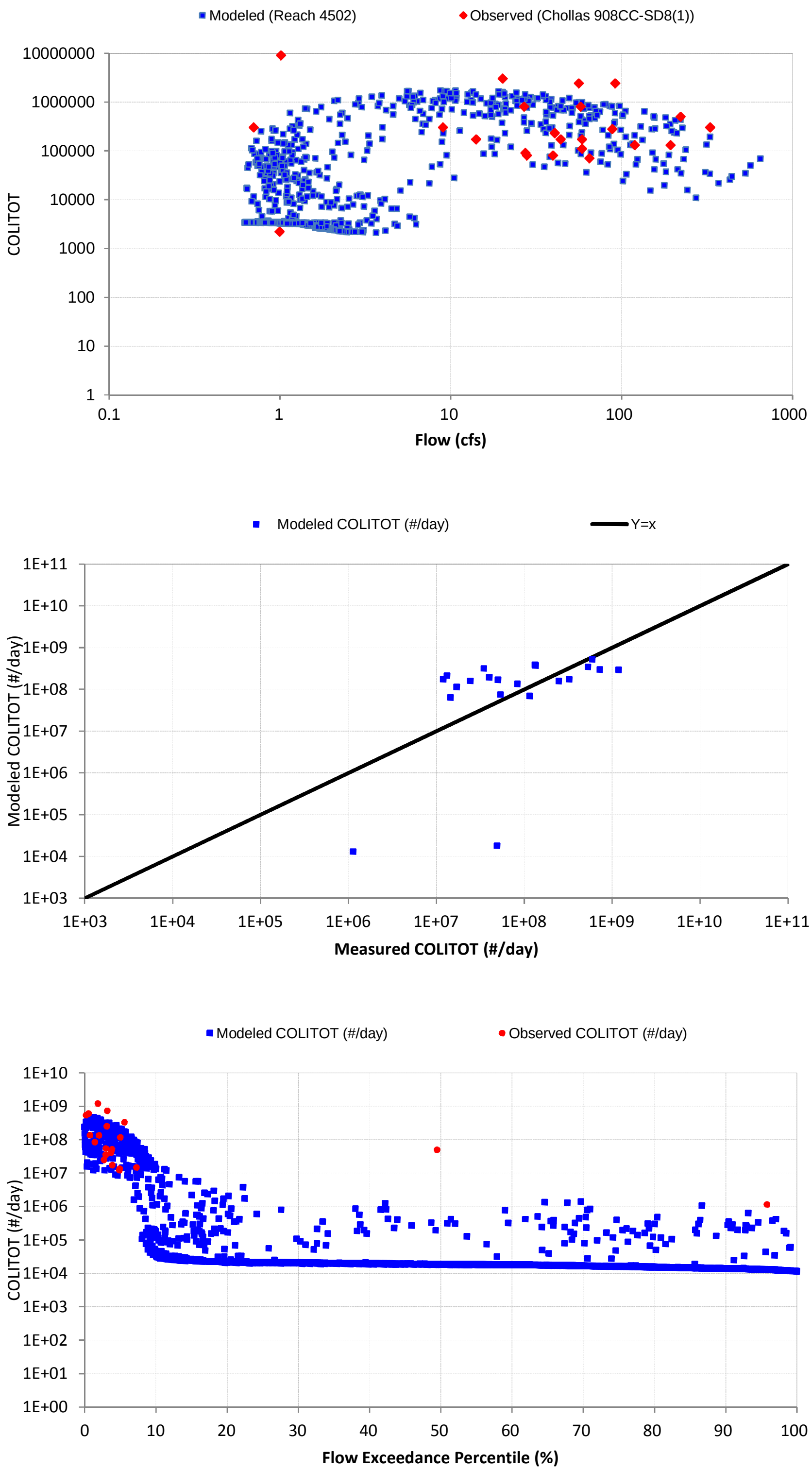
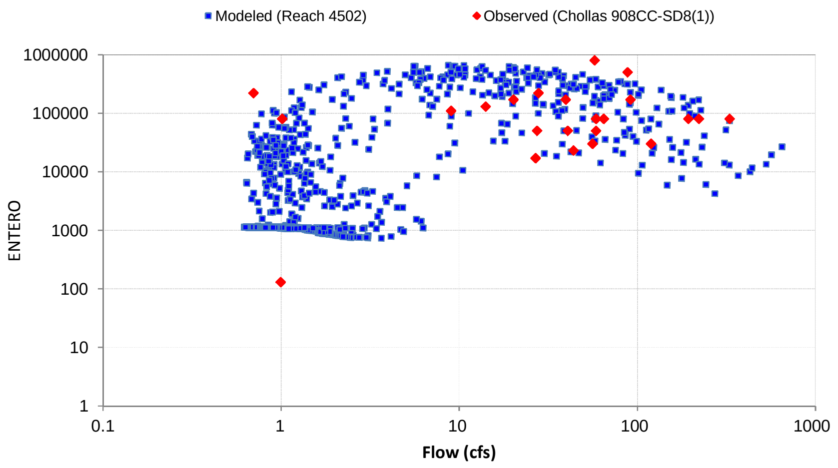
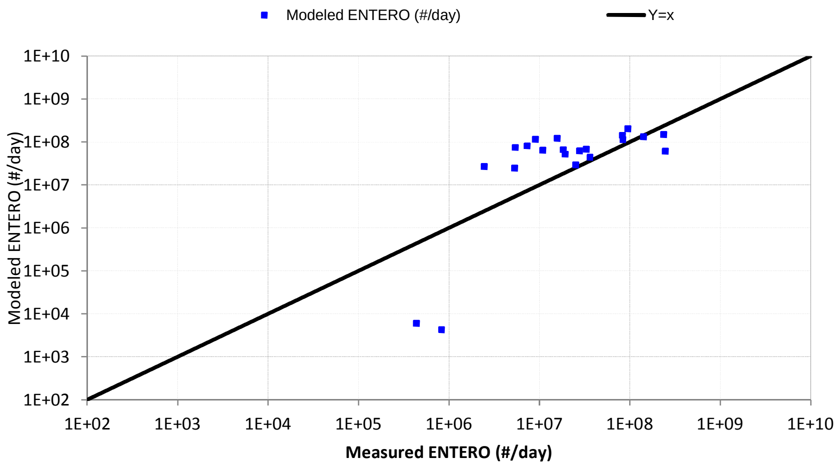



**Figure B-56. Total Coliform at Chollas Monitoring Site – Simulated and Observed Comparison**



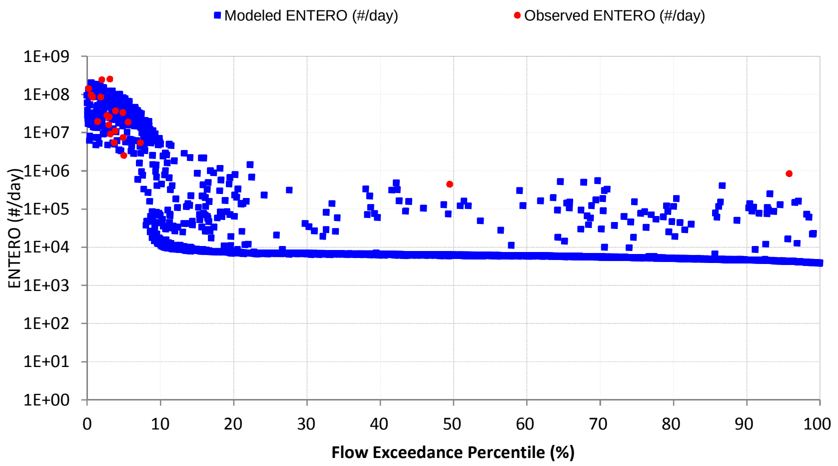




**Figure B-57. Enterococcus at Chollas Monitoring Site – Simulated and Observed Comparison**

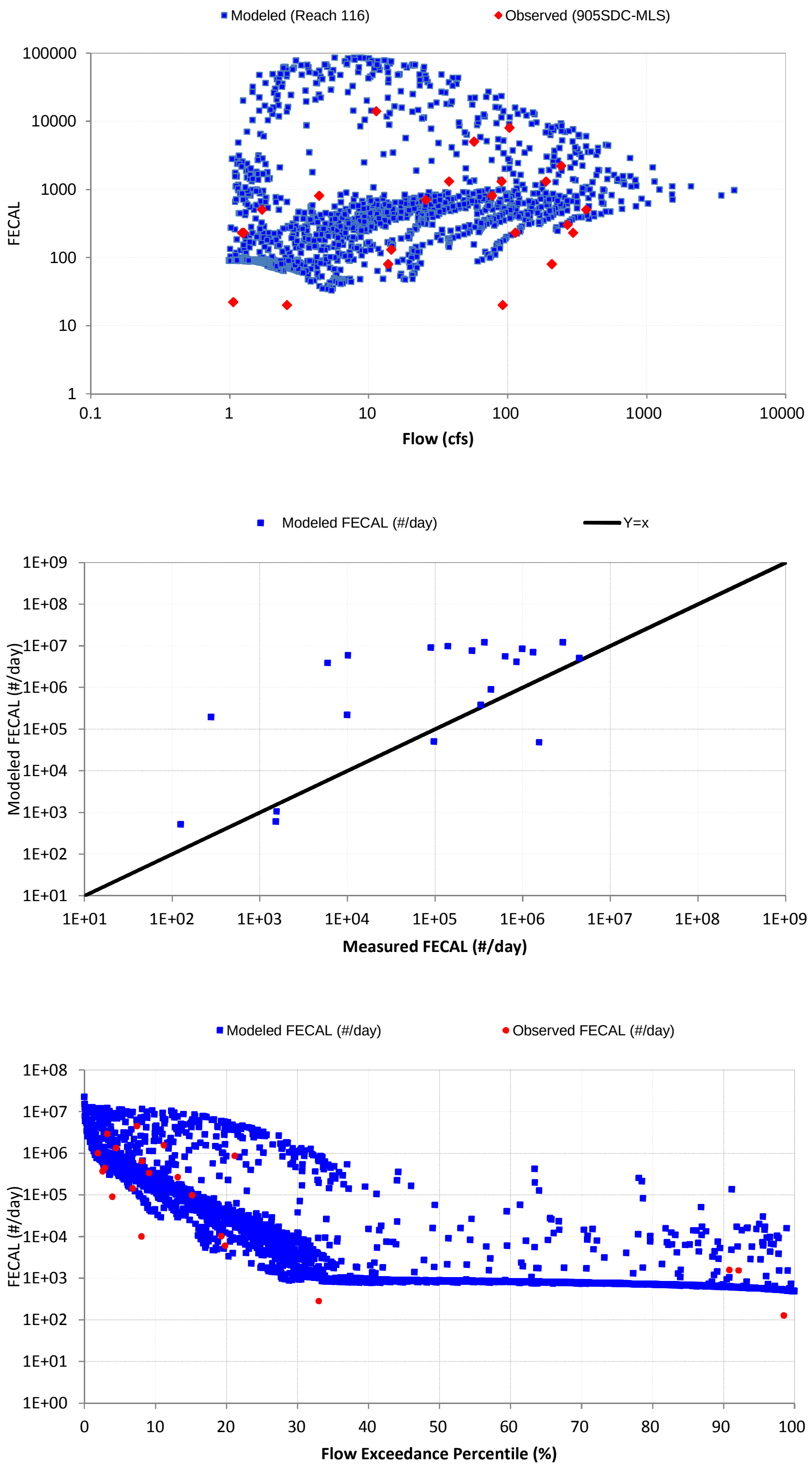



**Figure B-58. Fecal Coliform at San Dieguito Monitoring Site – Simulated and Observed Comparison**

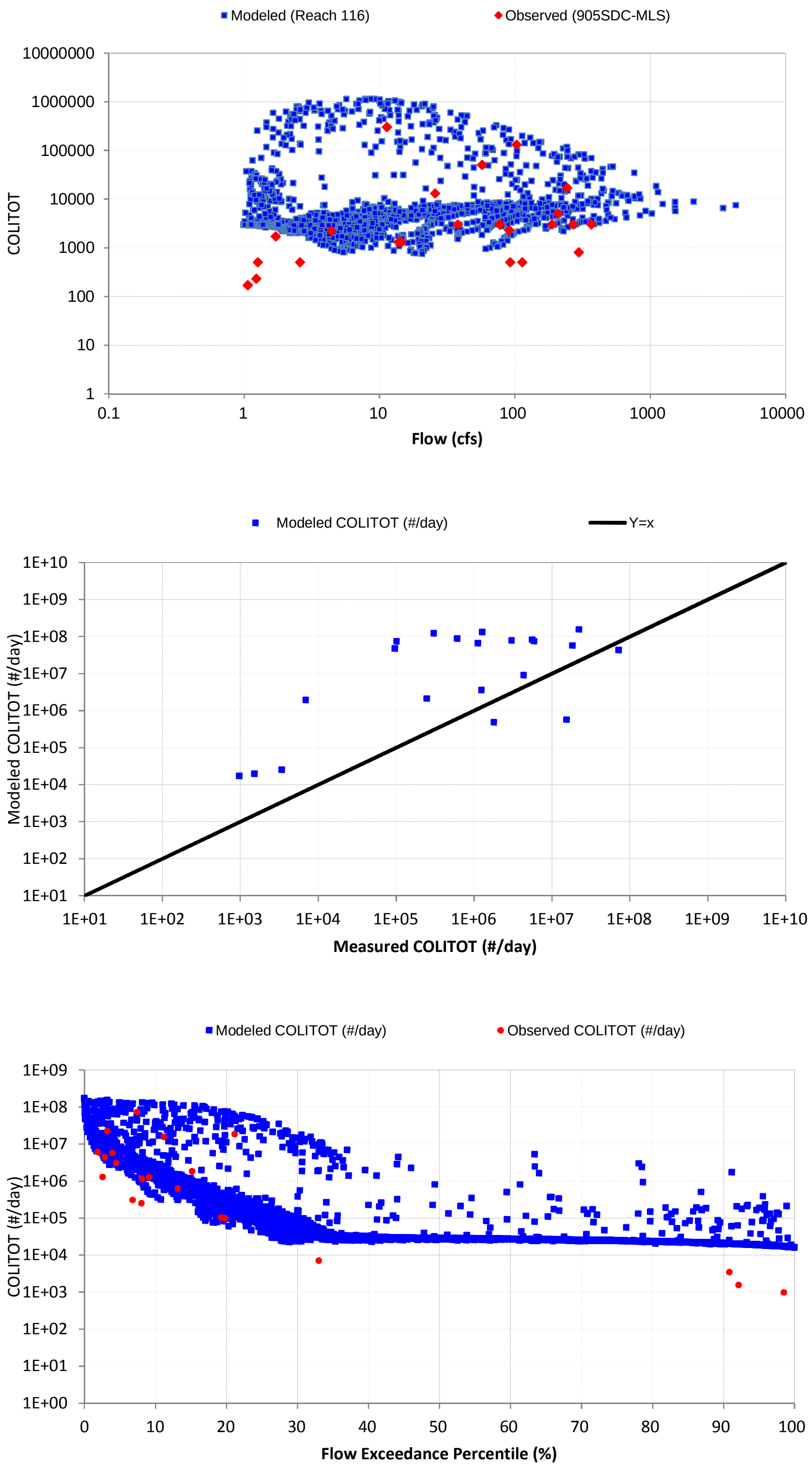



**Figure B-59. Total Coliform at San Dieguito Monitoring Site – Simulated and Observed Comparison**

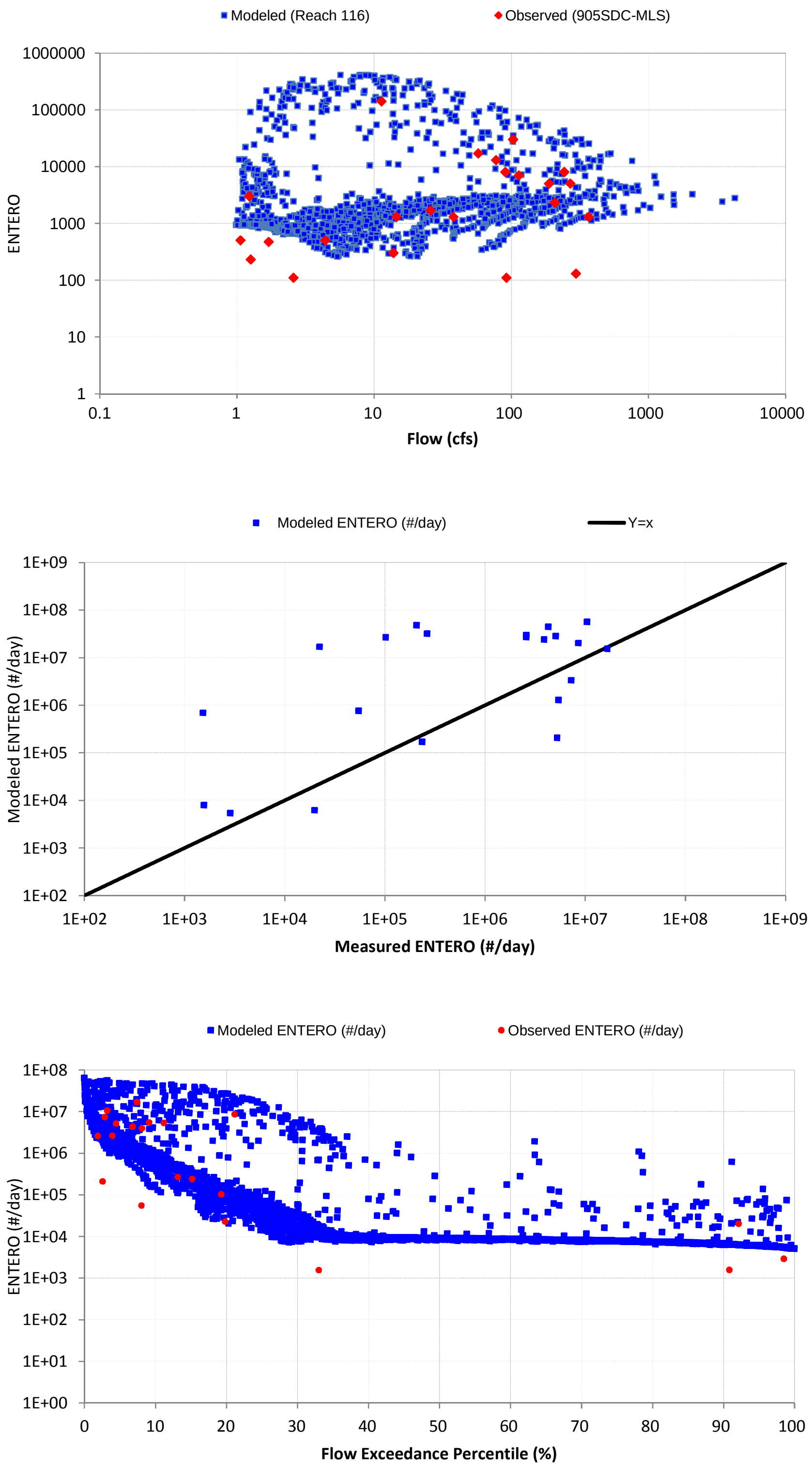



**Figure B-60. Enterococcus at San Dieguito Monitoring Site – Simulated and Observed Comparison**

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# Appendix C. Pollutant Source Prioritization Scores

Model subwatersheds were prioritized on the basis of modeled water quality parameters (see Section 3.4). Wet- and dry-weather composite scores were combined into an overall water quality composite score. These scores are illustrated in Figure C-1 through Figure C-3 below and Table C-1 presents the subwatershed-specific scores.

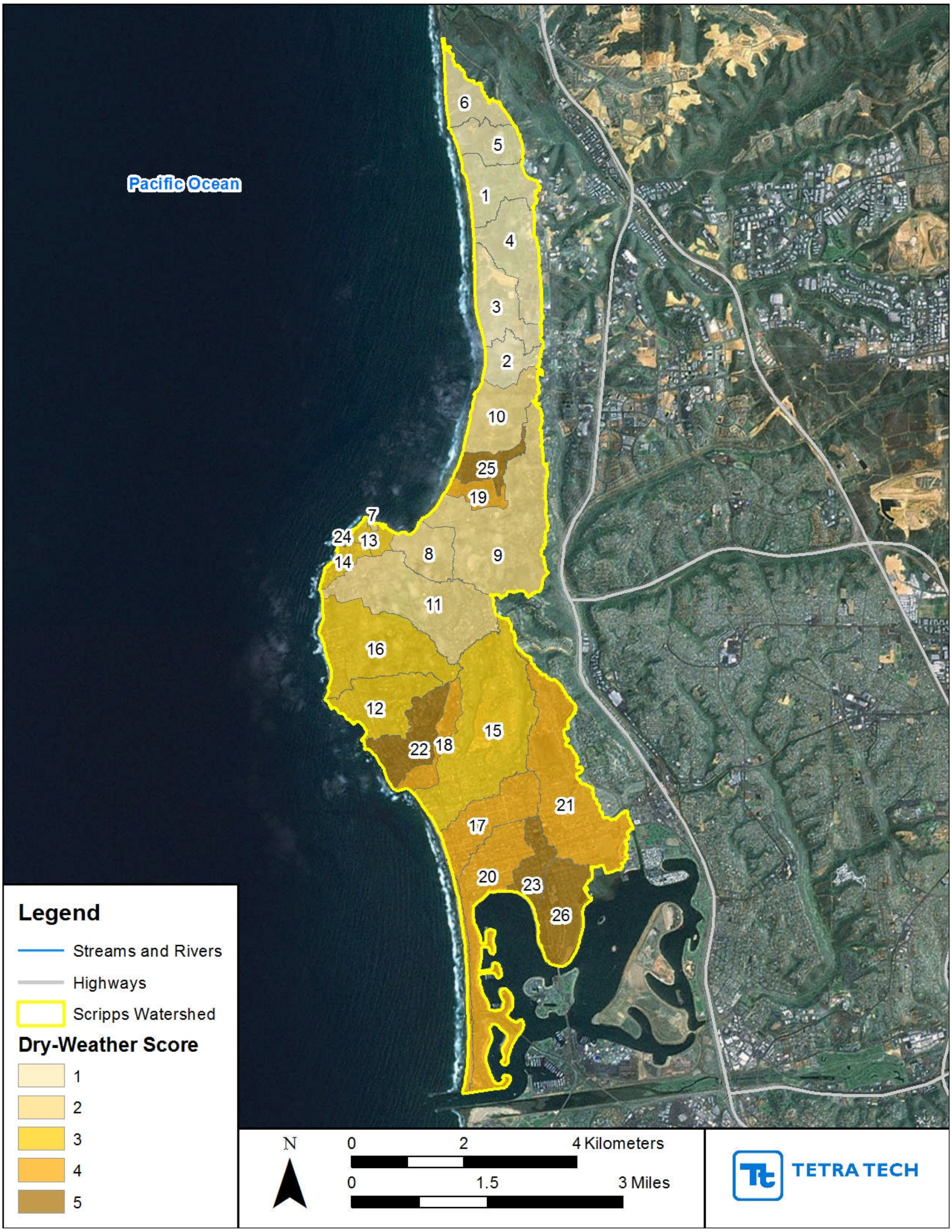


**Figure C-1. Dry-weather composite score (bacteria)**

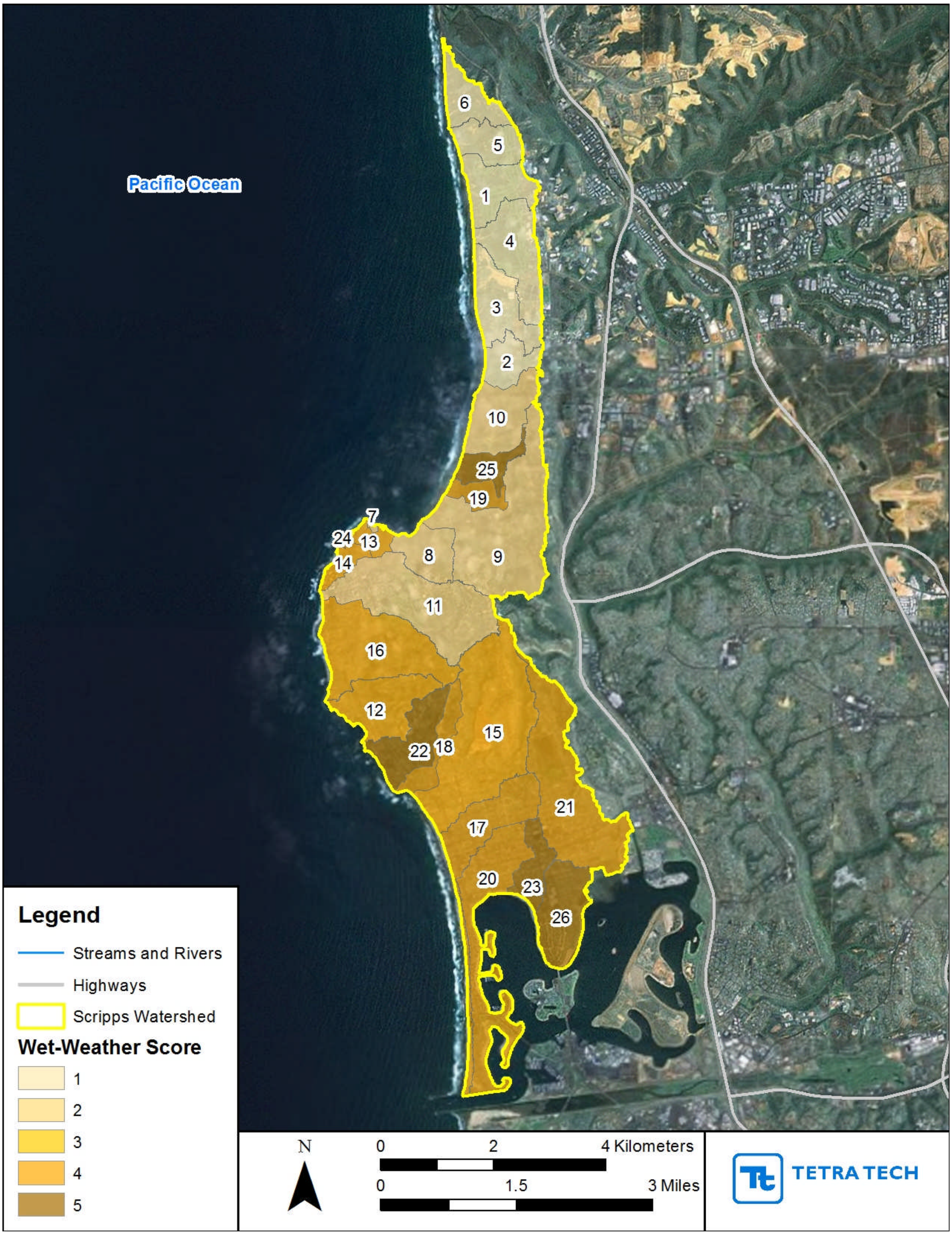


**Figure C-2. Wet-weather composite score (bacteria)**

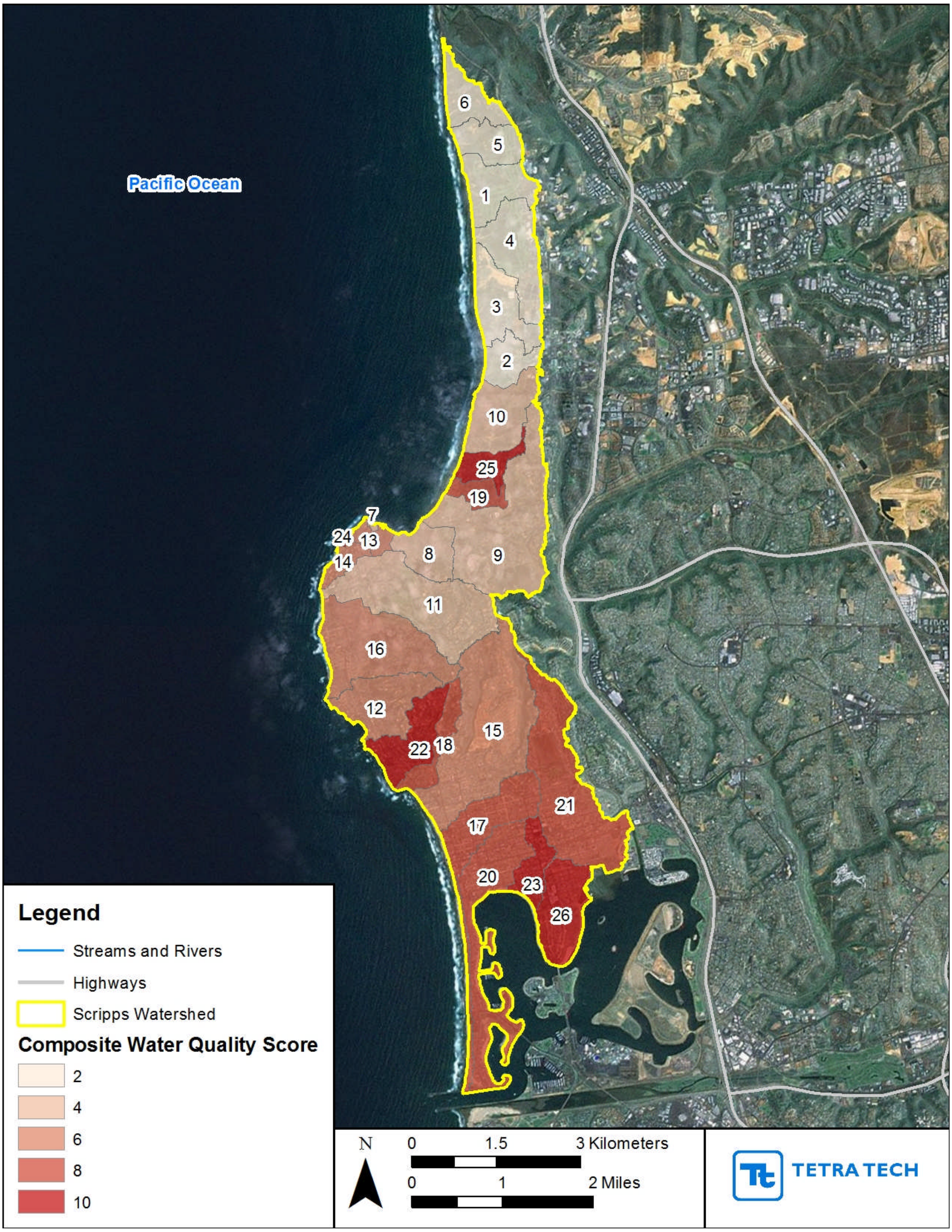


**Figure C-3. Water quality composite score (bacteria)**

## Table C-1. Wet- and dry-weather score details for the Scripps watershed

| Subwatershed ID | Total water quality score | Dry composite score (bacteria) | Wet composite score (bacteria) |
|---|---|---|---|
| 1 | 2 | 1 | 1 |
| 2 | 2 | 1 | 1 |
| 3 | 2 | 1 | 1 |
| 4 | 2 | 1 | 1 |
| 5 | 2 | 1 | 1 |
| 6 | 2 | 1 | 1 |
| 7 | 4 | 2 | 2 |
| 8 | 4 | 2 | 2 |
| 9 | 4 | 2 | 2 |
| 10 | 4 | 2 | 2 |
| 11 | 4 | 2 | 2 |
| 12 | 6 | 3 | 3 |
| 13 | 6 | 3 | 3 |
| 14 | 6 | 3 | 3 |
| 15 | 6 | 3 | 3 |
| 16 | 6 | 3 | 3 |
| 17 | 8 | 4 | 4 |
| 18 | 8 | 4 | 4 |
| 19 | 8 | 4 | 4 |
| 20 | 8 | 4 | 4 |
| 21 | 8 | 4 | 4 |
| 22 | 10 | 5 | 5 |
| 23 | 10 | 5 | 5 |
| 24 | 10 | 5 | 5 |
| 25 | 10 | 5 | 5 |
| 26 | 10 | 5 | 5 |

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# Appendix D. County of San Diego BMP Factsheets

The County of San Diego worked with the Copermittees to define a set of nonstructural BMP categories described as *families* to support consistency in regional CLRP development efforts. These BMP families were independently described in factsheets, which are incorporated below.

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# Appendix E. Non-Structural BMP Descriptions

This section presents the master list of all of the Non-Structural BMPs considered for implementation in any of the watersheds. Each description includes an explanation of the purpose of the BMP, examples (where available) from within and outside the region of comparable BMPs or pilot projects, and discussion some of the many possible forms that implementation may take in different RPs, depending upon the RP's unique conditions, resources, political environment, and priorities for reduction with watershed areas.

Table E-1 lists the full BMP menu and the watersheds to which the BMP applies. Each of the BMPs receives a narrative description following Table E-1. The effectiveness for each BMP to reduce pollutant loads and the relationships with Pollutant Source Characterization (PSC) land uses and Pollutant-Generating Activities (PGAs) appears in Appendix F.

### Table E-1. Menu of BMPs, Model Programs, and Principally Affected Watersheds

| BMP | | San Diego region CLRP watersheds principally affected | | | | |
|---|---|---|---|---|---|---|
| | | Scripps | Tecolote Creek | Chollas Creek | Los Peñasquitos | San Dieguito |
| *Development Review Process* | | | | | | |
| 1 | Amend zoning and other development regulations to facilitate LID implementation | 💧 | 💧 | 💧 | 💧 | 💧 |
| 2 | Develop design standards/manuals to facilitate LID implementation | | | | 💧 | 💧 |
| 3 | Train staff and boards to facilitate LID implementation and source control | 💧 | 💧 | 💧 | 💧 | 💧 |
| *Enhanced Inspections and Enforcement* | | | | | | |
| 4 | Training or certification requirements for mobile businesses | 💧 | 💧 | 💧 | 💧 | 💧 |
| 5 | Inspection/enforcement of power washing discharges | 💧 | 💧 | 💧 | 💧 | 💧 |
| 6 | Enhanced IC/ID reporting and enforcement | | 💧 | 💧 | 💧 | 💧 |
| 7 | Property-based inspections | 💧 | 💧 | 💧 | 💧 | 💧 |
| 8 | Supplemental inspection standards for PGAs of concern | | | 💧 | | |
| *SUSMP and Regulatory Enhancement* | | | | | | |
| Amend SUSMP, other code and zoning requirements, including the addition of retrofit requirements, to reduce pollutants from: | | | | | | |
| 9 | Trash enclosure and storage areas | 💧 | 💧 | 💧 | 💧 | 💧 |
| 10 | Animal-related facilities | 💧 | 💧 | 💧 | 💧 | 💧 |
| 11 | Keeping of large animals | | | | 💧 | 💧 |
| 12 | Nurseries and garden centers | 💧 | 💧 | 💧 | 💧 | 💧 |
| 13 | Auto-related uses | 💧 | 💧 | 💧 | 💧 | 💧 |
| 14 | Vehicle washing areas | | | | 💧 | 💧 |
| 15 | Update minimum BMPs | 💧 | 💧 | 💧 | 💧 | 💧 |
| *New/Expanded Initiatives* | | | | | | |
| 16 | Partnerships to address bacteria and trash impacts of homelessness | 💧 | 💧 | 💧 | 💧 | 💧 |
| 17 | Pilot projects disconnecting impervious surfaces from the MS4 (e.g. rain barrels, downspout disconnection) | 💧 | 💧 | 💧 | 💧 | 💧 |

| BMP | | San Diego region CLRP watersheds principally affected | | | | |
|---|---|---|---|---|---|---|
| | | Scripps | Tecolote Creek | Chollas Creek | Los Peñasquitos | San Dieguito |
| 18 | Mapping and risk assessment of agricultural operations | | | | 🌢 | 🌢 |
| 19 | Mapping and risk assessment of on-site wastewater treatment systems | | | | 🌢 | 🌢 |
| 20 | Support for Brake Pad Partnership | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 21 | Additional source reduction initiatives | | | | | 🌢 |
| *Landscape Practices* | | | | | | |
| Landscape BMP incentives, rebates, and training: | | | | | | |
| 22 | Residential properties | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 23 | Homeowners' associations/property managers | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 24 | Nonresidential properties | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 25 | Reducing over-irrigation | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 26 | Xeriscaping, turf conversion and other irrigation, pesticide and fertilizer reduction | | 🌢 | 🌢 | 🌢 | 🌢 |
| *Education and Outreach* | | | | | | |
| 27 | Enhanced and expanded trash cleanup programs | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 28 | Improved Web resources promoting reporting of enforceable discharges | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| Refocused or enhanced education and outreach to target audiences: | | | | | | |
| 29 | Equestrian community | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 30 | Garden and landscape practices | | | | | |
| 31 | On-site agricultural practices (e.g. chickens, compost) | | | | | |
| 32 | General/other | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| *MS4 Maintenance* | | | | | | |
| 33 | Optimized or enhanced catch basin inlet cleaning and management | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 34 | Proactive MS4 repair and replacement | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 35 | Increased channel cleaning and scour pond repair to improve MS4 function | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| Street sweeping enhancements and expansion: | | | | | | |
| 36 | Increased sweeping frequency or routes | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 37 | Sweeping medians on high-volume segments | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 38 | Upgraded sweeping equipment | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 39 | Sweeping of private roads and parking lots | 🌢 | 🌢 | | | |
| Erosion repair and slope stabilization: | | | | | | |
| 40 | Public property and right of way | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 41 | Enforcement on private properties | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| *Capital Improvement Projects* | | | | | | |
| 42 | Dry-weather flow separation | 🌢 | 🌢 | 🌢 | 🌢 | 🌢 |
| 43 | Sewer pipe replacement | | | 🌢 | | |
| 44 | Reducing groundwater infiltration | | | 🌢 | | |
| 45 | Mitigation and conservation initiatives | | 🌢 | 🌢 | 🌢 | 🌢 |

## Development Review Process

As land development occurs, the Responsible Parties (RPs) other than Caltrans have the opportunity to promote the implementation of LID storm water treatment and control measures which, collectively, amount to an additional set of structural BMPs on sites throughout the watershed. When redevelopment sites include LID, water quality treatment and load reductions often are improved over baseline developed conditions. The BMPs developed in this category reflect three key implementation needs: one, amendments to codes and ordinances so that barriers to LID, such as highly prescriptive landscaping requirements and provisions requiring curbing around landscaped areas can be removed; two, for some communities, development of standards and specifications for LID measures to provide guidance for their inclusion in capital projects; and three, training of municipal staff and volunteer boards (particularly planning commission) on LID design principles, and how these differ from conventional site planning and engineering.

### *BMP #1: Amend zoning and other development regulations to facilitate LID implementation*

**Description:** While SUSMPs in each community detail provisions relating to BMPs required for new development and redevelopment, and any retrofits required in the watershed. In particular, the SUSMP and zoning ordinances outline Low Impact Development (LID) requirements. Primarily, requirements are to detain and filter runoff using natural filters, but storm water retention for reuse may also be desired. However, in some jurisdictions, provisions in existing zoning codes and ordinances create barriers to LID implementation. Amending these codes and ordinances to enable, and where possible, to encourage the use of LID storm water management measures is expected to provide greater pollutant source control through the development process – particularly for redevelopment projects, where there can be significant opportunities to implement LID and improve existing conditions.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary* | Commercial | Animals |
| Bacteria | HD Residential | Auto body painting |
| Sediment | LD Residential | Auto repair |
| Nutrients | Rural Residential | Boat repair |
| Trash | Institutional | Corporate yards |
| Flow | Industrial | Food facilities |
| Volume reduction | Recreation | Golf courses |
| | Transportation | Industrial facilities |
| *Secondary* | Shopping Center | Municipal airfields |
| Metals | | Nurseries |
| Organics | | Paintball fields |
| Pesticides | | Zoos |
| Dissolved minerals | | |

### *BMP #2: Develop design standards/manuals to facilitate LID implementation*

**Description:** Along with changes to the zoning ordinances, jurisdictions implementing LID regulations often prepare design standards and manuals to facilitate LID implementation. A design manual should clarify criteria for compliance with LID regulations and provide guidance on acceptable LID design practices. A design manual that provides the necessary tools and training for a developer to identify appropriate designs for a given site and implement them easily will facilitate LID implementation by reducing resistance to implementation and increasing the likelihood of effective in-place BMPs.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Bacteria<br>Sediment<br>Nutrients<br>Trash<br>Flow<br>Volume reduction<br><br>*Secondary*<br>Metals<br>Organics<br>Pesticides<br>Dissolved minerals | Commercial<br>HD Residential<br>LD Residential<br>Rural Residential<br>Institutional<br>Recreation<br>Road<br>Transportation<br>Industrial<br>Shopping Center | Animals<br>Corporate yards<br>Food facilities<br>Golf courses<br>Industrial facilities<br>Municipal airfields<br>Nurseries<br>Paintball fields<br>Zoos |

### *BMP #3: Train staff and boards to facilitate LID implementation and source control*

**Description:** Beyond code language amendments, there is also a need to ensure that the many people involved in development plan review—from municipal planning and zoning staff, to engineering or public works reviewers, to the appointed members of planning and review boards—have a basic working knowledge of LID BMPs so that adverse conditions (e.g., requiring trees in swales, requesting alterations of drainage patterns that affect LID performance, etc.) are not imposed where LID measures are proposed. Particularly if LID is assumed as an overall reduction measure in the context of the CLRPs, this type of policy action and training will be essential to implementation.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>None<br><br>*Secondary*<br>Bacteria<br>Metals<br>Sediment<br>Pesticides<br>Nutrients<br>Dissolved minerals<br>Trash<br>Flow<br>Volume reduction | Commercial<br>HD Residential<br>LD Residential<br>Rural Residential<br>Institutional<br>Recreation<br>Road<br>Industrial<br>Shopping Center | Animals<br>Auto body painting<br>Auto repair<br>Boat repair<br>Corporate yards<br>Food facilities<br>Golf courses<br>Industrial facilities<br>Municipal airfields<br>Nurseries<br>Paintball fields<br>Zoos |

## Enhanced Inspections and Enforcement

The most universal recommendation from the RPs to achieve greater load reduction is to modify, re-focus and enhance the permit-based inspection program to ensure that municipal resources are directed towards the most likely sources of pollutants, and to ensure that both the program structure and the potential sanctions are encouraging better practices on the part of the regulated community. As part of this suite of BMPs, each RP is evaluating and recommending changes to their program, particularly the existing, standard industrial and commercial inspection program in the Permit, to focus on those land uses, PGAs, and high priority areas that are most likely to be contributing to loading, and where the greatest supplemental load reductions from inspection and enforcement are likely to be achieved. Property based inspections in particular offer a more efficient and effective alternative to the formulaic inspection of "high," "medium" and "low" risk properties that was initially important in structuring programs, but which has limited effectiveness as RP programs have become more informed and robust over time.

The RPs provided many best practice recommendations from their recent work on this issue that provide excellent methods of improving inspection and enforcement, and better engaging property owners and rewarding compliant behavior. For example, the City of La Mesa charges a fee for inspections and a supplemental fee to property owners whose properties must be re-inspected due to compliance issues, providing a financial incentive to ensure that properties are compliant. The City also uses a supplemental watershed questionnaire to keep track of whether inspections are effective and how well BMPs and code provisions are understood. As another example addressing restaurants and food-related uses, which are a substantial PGA in all CLRP watersheds, the City of Escondido has a strong ordinance and program for permits and inspections of food-related establishments, focused on minimizing unauthorized discharges to the MS4 and sanitary sewer systems. The 300+/- regulated food establishments in Escondido are charged $160 each for permitting and inspection, which helps the City fund the program and emphasizes the level of importance the City attaches to pollution prevention. This program is coordinated with the industrial pre-treatment division and provides inter-departmental communication as well.

All of these examples, and continued cross-jurisdiction work, provide a strong basis for implementing improved practices under this BMP category. Flexibility and support for the RPs is key in making these BMPs as effective as possible.

### *BMP #4: Training or certification requirements for mobile businesses*

**Description:** There is new focus within the Permit on mobile businesses as potential sources of pollutants to the MS4. The proliferation of mobile businesses and mobile business types makes this a potentially substantial area for load reduction; however the regulation of mobile businesses varies by jurisdiction, and mobile businesses, of course, are not subject to the types of SUSMP or zoning requirements applicable to "stationary" businesses and land uses. As such, the BMPs that can address pollution from mobile business sources are policy and code development and enforcement, education and outreach to mobile businesses, and inspections of these businesses while operating at various sites within an RP's jurisdiction.

The appropriate approach and strategy for each RP will vary by jurisdiction. Some RPs, such as Solana Beach and Del Mar, are considering a collaborative strategy as few mobile businesses are registered within each City. The County has in the past had an inventory of mobile businesses that could be revised. Escondido and La Mesa already have programs in place to work with mobile businesses at the time of licensing: La Mesa provides an affidavit regarding important water quality BMPs that mobile businesses sign at licensing, and Escondido has a training program for mobile businesses that may be replicable in other communities. Another key component for mobile businesses is random inspections of these operators in the field. Adding "drive-around" inspections of mobile businesses to the high-priority category can be expected to provide load reduction from this source, and may be incorporated into the RPs' programs. Each RP will adapt these and other strategies as their approaches are developed.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Organics | *Varies, not tied to a specific land use* | Auto Repair<br>Equipment Repair |

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| Oil and Grease<br><br>*Secondary*<br>Bacteria<br>Pesticides | | Nurseries |

### *BMP #5: Inspection/enforcement of power washing discharges*

**Description:** Nearly all of the RPs reported that violations related to building and surface area wash water continued to be an issue at some level, despite current levels of outreach, education, training and inspections. RPs with higher concentrations of commercial uses have a much greater need to address power washing of (for example) trash enclosure areas or animal-related facilities, so the approach by RP will differ.

In many cases, the RPs report that an issue of simple lack of understanding on the part of property managers or maintenance staff led to a problem, and that individual, one-on-one outreach has some effects in reducing the frequency of washing-related violations. It is likely that elevating the emphasis on washing as a pollutant source in outreach to property managers, potentially as part of a shift to property-based inspections or outreach to trash haulers, and ensuring that non-compliant washing is an enforceable violation of local ordinances, would provide load reduction, especially in commercial land use areas.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>None<br><br>*Secondary*<br>Bacteria<br>Metals<br>Organics<br>Sediment<br>Pesticides<br>Nutrients<br>Oil and grease<br>Dissolved minerals<br>Trash<br>Flow<br>Volume reduction | Commercial<br>HD Residential<br>Institutional<br>Recreation<br>Industrial<br>Heavy Industry<br>Extraction/Landfill | AWM Fueling<br>Airplane Repair<br>Animals<br>Auto Body Paint<br>Auto Repair<br>Boat Repair<br>Corporate Yards<br>Equipment Repair<br>Food Facilities<br>Golf Courses<br>Industrial Facilities<br>Municipal Airfield<br>Nurseries<br>Paintball Fields<br>Zoos |

### *BMP #6: Enhanced IC/ID reporting and enforcement*

**Description:** This BMP is specific to Caltrans, which has different IC/ID issues and approaches than the municipal RPs and the Unified Port of San Diego. Non-storm water discharges (dry weather discharges) are prohibited to the MS4, and are eliminated and documented when found by Caltrans staff. Common examples of such discharges include wash water, sediment, swimming pool water, spilled chemicals, sewage releases, and pollutants from various other sources that enter the MS4 rather than being captured and directed toward the sanitary sewer mechanism. Caltrans has proposed to continue to enhance its IC/ID program and staff training through the CLRPs, which provide a mechanism for achieving greater pollutant load reductions.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary* | Commercial | AWM Fueling |
| None | HD Residential | Airplane Repair |
| | LD Residential | Animals |
| *Secondary* | Rural Residential | Auto Body Paint |
| Bacteria | Institutional | Auto Repair |
| Metals | Military | Boat Repair |
| Organics | Recreation | Cemeteries |
| Sediment | Freeway | Corporate Yards |
| Pesticides | Road | Equipment Repair |
| Nutrients | Transportation | Food Facilities |
| Oil and grease | Industrial | Golf Courses |
| Dissolved minerals | Heavy Industry | Industrial Facilities |
| Trash | Extraction/Landfill | Municipal Airfield |
| Flow | Shopping Center | Municipal Landfills |
| Volume reduction | | Nurseries |
| | | POTWs |
| | | Paintball Fields |
| | | Zoos |

### *BMP #7: Property-based inspections*

**Description:** As described in the introduction to this section, a major load reduction opportunity is to shift the RPs from a business-based to a property-based inspections program, particularly enabling a focus on multi-tenant buildings and properties, sources most likely to lead to bacteria loading such as food-related uses, and "repeat offenders" who require more frequent follow-up than the high, medium, and low priority approach.

Property-based inspections are crucially important since property management—notably of trash, landscapes, and parking areas—is most often conducted by a property management company or contractor, rather than by the individual businesses. Shifting away from businesses towards properties provides significant opportunities to increase the effectiveness and reach of several of the RPs' ongoing outreach and education, enforcement, inspection, and landscape/water conservation strategies. The City of San Diego is actively developing new protocols to conduct enhanced property-based inspections.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary* | Commercial | Animals |
| None | HD Residential | Corporate Yards |
| | Institutional | Food Facilities |
| *Secondary* | Recreation | Industrial Facilities |
| Bacteria | Industrial | Nurseries |

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| Metals<br>Organics<br>Sediment<br>Pesticides<br>Nutrients<br>Oil and grease<br>Dissolved minerals<br>Trash<br>Flow<br>Volume reduction | Shopping Center | Zoos |

### *BMP #8: Supplemental inspection standards for PGAs of concern*

**Description:** Supplemental inspection standards for PGAs of concern will vary based on the PGA. Some examples are provided below. While the City of Lemon Grove has noted this as a specific BMP, all of the RPs may incorporate these standards as they work on enhanced and re-focused inspections.

*Food-related business inspections:* Building on the best practice example from Escondido, it appears that additional or re-focused efforts looking at food-related businesses in addition to restaurants (i.e. supermarkets, grocery markets/bodegas, specialty food stores, ‘big box’ stores with food sales, convenience marts with delis and food preparation, etc.) that may not be captured effectively by the current inspection program will improve pollutant load reductions. Inspections of these establishments would focus on the trash-handling facilities, as these are potential bacteria contributors. Due to the large number of food-related facilities and shopping centers in the San Diego watershed region, the potential for load reductions is significant. The City of Escondido has a strong ordinance and program for permits and inspections of food-related establishments, focused on minimizing unauthorized discharges to the MS4 and sanitary sewer systems. The 300+/- regulated food establishments in Escondido are charged $160 each for permitting and inspection, which helps the City fund the program and emphasizes the level of importance the City attaches to pollution prevention.

*Animal-related business inspections:* Increasing inspections of animal care facilities, including animal shelters, “doggie day care” facilities, veterinary clinics, breeding, boarding and training facilities, groomers, and even multi-function pet care stores, represent an opportunity for greater load reduction, particularly for bacteria. The focus of these inspections would be on paved surfaces, food and pet waste storage, landscaped animal relief areas, outdoor exercise areas, and trash enclosures.

*Nurseries and garden centers inspections:* Nurseries and garden centers generate sediment and pesticides, along with bacteria and nutrients, increased dry weather flows and volume concerns. Inspections of these facilities would focus on appropriate chemical storage (pesticides and fertilizers), appropriate use of chemicals, and preventing over-irrigation.

*Auto-related uses inspections:* Auto-related uses continue to be a focus of concern in all CLRP watersheds because of the high potential for pollutant discharges from fueling, repair, maintenance, trash, auto body painting, and storage of chemicals and other uses. Ensuring that BMPs are in place and followed scrupulously at auto-related facilities is an important load reduction strategy; as experience has developed among the RPs, standards and inspection checklists can be improved to note possible problems on site and best practices for fixing them.

*Vehicle washing areas inspections:* Vehicle washing areas primarily generate oil and grease and trash, and increase dry weather flows and volume concerns. Inspecting designated areas to ensure that, for example, wash water is being directed properly towards sanitary drains or properly-designed vegetated areas is recommended.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Varies – See SUSMP requirements below* | *Varies - see SUSMP requirements below* | *Varies - see SUSMP requirements below* |

## SUSMP and Regulatory Enhancement

As with inspections and inspection checklists, making improvements and refinements to the standards Standard Urban Storm Water Management Plans (SUSMPs) and other required BMPs offers the opportunity to improve source control and reduce pollutant loading through site-level changes. In developing the CLRPs, the RPs identified areas that, in their experience as program managers and from performing inspections, represent opportunities to enhance load reduction and source control through changes to SUSMP standards and BMPs.

### *BMP #9: Trash enclosure and storage areas*

**Description:** This BMP, recommended as the priority for SUSMP amendments, is to amend SUSMPs and other code and zoning requirements to reduce pollutants from common trash areas, especially restaurants and other trash areas with substantial food waste (e.g. supermarkets, 'big box' retail with food, pet stores). Four-sided trash enclosures and covers over trash areas have been established as an effective method of source control, particularly for bacteria and of course trash. However, the level of implementation required in SUSMPs and municipal zoning varies substantially among the RPs. The highest level of implementation through SUSMP is the Port of San Diego, which requires retrofits of trash enclosures, including covers. Other RPs have varying requirements, and in some cases, trash enclosures are not required for new development. Implementation of stronger SUSMP and zoning standards, up to and including retrofits of existing enclosure areas on a phased or gradual basis based on watershed risk, would be able to be credited as a load reduction measure.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary* | Commercial | Animals |
| Trash | HD Residential | Auto Body Paint |
| | Institutional | Auto Repair |
| *Secondary* | Open Space | Boat Repair |
| Bacteria | Recreation | Corporate Yards |
| Metals | Industrial | Equipment Repair |
| Pesticides | Heavy Industry | Food Facilities |
| Oil and grease | Shopping Center | Golf Courses |
| | | Industrial Facilities |
| | | Municipal Airfield |
| | | Municipal Landfills |
| | | Nurseries |
| | | POTWs |
| | | Paintball Fields |
| | | Zoos |

### *BMP #10: Animal-related facilities*

**Description:** This BMP would involve RPs amending SUSMPs and other code and zoning requirements, potentially including the addition of retrofit requirements, to provide supplemental standards for Animal facilities such as animal shelters, "doggie day care" facilities, veterinary clinics, breeding, boarding and training facilities, groomers, and even multi-function pet care stores. Supplemental standards for these uses represent an opportunity for greater load reduction, particularly for bacteria. Supplemental standards may include requiring identification of landscaped relief areas on site plans; requiring covered trash enclosures; careful review of outdoor exercise areas for grading, drainage, landscaping; and ensuring connection of drains from impervious surfaces to a sanitary sewer connection. These could be incorporated either through zoning (which could require retrofits or "best fix" approaches when properties seek amendment, as well as for new development), or through SUSMP standards.

| **Pollutants addressed** | **Land uses affected** | **PGAs targeted** |
|---|---|---|
| *Primary*<br>Bacteria<br>Sediment<br>Pesticides<br>Nutrients<br><br>*Secondary*<br>Flow<br>Volume reduction | Agriculture<br>Commercial<br>Rural Residential<br>Institutional<br>Military<br>Shopping Center | Animals<br>Zoos |

### *BMP #11: Keeping of large animals*

**Description:** This BMP, limited in applicability to jurisdictions where horse and animal keeping are common such as County unincorporated areas and parts of Poway and Escondido, would provide supplemental standards in the SUSMP or other codes for large-animal facilities, including equestrian facilities, agricultural facilities, and where needed, for zoos. Supplemental standards in zoning such as requiring manure collection and appropriate disposal, separating animals from water bodies, and erosion control would be appropriate BMPs to incorporate either through zoning (which could require retrofits or "best fix" approaches when properties seek amendment, as well as for new development), or through SUSMP standards. Introducing enhanced BMPs for these uses may be done first through education and outreach (see BMP #29).

| **Pollutants addressed** | **Land uses affected** | **PGAs targeted** |
|---|---|---|
| *Primary*<br>Bacteria<br>Sediment<br>Pesticides<br>Nutrients<br><br>*Secondary*<br>Flow | Agriculture<br>Rural Residential<br>Open Space<br>Recreation | Animals<br>Zoos |

| | | |
|---|---|---|
| Volume reduction | | |

### BMP #12: Nurseries and garden centers

**Description:** Runoff from the outdoor areas of nurseries and garden centers, which are found in many areas of the CLRP watersheds, can contain high concentrations of nutrients and pesticides. This BMP would involve amendment of SUSMPs, other code and zoning requirements, potentially including the addition of retrofit requirements, to reduce loading from sediments, pesticides, nutrients, and also the prevalence of over-irrigation. Measures may include requiring berms or other containment of runoff from impervious areas where materials and plants are stored; covering outdoor storage areas or portions thereof; green waste management BMPs; and measures to improve irrigation efficiency and reduce the potential for dry-weather runoff.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Sediment<br>Pesticides<br><br>*Secondary*<br>Bacteria<br>Nutrients<br>Flow<br>Volume reduction | Commercial<br>LD Residential<br>Shopping Center | Nurseries |

### BMP #13: Auto-related uses

**Description:** Providing supplemental standards for auto-related uses represents an opportunity for load reductions, particularly for metals, oil and grease, and trash. Supplemental standards including full four-sided, covered trash enclosures and storage areas, and careful review of auto-related use areas (e.g., garage bays at repair shops) for grading, drainage, and connection of drains to a sanitary sewer system, would be appropriate BMPs to incorporate either through zoning (which could require retrofits or "best fix" approaches when properties seek amendment, as well as for new development), or through SUSMP standards.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Bacteria<br>Metals<br>Oil and Grease<br><br>*Secondary*<br>Organics<br>Trash<br>Flow<br>Volume reduction | Commercial<br>LD Residential<br>Military<br>Freeway<br>Road<br>Transportation<br>Industrial<br>Shopping Center | Auto Body Paint<br>Auto Repair<br>Equipment Repair |

### *BMP #14: Vehicle washing areas*

**Description:** Providing supplemental standards for vehicle washing areas represent an opportunity for load reductions, particularly for oil and grease and trash. Supplemental standards including covered trash enclosures, careful review of washing areas for grading, drainage, landscaping and connection of drains to a sanitary sewer system, and appropriate signage would be appropriate BMPs to incorporate either through zoning (which could require retrofits or "best fix" approaches when properties seek amendment, as well as for new development), or through SUSMP standards.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary* | Agriculture | Airplane Repair |
| Oil and grease | Commercial | Auto Body Paint |
| Trash | HD Residential | Auto Repair |
| | LD Residential | Boat Repair |
| *Secondary* | Rural Residential | Equipment Repair |
| Bacteria | Military | Industrial Facilities |
| Metals | Transportation | Municipal Airfield |
| Organics | Industrial | Municipal Landfills |
| Sediment | Heavy Industry | Nurseries |
| Flow | Extraction/Landfill | Zoos |
| Volume reduction | Shopping Center | |

### *BMP #15: Update minimum BMPs*

**Description:** This BMP is a "catch-all" category for updating required minimum measures as standards in the MS4 Permit change.  The City of San Diego intends to update minimum BMPs and prohibitions for residential, commercial and industrial uses in the initial years of CLRP implementation, particularly in watersheds where load reduction targets are the greatest (See Section 4 and Section 7); the County of San Diego has used this category to cover any required updates to the SUSMP required by the MS4 permit.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Varies by SUSMP and Regulatory Enhancement* | *Varies by SUSMP and Regulatory Enhancement* | *Varies by SUSMP and Regulatory Enhancement* |

## New/Expanded Initiatives

The BMPs under the heading of "New/Expanded Initiatives" are initiatives that would require a substantial new investment of time or resources by one or more of the RPs – and which thus will require the greatest degree of new resources, political support, and time to implement. These BMPs represent the recommended strategy in the CLRP for addressing several significant, but challenging, sources of pollutants in the watersheds:  bacteria and trash from persons experiencing homelessness; contributions of metals from brake pads and atmospheric deposition; multiple pollutants or impacts from potentially regulated sources such as plastic bags, leaf blowers, and phosphate fertilizers; bacteria and nutrients from on-site wastewater systems; and contributions from agricultural activities, including small-scale or 'hobby' farms.

Some of the BMPs below, such as pilot programs for disconnecting impervious surfaces (#17) and the Brake Pad Partnership (#20) are already in place in the region; however, expanding these BMPs to involve other RPs or increase the geographic reach would require a substantial investment of time or resources on the part of the RPs not currently participating, and also will involve political decisions to allocate staff time and resources in support. In the same vein, developing partnerships to address bacteria and trash impacts from homelessness (#16) and additional source reduction initiatives (#21) are contingent on significant political support from the legislative bodies of each RP.

### *BMP #16: Partnerships to address bacteria and trash impacts of homelessness*

**Description:** Camps and temporary shelters used by persons experiencing homelessness in San Diego County are a documented source of bacteria and trash. Many of the RPs, particularly Caltrans, actively remove encampments from along waterways, but acknowledged that measures such as Caltrans uses to discourage re-settlement are not always effective.

Fully recognizing that the RPs are not social service providers, and the very complex nature of this problem, discussions with community service providers around the “pollution contribution” aspects of homelessness, and a careful review of other initiatives in California, provided insights into the types of BMPs that potentially could provide load reductions if led by a skilled, appropriate social service agency or consortium, and supported financially by the RPs at a level appropriate to their municipal budgets, the other social support services offered locally, and the estimated degree of impact of this source in the affected watersheds.

Several options did emerge which, if supported financially by the RPs and led by a social service agency or consortium, could lead legitimately to bacteria and trash load reductions in the watershed. Supporting a non-profit or consortium to provide mobile showers and sanitation using shower/sanitary trailers (which can be rented or purchased) at appropriate locations, at scheduled times, has been proposed as a likely method of preventing use of surface waters for sanitation and bathing, as well as an excellent opportunity for outreach and referrals by social service agencies. A similar program currently is operating in Orange County and in the City of Los Angeles (J. Dirbas, personal communication, 2012 Jan 18; L. Reynolds, personal communication, 2012 Mar 8). Supporting a non-profit or consortium to provide trash bags, trash collection areas, and shower and sanitary facilities at centers providing daytime shelter to their clients, or on a mobile basis near areas of known encampments, also could provide support for trash and bacteria reductions. At some service locations, making facilities ADA-compliant is required to enable use of existing shower facilities; supporting such retrofits may be another approach.

More recently, the City of San Jose, CA has engaged with a grant-funded partnership with the United States Environmental Protection Agency to implement a program wherein persons experiencing homelessness are compensated to perform trash clean-ups (J. Horwedel, personal communication, 2012 Apr 14). This is another example of the type of option which, while politically challenging, may be able to be supported by the RPs.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Bacteria<br>Trash<br><br>*Secondary*<br>Nutrients | *Not tied to a specific land use* | Not related to PGAs |

### BMP #17: Pilot projects disconnecting impervious surfaces from the MS4 (e.g. rain barrels, downspout disconnection)

**Description:** In watershed management programs throughout the US, there has been an increased focus on the importance of "disconnecting" developed impervious surfaces – building roofs, parking lots, driveways, and other paved or impervious areas - from the MS4. Interrupting the flow of storm water from impervious surfaces on a site by capturing flow in a rain barrel or cistern, redirecting a downspout into a landscaped area or "rain garden," or installing trench drains at the end of driveways all are methods of reducing the amount of water that flows untreated from surfaces and sites into the MS4.

A handful of pilot projects have been carried out in the San Diego Region to identify and carry out site disconnections in targeted areas. Recently, the City of San Diego worked with a student organization to carry out a neighborhood-level disconnection study in Ocean Beach (W. Harris, personal communication, 4 Apr 2012), which provides a model for additional efforts. Other projects and initiatives have been documented in the City of San Diego's 2011 program evaluation for the rain barrel incentive program (City of San Diego 2011). The RPs proposing to include pilot disconnection projects as a BMP may take any number of different approaches to program development, pilot projects, and initiatives, from partnerships with non-profit organizations to grant-funded pilots in specific neighborhoods.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Flow<br>Volume reduction<br><br>*Secondary*<br>Bacteria<br>Metals<br>Organics<br>Sediment<br>Pesticides<br>Nutrients<br>Dissolved minerals | Commercial<br>HD Residential<br>LD Residential<br>Institutional<br>Industrial<br>Shopping Center | Relates to structures and applies to multiple settings |

### BMP #18: Mapping and risk assessment of agricultural operations

**Description:** With water quality monitoring data and source evaluations indicating that there are continued inputs from agricultural sources in the Los Peñasquitos and San Dieguito watersheds, including both field runoff and animal waste, and with the increasing prevalence of small-scale agricultural operations and activities such as farmer's markets and community-supported agriculture (CSAs), it is clear that agricultural sources represent a pollutant source in some watersheds that may be addressed through non-structural measures. Currently both San Diego County and the University of California-Extension are active in outreach to agricultural operations, including small farms on land less than 5 acres (T. Cline, personal communication, 23 Jan 2012). In fact, the County estimates that perhaps 90 percent of its agricultural operations are small farms. However, there are issues of jurisdiction related to the Clean Water Act waiver for agricultural facilities.

A recommended starting point is mapping agricultural uses and facilities, and emerging small-scale and quasi-agricultural uses such as farmer's markets, CSAs, and hobby farms, to the extent possible. This mapping also could include identification of animal facilities versus plants and nurseries, and a subsequent assessment of risk to surface waters and watersheds based on proximity to tributaries, land cover, soils, etc. This step would greatly facilitate load reduction planning by identifying, systematically, the facilities and areas with the greatest potential loading contributions. Subsequent, expanded BMPs would then include targeted education and outreach; policy development (whether voluntary guidelines or more active ordinances); and depending entirely on the political outcome of the BMP development process, inspections and enforcement.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>None<br><br>*Secondary*<br>Bacteria<br>Metals<br>Organics<br>Sediment<br>Pesticides<br>Nutrients<br>Oil and grease<br>Dissolved minerals<br>Trash<br>Flow<br>Volume reduction | Agriculture<br>Rural Residential<br>Open Space | Animals |

### *BMP #19: Mapping and risk assessment of on-site wastewater treatment systems*

**Description:** On-site wastewater treatment or septic systems are a documented source of bacteria and nutrient loading in the San Dieguito and Los Penasquitos watersheds. The unincorporated areas of San Diego County are believed to have somewhere in the vicinity of 80,000 on-site wastewater (septic) systems. In two of the five watersheds being addressed by these CLRPs, San Dieguito and Los Peñasquitos, there are large areas of residential development served by on-site systems. If not properly sited, installed and managed over time, on-site systems can be a substantial source of bacteria and nutrients in surface waters.

Since the extent, age, and siting of the on-site systems in these two watersheds is not well documented or known, the recommended first step is an inventory and map documenting the on-site systems. Techniques for this typically involve cross-referencing the addresses of all customers of central sewer providers with the addresses of properties on the associated tax assessor’s list, and identifying those addresses without a sewer account. Once identified in this manner, the locations of systems can be analyzed along with the estimated system age (from permit or property tax records), soil and slope conditions, development densities, and proximity to surface and ground water resources for risk assessment.

Actual load reductions from improved on-site systems would subsequently require some implementation of an outreach and education program, or potentially a step up to an incentive-based or even required program of system inspections and maintenance. Efforts of this type are most successful when based on risk to watersheds, and coupled with strong education and information resources for affected property owners.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>None<br><br>*Secondary*<br>Bacteria<br>Metals<br>Organics<br>Sediment<br>Pesticides<br>Nutrients<br>Oil and grease<br>Dissolved minerals<br>Trash<br>Flow<br>Volume reduction | Agriculture<br>LD Residential<br>Rural Residential<br>Open Space<br>Recreation | Relates to structures and applies to multiple settings |

### BMP #20: Support for Brake Pad Partnership

**Description:** Many of the RPs currently are engaged in the Brake Pad Partnership, an effort aimed at reducing pollutant deposition from automobile brake pads through legislative mandates and subsequent cooperative implementation. Several RPs not presently engaged in the Brake Pad Partnership have included this as a recommended BMP to reduce metals loading, and would begin to participate in and support the Partnership over the CLRP implementation period.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Metals (Copper)<br><br>*Secondary*<br>None | Freeway<br>Road<br>Transportation | n/a (not associated with a PGA other than vehicle transportation) |

### BMP #21: Additional source reduction initiatives

**Description:** Many of the RPs have pointed out that simple source reduction, whether through an outright ban or a phased program, is ultimately the most effective means of removing a pollutant from the region's surface waters. All of the RPs currently are engaged in the Brake Pad Partnership, aimed at reducing pollutant deposition from automobile brake pads. The City of Solana Beach recently instituted a plastic bag ban at commercial outlets, which not only removes a source of trash from catch basins and open channels, but also eliminates a common cause of sewer and dry-weather diversion pumps burning out. The City of Del Mar has banned leaf blowers, another common source of pollutants. Each of these two RPs will continue to implement these source reduction measures over the life of the CLRP.

Additional source reductions could be considered as the CLRP implementation and adaptive management process begin. Bans on pesticides and herbicides, to phase out their use in the landscape, the potential to prohibit or more aggressively regulate vehicle washing in or near storm drains, bans on architectural copper (though some RPs believe this has become principally a legacy issue), and bans on leaf blowers and plastic bags all could be considered. Any of these measures would be politically controversial, but could have a quantifiable load reduction impact, depending only on the timeframe and geographic extent of the ban.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Varies by initiative* | *Varies by initiative* | *Varies by initiative* |

## Landscape Practices

Developed landscapes are a widespread, substantial source of pollutant loading in the CLRP watersheds and as such, offer a wealth of opportunities for BMP implementation and load reduction ranging from education and outreach to ramped-up inspection and enforcement, to active implementation of landscaped based BMPs.  Landscape-based incentive programs, which include rebates and incentives for some combination of turf conversion, irrigation controller, xeriscaping, disconnection and rainwater harvesting rebates, are or have been in place in the City of San Diego (current); City of Poway (past pilot program); Unified Port of San Diego (ongoing); San Diego County (periodic); and through the San Diego County Water Authority (ongoing).

Water bill-based rebates and other financial incentives for turf conversion, xeriscaping, downspout disconnection, and rainwater harvesting represent an increasingly popular BMP, particularly in ultra-urban watersheds where the opportunity to construct BMPs is limited by the lack of available open land (whether public or private).  In January 2012, the City of San Diego Public Utilities Department expanded its existing rebate program for turf conversion and improved irrigation controls to provide rebates for the purchase and installation of rain barrels and cisterns. The Unified Port of San Diego has a strong, ongoing turf conversion program within its jurisdiction, which represents an important strategy within the highly urbanized Chollas Creek watershed.

Because the level of participation and implementation in the CLRP watersheds is still relatively low, there are significant opportunities to enhance or expand both existing rebate programs, and to initiate pilot education, outreach, and incentive programs focused on this . Several RPs are in early stages of discussions with local water providers about partnership possibilities, since storm water-oriented landscape practices are especially supportive of water conservation.  Expansion of the existing programs, which would require additional financial and potentially staff resources through storm water or public utility departments, nonetheless represents a potential area for reducing both over-irrigation, and nutrient, pesticide and sediment loading from developed sites.

### *BMPs #22-#24: Landscape BMP Incentives, Rebates and Training for:*

### *BMP #22:  Residential properties*

**Description:** As detailed in an extensive 2011 program development background study prepared for the City of San Diego (City of San Diego 2011), landscape-based rebates often act as a "gateway" for adoption of other beneficial practices, and are one of the few non-structural methods to address impacts from single-family residential areas. Residential incentives can take many forms, from education and training such as neighborhood watershed field days, to aggressive subsidies or rebates for turf conversion and rainwater harvesting.  Existing programs also may be expanded to achieve greater impact within the watershed, or targeted for expansion within an HPMA or specific sub-watershed.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary* | HD Residential | Animals |

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| Pesticides<br><br>*Secondary*<br>Sediment<br>Nutrients<br>Flow<br>Volume reduction | LD Residential<br>Rural Residential | Auto Repair |

### *BMP #23: Homeowners' associations/property managers*

**Description:** Expansion of landscape-based incentive programs to reach Homeowners Associations (HOAs) and property managers responsible for common land represents an important consideration for incentive program expansion. As part of this BMP the RPs may consider any number of different approaches to engaging HOAs and property managers, such as: offering incentives to HOAs and maintenance districts that adopt water-conserving or storm water reduction-related changes to their landscapes, irrigation, or maintenance; conducting workshops with property managers; or providing supplemental standards, inspection or enforcement around HOA-managed properties. Because many of the RPs, including the City of San Diego, have identified property managers as an important focus for enhanced outreach, this BMP also may be integrated with Education and Outreach BMPs #30 (landscape and garden practices) and #32 (general enhanced/refocused education).

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Pesticides<br><br>*Secondary*<br>Sediment<br>Nutrients<br>Flow<br>Volume reduction | HD Residential<br>LD Residential | Animals |

### *BMP #24: Nonresidential properties*

**Description:** Landscaping at non-residential facilities – from hospitals and office buildings to industrial areas and shopping centers – offers a host of opportunities for landscape BMP implementation. While rebate programs for non-residential property managers who choose to improve irrigation, install xeriscaping, or otherwise reduce the storm water impacts of non-residential landscapes. Various RPs are considering expansion approaches including increased outreach to commercial properties and property managers about available regional incentives, as well as locally-sponsored pilot programs. Depending upon available resources, partnership opportunities, and the success of initial pilot programs, RPs may consider establishing or supporting rebate programs to further incentivize landscape practices on non-residential properties, especially within HPMAs and areas with greater load reduction targets.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Pesticides | Commercial<br>Institutional | Animals<br>Corporate Yards |

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| | Military | Food Facilities |
| *Secondary* | Recreation | Golf Courses |
| Sediment | Industrial | Industrial Facilities |
| Nutrients | Shopping Center | Municipal Airfield |
| Flow | | Zoos |
| Volume reduction | | |

### *BMP #25: Reducing over-irrigation*

**Description:** Dry-weather flows from over-irrigation on properties of all types are an issue to be addressed in each of the CLRP watersheds. Each RP is considering how best to structure its approach to reducing over-irrigation. Some of the many options to be considered in the program development and implementation phase include pilot projects (e.g., the City of Del Mar's pilot door hanger project), education and outreach, adoption of prohibitions on over-irrigation, and ramped-up enforcement of over-irrigation in those RPs with an existing prohibition. Caltrans, as another example, continues to work to reduce irrigation demand within its right-of-way (See BMP #26 below).

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary* | Commercial | Animals |
| Pesticides | HD Residential | Auto Repair |
| Flow | LD Residential | Cemeteries |
| Volume reduction | Rural Residential | Corporate Yards |
| | Institutional | Food Facilities |
| *Secondary* | Military | Golf Courses |
| Sediment | Open Space | Industrial Facilities |
| Nutrients | Recreation | Municipal Airfield |
| | Industrial | Nurseries |
| | Shopping Center | Zoos |

### *BMP #26: Xeriscaping, turf conversion and other irrigation, pesticide and fertilizer reduction*

**Description:** This BMP is specific to Caltrans to reflect its multi-part, multi-year efforts to reduce pesticide and fertilizer use and irrigation within its right-of-way and on Caltrans owned and maintained properties. Caltrans will continue to refine its practices through the CLRP implementation period.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary* | Agriculture | Animals |
| Bacteria | Commercial | Corporate Yards |
| Sediment | HD Residential | Golf Courses |
| Nutrients | LD Residential | Industrial Facilities |
| Flow | Rural Residential | Nurseries |
| Volume reduction | Institutional | Zoos |
| | Military | |
| *Secondary* | Open Space | |

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| Metals<br>Organics<br>Pesticides<br>Dissolved minerals | Recreation<br>Freeway<br>Road<br>Transportation<br>Industrial<br>Shopping Center | |

## Education and Outreach

From the inception of the MS4 permit program, education and outreach have been recognized as a cornerstone of pollutant reduction programs. The RPs currently participate actively in collaborative regional and watershed-focused education and outreach programs, and their experience implementing these programs, along with the results of effectiveness evaluations, form the basis for the BMPs and focus areas recommended in this CLRP.

Some of the recommended BMPs below deal with a focused audience or issue, such as trash clean-ups (#27) and outreach to the equestrian community (#29). Importantly, however, the CLRP includes a "placeholder" BMP (#32) for RP- and watershed-specific education and outreach programs, and implementation strategies, that the RPs may decide to implement over the course of the CLRP implementation period. This flexibility is especially important in education and outreach, as the ability to change target audience and geographic focus rapidly are crucial to program effectiveness over the long term.

### *BMP #27: Enhanced and expanded trash cleanup programs*

**Description:** While trash clean-ups are a robust, existing program in each watershed, several of the RPs are increasing the effectiveness and reach of these efforts by engaging community groups to define and carry out community-based trash cleanups. Partnerships and sponsorships with I Love a Clean San Diego (ILACSD) and others have been longstanding programs in the watershed that are recommended to continue or be enhanced. In addition, to target stream clean-up efforts more effectively, and with a longer impact and reach in the affected communities, the RPs intend to explore greater partnership opportunities with community organizations who can provide strong engagement with target audiences and communities. As a best practice example, the Port of San Diego and Think Blue issued an RFP to community-based organizations in the Chollas Creek watershed to develop and carry out stream clean-ups. This is part of the effort to contact and engage audiences who are not being engaged through regular JURMP mandated outreach. This engages the target audience itself in defining the best way to reach the community and reduce trash impacts, rather than having the RP's storm water staff defining the information pathways and message. Adoption of this approach by other RPs on stream clean ups and potentially other approaches (including equestrian community outreach and efforts with homelessness) is recommended as a means of achieving greater load reduction.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>None<br><br>*Secondary*<br>Metals | Agriculture<br>Commercial<br>HD Residential<br>LD Residential<br>Rural Residential | Animals<br>Corporate Yards<br>Food Facilities<br>Golf Courses<br>Industrial Facilities |

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| Organics<br>Pesticides<br>Oil and grease<br>Trash | Institutional<br>Military<br>Open Space<br>Recreation<br>Freeway<br>Road<br>Transportation<br>Industrial<br>Shopping Center | Nurseries<br>POTWs<br>Zoos |

### *BMP #28: Improved Web resources promoting reporting of enforceable discharges*

**Description:** While each RP has a program website, certain enhancements or modifications could be made that have a legitimate connection to load reduction. This is included as a BMP to reflect what could be a regional or inter-jurisdictional effort, or an individual effort, to make websites and resources as effective as possible in educating the public on enforceable discharges, and engaging them in reporting the information.

As part of program review for the CLRP, it was noted that the RP program websites may or may not provide typical citizens with sufficient and sufficiently brief information to know whether, and where, to report a violation. To provide greater user-friendliness, websites could make a more direct connection between storm water violations or conditions citizens are most likely to observe that should be reported, and the reporting number or methods available. Examples of common incidents that should be reported could be developed and posted, based on local experience and conditions, with simple illustrations or photos indicating the types of practices that are not allowable discharges and which should be reported. Displaying hotline numbers in larger and bolded type, and ensuring these numbers are prominently displayed and easily retrieved through internet searches, also would benefit load reduction efforts.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>None<br><br>*Secondary*<br>Bacteria<br>Metals<br>Organics<br>Sediment<br>Pesticides<br>Nutrients<br>Oil and grease<br>Dissolved minerals<br>Trash<br>Flow<br>Volume reduction | Agriculture<br>Commercial<br>HD Residential<br>LD Residential<br>Rural Residential<br>Institutional<br>Open Space<br>Recreation<br>Road<br>Transportation<br>Industrial<br>Heavy Industry<br>Shopping Center | Animals<br>Auto Body Paint<br>Auto Repair<br>Boat Repair<br>Corporate Yards<br>Equipment Repair<br>Food Facilities<br>Golf Courses<br>Industrial Facilities<br>Nurseries<br>POTWs<br>Paintball Fields<br>Zoos |

### BMP #29: Equestrian community

**Description:** Discussions with storm water managers from many of the RPs, and the Bacteria Source Analyses completed as part of the CLRPs, indicate that equestrian facilities represent a potentially significant area of practice for load reduction. Some initial targeted outreach to the equestrian was done in the San Diego Bay watershed, as reported in the FY2011 WURMP (San Diego Bay Copermittees, 2012), and other jurisdictions in southern California are beginning to work on this issue in a targeted way. Effective outreach and BMP programs for equestrian properties have been initiated, at different levels of effort, in northern California, Virginia, and Oregon. Education and outreach may be regional, inter-jurisdictional, or specific to each RP, depending upon the outcome of program development evaluations.

The BMPs that help mitigate horse-related impacts on watersheds are largely identical to measures recommended for most livestock management: fencing animals out of surface waters and buffers; siting manure storage areas in appropriately covered and surfaced areas; connecting floor drains in animal washing areas and barns to sanitary sewers or vegetated infiltration areas away from streams; and proper handling of insecticides and horse care products. However, for perhaps all but the largest commercial equestrian facilities, it is certain that new zoning or SUSMP standards, inspections, required buffering, or required fencing would be politically challenging. Nonetheless, the San Diego County Planning Department is in the process of developing an EIR for a three-tiered approach to zoning for commercial equestrian facilities, with the EIR expected to be completed in the late fall of 2012. The outcome of this zoning process may help inform additional efforts by the RPs.

Partnerships with organizations such as the San Diego Equestrian Foundation, United States Pony Club – Southern California, and 4-H may be feasible for outreach and education, potentially through the community-based RFP process piloted for the Chollas Family Stream Teams. Equestrian properties in high-risk areas, particularly floodplains, may also become excellent candidates for initial structural BMP or stream bank buffer pilot projects, since all things being equal, sites on equestrian properties would offer greater potential bacteria and nutrient reduction than other stream channel sections.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Bacteria<br><br>*Secondary*<br>Sediment<br>Nutrients | Agriculture<br>Rural Residential<br>Open Space<br>Recreation | Animals |

### BMP #30: Garden and landscape practices

**Description:** The opportunity and need to provide more active outreach, training, and potentially even required certification of landscape and gardening contractors on storm water BMPs, particularly pesticide and herbicide reduction, arose in a number of the areas of the CLRP research. A number of the RPs noted that outreach to lawn and garden contractors remained a weak point in overall education, outreach and training efforts. An assessment of public awareness and behaviors conducted for the County of San Diego in 2009 (Goodwin et al. 2009) indicated that “Clearly there is a sizable opportunity to reach out to unincorporated area residents on the issue of yard and garden care” (4).

For load reduction purposes, an outreach, certification or regulatory program would focus on methods of limiting or eliminating pesticide and herbicide use and runoff, minimizing erosion from landscaped areas, proper disposal of green waste, and implementation of water-conserving and irrigation improvement measures. Ideally, to maximize load reductions, municipal and public landscapes at least would be managed with Integrated Pest Management (IPM) practices, as is currently done in Solana Beach. While these measures would not need to be limited to commercial or residential common lands, these are the areas where the least outreach has been completed to date and where contractors and services are most commonly used.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Sediment<br>Pesticides<br><br>*Secondary*<br>Bacteria<br>Nutrients<br>Flow<br>Volume reduction | Commercial<br>HD Residential<br>LD Residential<br>Rural Residential<br>Institutional<br>Military<br>Recreation<br>Freeway<br>Road<br>Transportation<br>Industrial<br>Shopping Center | <br>Animals<br>Cemeteries<br>Nurseries |

### *BMP #31: On-site agricultural practices (e.g. chickens, compost)*

**Description:** As small-scale or on-site composting and keeping of chickens becomes increasingly widespread, RP storm water program managers have identified a prospective need to educate residents on how to ensure that these practices do not adversely affect water quality. While few RPs have identified this as an immediate education and outreach need, it has been included as a specific BMP since other RPs may choose to focus on this in the CLRP implementation period as it becomes more prevalent in the region's residential areas.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Bacteria<br>Nutrients<br><br>*Secondary*<br>Sediment<br>Pesticides | Agriculture<br>HD Residential<br>LD Residential<br>Rural Residential<br>Open Space | Animals |

### *BMP #32: General/other*

**Description:** As noted in the introduction to the Education and Outreach BMPs, this BMP covers locally-specific initiatives and investments in enhanced, expanded, and refocused education and outreach that RPs plan to undertake as part of CLRP implementation and load reduction. Each RP is considering appropriate target audiences by watershed, focusing on under-served or poorly addressed populations in HPMAs and even more specific areas, such as individual neighborhoods or planned developments. Updates under this BMP category will be part of the three-year reporting cycle of the CLRP as implementation proceeds.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Varies by focus* | *Varies by focus area* | *Varies by focus area* |

## MS4 Maintenance

Maintenance, cleaning and repair of the MS4 and its components – roadways, storm drain inlets, catch basins, pipes, outfalls, and open channels – is a backbone of nonstructural pollutant reduction. Minimum requirements for catch basin cleaning and street sweeping are set through regulatory requirements; however, each RP is considering measures to improve load reduction through more efficient and optimized maintenance strategies, which may or may not imply greater frequency or more staff time and resources. As described under BMP #33 below, several RPs, notably the City of Escondido and City of San Diego, are working actively to improve MS4 maintenance through measures such as optimizing catch basin cleaning to focus on inlets in HPMAs, or land use settings with greater accumulation rates. Others such as the County of San Diego plan to upgrade street sweeping equipment, which also is expected to lead to load reductions within the current level of program effort.

This BMP category is intended to capture the planned enhancements to MS4 maintenance practices that may be undertaken by the RPs over the CLRP period. Specific implementation will be adjusted based on the outcome of pilot evaluations and studies of effectiveness, the availability of resources, and regulatory requirements; however, with respect to the latter, it is strongly encouraged that the outcome of optimization programs, such as the catch basin cleaning initiatives in the City of Escondido and City of San Diego be considered when requirements are determined.

### *BMP #33: Optimized or enhanced catch basin inlet cleaning and management*

**Description:** Analyses of MS4 cleaning practices in different jurisdictions, including San Diego County, have shown consistently that "all catch basins are not created equal;" different land use settings, drainage network conditions, and pipe conditions lead to very different amounts of materials accumulating in specific locations. The experience of the RPs administering their programs suggests that a greater frequency in high-accumulation areas would be more effective at load reduction than a blanket recommendation of annual cleaning.

A pilot program to assess catch basin materials, build data records of catch basin constituents and build-up levels in certain areas, and optimization of cleaning based on the materials removed, would potentially enable the RPs to re-focus their level of effort on the highest priority loading areas and pollutant sources. The City of Escondido recently concluded a three-year effort to accomplish this, and is beginning implementation of its optimized program in the next fiscal year (C. Filar, City of Escondido, personal communication 10 Apr 2012). Currently, the City of San Diego is engaged in a pilot study of catch basin cleaning efficiency in different land use settings. The pilot study has found, in one instance, that there is a significant amount of yard waste in one neighborhood where another has high level of trash and sediment. The materials removed are being evaluated for pollutant concentrations, as well as total volumes of materials removed and particle sizes.

Based on this effort and other literature studied in conjunction with the CLRPs, catch basin record keeping assessment, and cleaning optimization by each of the RPs is a recommended load reduction strategy to be implemented over a period of several years.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary* | Commercial | N/A, BMPs address public MS4 |

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| Metals<br>Sediment<br>Pesticides<br><br>*Secondary*<br>Bacteria<br>Nutrients | HD Residential<br>LD Residential<br>Institutional<br>Military<br>Recreation<br>Freeway<br>Road<br>Transportation<br>Industrial<br>Shopping Center | |

### *BMP #34: Proactive MS4 repair and replacement*

**Description:** Proactively improving the condition of the MS4 by repairing and replacing MS4 components, including inlets and outfalls, will help limit inflow of pollutants and reduce pollutant loads. The City of San Diego anticipates starting a multi-year program of storm drain pipe repair and replacement, intended in part to prevent the intrusion of large quantities of sediment into the City's MS4. As this program is funded and moves ahead, tracking the load reduction will provide an important and quantifiable component of the load reductions anticipated in the CLRPs.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Metals<br>Sediment<br><br>*Secondary*<br>Bacteria<br>Nutrients | Commercial<br>HD Residential<br>LD Residential<br>Institutional<br>Military<br>Recreation<br>Freeway<br>Road<br>Transportation<br>Industrial<br>Shopping Center | N/A, BMPs address public MS4 |

### *BMP #35: Increased channel cleaning and scour pond repair to improve MS4 function*

**Description:** Continued identification and cleaning of open channels, along with tracking of adjacent and in-channel conditions, is recommended as a non-structural strategy for load reduction. Cleaning of the open channels in the CLRP watersheds represents an important source of debris and particularly sediment removal, as well as an important measure for flood control. In the course of the interviews, several RPs expressed that enhancing or expanding the degree of open channel repair currently undertaken would improve the function of the MS4 system, in spite of permit issues that can sometimes discourage more extensive channel cleaning. The City of San Diego and Caltrans in particular have identified scour pond repair as an additional necessary BMP in some locations.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Metals<br>Sediment<br><br>*Secondary*<br>Bacteria<br>Nutrients | Commercial<br>HD Residential<br>LD Residential<br>Institutional<br>Military<br>Recreation<br>Freeway<br>Road<br>Transportation<br>Industrial<br>Shopping Center | N/A, BMPs address public MS4 |

### BMP #36: Increased sweeping frequency or routes

**Description:** All of the RPs have extensive street and public parking lot sweeping programs in place that meet minimum permit requirements and in most RPs exceed these requirements, in some cases substantially. Increasing the frequency of sweeping or the routes covered generally would improve sediment, metals, and trash removal from roadways, further improving pollutant load reductions. However, a blanket BMP or requirement to increase street sweeping may not represent an optimal investment in pollutant reduction.

Therefore, as the CLRP proceeds and modeling is initiated, supplemental sweeping frequencies and routes will be considered as a BMP, particularly in HPMAs and other target areas such as those areas with high road density. The overall CLRP strategy will benefit from close evaluation of street sweeping as a BMP over the implementation period.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Metals<br>Sediment<br>Nutrients<br>Trash<br><br>*Secondary*<br>Bacteria<br>Organics<br>Dissolved minerals | Freeway<br>Road<br>Transportation | Not related to PGAs |

### BMP #37: Sweeping medians on high-volume segments

**Description:** One possible enhancement to the RPs' street sweeping programs is an effort to sweep the medians. The City of San Diego's Median Sweeping Study, Phase III (City of San Diego, 2009) found substantial pollutant concentrations in materials removed from medians (notably metals) and recommended median sweeping as a potential BMP. The RPs will need to discuss the feasibility and potential methods of implementing median sweeping, such as the relative advantages of hand sweeping versus mechanical, and the potential to redirect staff resources to medians instead of streets.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Metals<br>Sediment<br>Nutrients<br>Trash<br><br>*Secondary*<br>Bacteria<br>Organics<br>Dissolved minerals | Freeway<br>Road<br>Transportation | Not related to PGAs |

### BMP #38: Upgraded sweeping equipment

**Description:** Replacement of street sweeping equipment with high-efficiency regenerative air and vacuum-assisted sweepers over time is expected to further increase load reductions, even keeping current sweeping routes and intervals constant. The RPs intend to continually evaluate opportunities and the cost/benefit profile of upgrading sweeping equipment over the CLRP implementation period. In those RP jurisdictions that contract out municipal street sweeping, improved street sweeping equipment may be specified as a required contract provision, depending upon costs and the overall importance of sweeping to the individual RP and watershed load reduction targets. RPs that own their own sweeping equipment are evaluating opportunities and timing to purchase upgraded equipment, particularly as older models are retired.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Metals<br>Sediment<br>Nutrients<br>Trash<br><br>*Secondary*<br>Bacteria<br>Organics<br>Dissolved minerals | Freeway<br>Road<br>Transportation | Not related to PGAs |

### BMP #39: Sweeping of private roads and parking lots

**Description:** The "next frontier" for reductions from street sweeping would be requirements for sweeping of private streets and parking lots not currently subject to these requirements. In the same manner that trash management and other BMPs on private property provide important reductions, sweeping private streets and parking areas would represent an additional means of reduction. This is a particularly important BMP for metals reduction, and in watersheds where the lack of available open land substantially limits structural BMP opportunities.

The selection of private areas for sweeping will require analysis and prioritization based on connectivity to the MS4 system, size and extent of impervious areas, and impairment of the receiving water, and may be most appropriate in areas such as the Chollas Creek watershed with impairments for metals and sediment, which sweepers most directly address.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary* | Commercial | Auto Body Paint |
| Metals | HD Residential | Auto Repair |
| Sediment | Institutional | Boat Repair |
| Nutrients | Military | Corporate Yards |
| Trash | Recreation | Equipment Repair |
| | Industrial | Food Facilities |
| *Secondary* | Shopping Center | Golf Courses |
| Bacteria | | Industrial Facilities |
| Organics | | Nurseries |
| Dissolved minerals | | Paintball Fields |
| | | Zoos |

### *BMP #40: Identification and remediation of erosion and unstable slopes on public property and in public rights of way*

**Description:** Identifying and addressing sedimentation from unstable slopes and eroding areas is a BMP that combines nonstructural and structural elements. The best practice model for the region is from Caltrans, which has an active program and effort to identify and repair eroding slopes that may be contributing to sediment loading. Other RPs may do some slope stabilization that is not reported as a watershed or JURMP activity per se, but do not have proactive programs. Since many pollutants, including phosphorous, lead, and bacteria, can be attached to sediments, preventing and repairing eroding areas is an important BMP for consideration in the CLRPs. As with the agricultural and equestrian initiatives described in this memo, a first step would be an inventory and assessment of eroding areas and their risk to surface waters. Subsequently, a schedule for ongoing inspection and stabilization potentially based on a certain number or percentage of sites annually, could be developed. This is comparable to the approach Caltrans takes with its schedule for annual erosion inspection and repair.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary* | Open Space | Municipal Airfield |
| Sediment | Recreation | Municipal Landfills |
| | Freeway | Nurseries |
| *Secondary* | Road | POTWs |
| Bacteria | Transportation | |
| Nutrients | | |
| Dissolved minerals | | |

### *BMP #41: Enforcement of discharges from erosion and unstable slopes on private properties*

**Description:**

A possible BMP, and expansion of BMP#40, would be addressing eroding and unstable slope areas on private property (excluding construction sites) that can be treated as discharges and made subject to enforcement actions. This BMP has been slated on a longer timeframe for program development and implementation to ensure that this would be a cost-effective BMP, particularly in terms of staff time, and to work out issues with codes and enforcement. In the interim, this BMP could be coordinated with enhanced inspection and enforcement programs to ensure that inspectors are addressing erosion and slope instability at least on an educational basis in the course of their visits.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Sediment<br><br>*Secondary*<br>Bacteria<br>Nutrients<br>Dissolved minerals | Agriculture<br>Commercial<br>HD Residential<br>LD Residential<br>Rural Residential<br>Institutional<br>Industrial<br>Heavy Industry<br>Extraction/Landfill | Auto Body Paint<br>Cemeteries<br>Golf Courses<br>POTWs<br>Zoos |

## Capital Improvement Projects

Finally, four categories of capital improvement projects that have quantifiable load reduction benefits have been included under the heading of nonstructural BMPs.

### *BMP #42: Dry-weather flow separation*

**Description:**

Dry weather flow separation (also known as low-flow diversion) is an engineering solution that diverts flow from the storm drain system into the sanitary sewer system under low-flow conditions. Dry-weather flow separation projects are under consideration or in design in several RPs, and may be considered in other jurisdictions to address issues such as “hot spots” and sites where an upstream pollutant source cannot be identified.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Bacteria<br>Flow<br>Volume reduction<br><br>*Secondary*<br>Nutrients<br>Oil and grease | *Capital improvement project; not tied to land use setting* | N/A, BMPs address public MS4 |

### *BMP #43: Sewer pipe replacement*

**Description:** This BMP is unique to the City of La Mesa, which is in the midst of a multi-year effort to replace aging clay sewer pipes in its sewer service area. Replacing the clay pipes with well-sealed sewer pipes is expected to reduce bacteria loading in particular within the Chollas Creek watershed.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Bacteria<br>Nutrients<br><br>*Secondary*<br>None | *Capital improvement project; not tied to land use setting* | N/A, BMPs address public MS4 |

### *BMP #44: Reducing groundwater infiltration*

**Description:** The extent to which groundwater inflow is a pollutant source for the MS4 in the CLRP watersheds is not especially well-documented. The City of La Mesa reported impacts related to groundwater inflow, and has initiated long-term capital planning for management measures including lining or replacing pipes, or other site-specific measures. The extent to which this is an ongoing issue for the RPs and an appropriate load reduction measure for the CLRPs is an important area of discussion for the RPs. Initial identification of areas where groundwater inflow prevention could be accomplished is scheduled in later years for the City of La Mesa once its current sewer pipe replacement program is complete, and may be undertaken by other RPs in some locations over the course of CLRP implementation.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>None<br>*Secondary*<br>Bacteria<br>Sediment<br>Nutrients | *Capital improvement project; not tied to land use setting* | N/A, BMPs address public MS4 |

### *BMP #45: Mitigation and conservation initiatives*

**Description:** Mitigation projects such as wetland and lagoon restoration or stream restoration are an important component of the region's overall restoration strategy for its surface waters. Caltrans anticipates completing mitigation projects with water quality and load reduction benefits over the course of the CLRP implementation period in conjunction with various surface transportation projects.

Land conservation, including and especially continuing implementation of the region's Multiple Species Conservation Plan (MSCP), is in and of itself an important BMP. Stewardship of public park lands, reserves, and MSCP areas over 300 acres likewise provides water quality benefits and should be evaluated and counted towards watershed load reduction targets, potentially through watershed partnerships. The San Diego County Department of Parks and Recreation has been active in park and trail maintenance, including erosion repair and fencing areas to allow for vegetation growth and regeneration. Greater cooperative tracking of these activities, and potentially prioritization that recognizes the water quality benefits of different areas and actions, would allow additional credits towards load reduction goals.

| Pollutants addressed | Land uses affected | PGAs targeted |
|---|---|---|
| *Primary*<br>Sediment<br><br>*Secondary*<br>Bacteria<br>Pesticides<br>Nutrients | *Capital improvement project; not tied to land use setting* | N/A, BMPs address public MS4 |

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# Appendix F. Nonstructural BMP Matrices

This appendix presents a series of four tables. The first table presents the full menu of BMPs recommended for implementation in any of the five San Diego region CLRP watersheds and their primary and secondary pollutant reduction effectiveness relative to the pollutants of concern. In addition to the pollutants of concern in the watershed, BMPs must address the specific types of pollutant sources (PSC land uses) expected to generate those pollutants, and the specific Pollutant Generating Activities (PGAs) in the watershed. The last three tables present the inter-relationships between the Pollutant Source Characterization (PSC) land uses and Pollutant Generating Activities (PGAs) in the CLRP watershed with the BMPs. For completeness, each table presents the combination of all the BMPs, land uses, and PGAs for the five combined San Diego region CLRP watersheds.

Table F-1 shows the BMPs' *primary*, *secondary*, and *no* reduction values, considering the typical design approach, typical land use setting, and common geographic extent of application for the specific BMP. In Table F-1, the closed circle (●) indicates that the BMP provides primary reduction for the pollutant; the half circle (◗) indicates secondary/incidental reduction; and the open circle (○) indicates that the BMP does not address the pollutant. BMPs have been recommended that have a primary reduction impact (●) on each of the watershed or HA impairments.

**Table F-1. Effectiveness of nonstructural BMP types[2]**

| BMP | | Impairment | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Bacteria | Metals | Organics | Sediment | Pesticides | Nutrients | Oil and grease | Dissolved minerals | Trash | Flow | Volume reduction |
| *Development Review Process* | | | | | | | | | | | | |
| 1 | Amend zoning and other development regulations to facilitate LID implementation | ● | ◗ | ◗ | ● | ◗ | ● | ○ | ◗ | ● | ● | ● |
| 2 | Develop design standards/manuals to facilitate LID implementation | ● | ◗ | ◗ | ● | ◗ | ● | ○ | ◗ | ● | ● | ● |
| 3 | Train staff and boards to facilitate LID implementation and source control | ◗ | ◗ | ○ | ◗ | ◗ | ◗ | ○ | ◗ | ◗ | ◗ | ◗ |
| *Enhanced Inspections and Enforcement* | | | | | | | | | | | | |
| 4 | Training or certification requirements for mobile businesses | ◗ | ○ | ● | ○ | ◗ | ○ | ● | ○ | ○ | ○ | ○ |
| 5 | Inspection/enforcement of power washing discharges | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ |

[2] The numbering of BMPs is, in some cases, not sequential. The San Diego Region Copermittees have prepared five City-led CLRPs in FY2012. For management and planning purposes, they have created a common, merged list of all BMPs considered for all City-led CLRPs. The numbering from this master merged list has been used in each of the CLRPs. Where a BMP from the master list has not been recommended for any watershed, this BMP is missing and the list has not been re-numbered.

| BMP | | Impairment | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Bacteria | Metals | Organics | Sediment | Pesticides | Nutrients | Oil and grease | Dissolved minerals | Trash | Flow | Volume reduction |
| 6 | Enhanced IC/ID reporting and enforcement | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ |
| 7 | Property-based inspections | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ |
| 8 | Supplemental inspection standards for PGAs of concern | *Varies - see SUSMP requirements below* | | | | | | | | | | |
| *SUSMP and Regulatory Enhancement* | | | | | | | | | | | | |
| Amend SUSMP, other code and zoning requirements, including the addition of retrofit requirements, to reduce pollutants from: | | | | | | | | | | | | |
| 9 | Trash enclosure and storage areas | ◗ | ◗ | ○ | ○ | ◗ | ○ | ◗ | ○ | ● | ○ | ○ |
| 10 | Animal-related facilities | ● | ○ | ○ | ● | ● | ● | ○ | ○ | ○ | ◗ | ◗ |
| 11 | Keeping of large animals | ● | ○ | ○ | ● | ● | ● | ○ | ○ | ○ | ◗ | ◗ |
| 12 | Nurseries and garden centers | ◗ | ○ | ○ | ● | ● | ◗ | ○ | ○ | ○ | ◗ | ◗ |
| 13 | Auto-related uses | ○ | ● | ◗ | ○ | ○ | ○ | ● | ○ | ◗ | ◗ | ◗ |
| 14 | Vehicle washing areas | ◗ | ◗ | ◗ | ◗ | ○ | ○ | ● | ○ | ● | ◗ | ◗ |
| 15 | Update minimum BMPs | *Varies by SUSMP and Regulatory Enhancement* | | | | | | | | | | |
| *New/Expanded Initiatives* | | | | | | | | | | | | |
| 16 | Partnerships to address bacteria and trash impacts of homelessness | ● | ○ | ○ | ○ | ○ | ◗ | ○ | ○ | ● | ○ | ○ |
| 17 | Pilot projects disconnecting impervious surfaces from the MS4 (e.g. rain barrels, downspout disconnection) | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ○ | ◗ | ○ | ● | ● |
| 18 | Mapping and risk assessment of agricultural operations | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ |
| 19 | Mapping and risk assessment of on-site wastewater treatment systems | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ |
| 20 | Support for Brake Pad Partnership | ○ | ● | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 21 | Additional source reduction initiatives | *Varies by initiative* | | | | | | | | | | |
| *Landscape Practices* | | | | | | | | | | | | |
| Landscape BMP incentives, rebates, and training: | | | | | | | | | | | | |
| 22 | Residential properties | ○ | ○ | ○ | ◗ | ● | ◗ | ○ | ○ | ○ | ◗ | ◗ |
| 23 | Homeowners' associations/property managers | ○ | ○ | ○ | ◗ | ● | ◗ | ○ | ○ | ○ | ◗ | ◗ |
| 24 | Nonresidential properties | ○ | ○ | ○ | ◗ | ● | ◗ | ○ | ○ | ○ | ◗ | ◗ |
| 25 | Reducing over-irrigation | ○ | ○ | ○ | ◗ | ● | ◗ | ○ | ○ | ○ | ● | ● |

| **BMP** | | **Impairment** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Bacteria** | **Metals** | **Organics** | **Sediment** | **Pesticides** | **Nutrients** | **Oil and grease** | **Dissolved minerals** | **Trash** | **Flow** | **Volume reduction** |
| 26 | Xeriscaping, turf conversion and other irrigation, pesticide and fertilizer reduction | ● | ◗ | ◗ | ● | ◗ | ● | ○ | ◗ | ○ | ● | ● |
| *Education and Outreach* | | | | | | | | | | | | |
| 27 | Enhanced and expanded trash cleanup programs | ○ | ◗ | ◗ | ○ | ◗ | ○ | ◗ | ○ | ◗ | ○ | ○ |
| 28 | Improved Web resources promoting reporting of enforceable discharges | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ | ◗ |
| Refocused or enhanced education and outreach to target audiences: | | | | | | | | | | | | |
| 29 | Equestrian community | ● | ○ | ○ | ◗ | ○ | ◗ | ○ | ○ | ○ | ○ | ○ |
| 31 | On-site agricultural practices (e.g. chickens, compost) | ● | ○ | ○ | ◗ | ◗ | ● | ○ | ○ | ○ | ○ | ○ |
| 32 | General/other | *Varies by focus* | | | | | | | | | | |
| *MS4 Maintenance* | | | | | | | | | | | | |
| 33 | Optimized or enhanced catch basin inlet cleaning and management | ◗ | ● | ○ | ● | ○ | ◗ | ○ | ○ | ○ | ○ | ○ |
| 34 | Proactive MS4 repair and replacement | ◗ | ● | ○ | ● | ○ | ◗ | ○ | ○ | ○ | ○ | ○ |
| 35 | Increased channel cleaning and scour pond repair to improve MS4 function | ◗ | ● | ○ | ● | ○ | ◗ | ○ | ○ | ○ | ○ | ○ |
| Street sweeping enhancements and expansion: | | | | | | | | | | | | |
| 36 | Increased sweeping frequency or routes | ◗ | ● | ◗ | ● | ○ | ● | ○ | ◗ | ● | ○ | ○ |
| 37 | Sweeping medians on high-volume segments | ◗ | ● | ◗ | ● | ○ | ● | ○ | ◗ | ● | ○ | ○ |
| 38 | Upgraded sweeping equipment | ◗ | ● | ◗ | ● | ○ | ● | ○ | ◗ | ● | ○ | ○ |
| 39 | Sweeping of private roads and parking lots | ◗ | ● | ◗ | ● | ○ | ● | ○ | ◗ | ● | ○ | ○ |
| Erosion repair and slope stabilization: | | | | | | | | | | | | |
| 40 | Public property and right of way | ◗ | ○ | ○ | ● | ○ | ◗ | ○ | ◗ | ○ | ○ | ○ |
| 41 | Enforcement on private properties | ◗ | ○ | ○ | ● | ○ | ◗ | ○ | ◗ | ○ | ○ | ○ |
| *Capital Improvement Projects* | | | | | | | | | | | | |
| 42 | Dry-weather flow separation | ● | ◗ | ○ | ○ | ○ | ◗ | ◗ | ○ | ○ | ● | ● |
| 43 | Sewer pipe replacement | ● | ○ | ○ | ○ | ○ | ● | ○ | ○ | ○ | ○ | ○ |
| 44 | Reducing groundwater infiltration | ◗ | ○ | ○ | ◗ | ○ | ◗ | ○ | ○ | ○ | ○ | ○ |
| 45 | Mitigation and conservation initiatives | ◗ | ○ | ○ | ● | ◗ | ◗ | ○ | ○ | ○ | ○ | ○ |

PSC land uses evaluated in the CLRP are comprised of spatially-defined land uses, such as agricultural or commercial uses. However, not all pollutant sources can be represented spatially as specific geographic points or even as land use categories. Some identified pollutant sources, such as trash and bacteria contributions from homeless persons in the watershed, are documented in the San Diego region CLRP watersheds but cannot be assigned to a specific location. Others, such as runoff from over-irrigation or atmospheric deposition of copper from automobile brake pads, certainly are associated with specific land use or land cover types but cannot be located with the certainty of, for example, an animal-related facility or a community shopping center's trash area. These sources create the set of PGAs evaluated in the CLRP.

PGAs are those activities (e.g., airplane repair) or land uses (e.g., golf courses) from which the discharge of pollutants or substances of concern to water quality may reasonably be expected based on the nature of the associated operations and actions, and which thus may need supplemental practices, controls, site enhancements or other measures to prevent the discharge of pollutants. Table F-2 presents the relationship between PGAs and PSC land uses. In Table F-2, the PSC land uses identified in the San Diego Region are listed as columns; the actions or operations associated with each PGA which can lead to pollutant discharges or impacts are listed in rows. The pollutant generating actions or operations potentially associated with each PGA are indicated by a water drop in the associated cell.

#### Table F-2. Relationship between PGAs and PSC land uses

| | Land Use | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PGAs | Agriculture | Commercial | HD Residential | LD Residential | Rural Residential | Institutional | Military | Open Space | Recreation | Freeway | Road | Transportation | Water | Industrial | Heavy Industry | Extraction/Landfill | Shopping Center |
| AWM Fueling | | 💧 | | | | | 💧 | | | | | 💧 | | | 💧 | | |
| Airplane Repair | | 💧 | | | | | 💧 | | | | | 💧 | | | 💧 | | |
| Animals | 💧 | 💧 | | | | | | 💧 | 💧 | | | | | | | | 💧 |
| Auto Body Paint | | 💧 | | | | | | | | | | | | 💧 | | | |
| Auto Repair | | 💧 | | | | | | | | | | | | | | | 💧 |
| Boat Repair | | 💧 | | | | | | | | | | | | | | | |
| Cemeteries | | | | | 💧 | 💧 | | 💧 | | | | | | | | | |
| Corporate Yards | | 💧 | | | | | | | | | | | | 💧 | | | |
| Equipment Repair | 💧 | 💧 | | | | 💧 | | | | | | | | 💧 | 💧 | 💧 | 💧 |
| Food Facilities | | 💧 | | | | 💧 | 💧 | | 💧 | | | | | 💧 | | | 💧 |
| Golf Courses | | | | | | | | 💧 | 💧 | | | | | | | | |
| Industrial Facilities | | | | | | | | | | | | | | 💧 | 💧 | 💧 | |
| Municipal Airfield | | | | | | | | | | | | 💧 | | | | | |
| Municipal Landfills | | | | | | | | | | | | | | | | 💧 | |
| Nurseries | 💧 | 💧 | | | | | | | | | | | | | | | 💧 |

| PGAs | Land Use | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Agriculture** | **Commercial** | **HD Residential** | **LD Residential** | **Rural Residential** | **Institutional** | **Military** | **Open Space** | **Recreation** | **Freeway** | **Road** | **Transportation** | **Water** | **Industrial** | **Heavy Industry** | **Extraction/Landfill** | **Shopping Center** |
| **POTWs** | | | | | | 💧 | | | | | | | | | | | |
| **Paintball Fields** | | | | | | | | 💧 | 💧 | | | | | | | | |
| **Zoos** | | | | | | 💧 | | | | | | | | | | | |

BMPs were assessed relative to the impact of specific land uses and PGAs in the watershed. Table F-3 presents the expected relationships between BMP types and PSC land uses for the San Diego region CLRP watersheds. Table F-3 lists the PSC land uses as columns, with the BMPs as rows. The BMPs that might reasonably be applied to reduce pollutant loads generated by the PSC land are indicated by a water drop in the associated cell.

### Table F-3. Nonstructural BMP types and their application to PSC land uses

| BMP | | Land Use | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Agriculture** | **Commercial** | **HD Residential** | **LD Residential** | **Rural Residential** | **Institutional** | **Military** | **Open Space** | **Recreation** | **Freeway** | **Road** | **Transportation** | **Water** | **Industrial** | **Heavy Industry** | **Extraction/Landfill** | **Shopping Center** |
| *Development Review Process* | | | | | | | | | | | | | | | | | | |
| 1 | Amend zoning and other development regulations to facilitate LID implementation | | 💧 | 💧 | 💧 | 💧 | 💧 | | | 💧 | | | 💧 | | 💧 | | | 💧 |
| 2 | Develop design standards/manuals to facilitate LID implementation | | 💧 | 💧 | 💧 | 💧 | 💧 | | | 💧 | | 💧 | 💧 | | 💧 | | | 💧 |
| 3 | Train staff and boards to facilitate LID implementation and source control | | 💧 | 💧 | 💧 | 💧 | 💧 | | | 💧 | | 💧 | | | 💧 | | | 💧 |
| *Enhanced Inspections and Enforcement* | | | | | | | | | | | | | | | | | | |
| 4 | Training or certification requirements for mobile businesses | *Varies, not tied to a specific land use* | | | | | | | | | | | | | | | | |
| 5 | Inspection/enforcement of power | | 💧 | 💧 | | | 💧 | | | 💧 | | | | | 💧 | 💧 | 💧 | |

| BMP | | Land Use | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Agriculture | Commercial | HD Residential | LD Residential | Rural Residential | Institutional | Military | Open Space | Recreation | Freeway | Road | Transportation | Water | Industrial | Heavy Industry | Extraction/Landfill | Shopping Center |
| | washing discharges | | | | | | | | | | | | | | | | | |
| 6 | Enhanced IC/ID reporting and enforcement | | ● | ● | ● | ● | ● | ● | | ● | ● | ● | ● | | ● | ● | ● | ● |
| 7 | Property-based inspections | | ● | ● | | | ● | | | ● | | | | | ● | | | ● |
| 8 | Supplemental inspection standards for PGAs of concern | *Varies - see SUSMP requirements below* | | | | | | | | | | | | | | | | |
| *SUSMP and Regulatory Enhancement* | | | | | | | | | | | | | | | | | | |
| Amend SUSMP, other code and zoning requirements, including the addition of retrofit requirements, to reduce pollutants from: | | | | | | | | | | | | | | | | | | |
| 9 | Trash enclosure and storage areas | | ● | ● | | | ● | | ● | ● | | | | | ● | ● | | ● |
| 10 | Animal-related facilities | ● | ● | | | ● | ● | ● | | | | | | | | | | ● |
| 11 | Keeping of large animals | ● | | | | ● | | | ● | ● | | | | | | | | |
| 12 | Nurseries and garden centers | | ● | | ● | | | | | | | | | | | | | ● |
| 13 | Auto-related uses | | ● | | ● | | | ● | | | ● | ● | ● | | ● | | | ● |
| 14 | Vehicle washing areas | ● | ● | ● | ● | ● | | ● | | | | | ● | | ● | ● | ● | ● |
| 15 | Update minimum BMPs | *Varies by SUSMP and Regulatory Enhancement* | | | | | | | | | | | | | | | | |
| *New/Expanded Initiatives* | | | | | | | | | | | | | | | | | | |
| 16 | Partnerships to address bacteria and trash impacts of homelessness | *Not tied to a specific land use* | | | | | | | | | | | | | | | | |
| 17 | Pilot projects disconnecting impervious surfaces from the MS4 (e.g. rain barrels, downspout disconnection) | | ● | ● | ● | | ● | | | | | | | | ● | | | ● |
| 18 | Mapping and risk assessment of agricultural operations | ● | | | | ● | | | ● | | | | | | | | | |
| 19 | Mapping and risk assessment of on-site wastewater treatment systems | ● | | | ● | ● | | | ● | ● | | | | | | | | |

| BMP | | Land Use | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Agriculture** | **Commercial** | **HD Residential** | **LD Residential** | **Rural Residential** | **Institutional** | **Military** | **Open Space** | **Recreation** | **Freeway** | **Road** | **Transportation** | **Water** | **Industrial** | **Heavy Industry** | **Extraction/Landfill** | **Shopping Center** |
| 20 | Support for Brake Pad Partnership | | | | | | | | | | ● | ● | ● | | | | | |
| 21 | Additional source reduction initiatives | *Varies by initiative* | | | | | | | | | | | | | | | | |
| *Landscape Practices* | | | | | | | | | | | | | | | | | | |
| Landscape BMP incentives, rebates, and training: | | | | | | | | | | | | | | | | | | |
| 22 | Residential properties | | | ● | ● | ● | | | | | | | | | | | | |
| 23 | Homeowners' associations/property managers | | | ● | ● | | | | | | | | | | | | | |
| 24 | Nonresidential properties | | ● | | | | ● | ● | | ● | | | | | ● | | | ● |
| 25 | Reducing over-irrigation | | ● | ● | ● | ● | ● | ● | ● | ● | | | | | ● | | | ● |
| 26 | Xeriscaping, turf conversion and other irrigation, pesticide and fertilizer reduction | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● | | | ● |
| *Education and Outreach* | | | | | | | | | | | | | | | | | | |
| 27 | Enhanced and expanded trash cleanup programs | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● | | | ● |
| 28 | Improved Web resources promoting reporting of enforceable discharges | ● | ● | ● | ● | ● | ● | | ● | ● | | ● | ● | | ● | ● | | ● |
| Refocused or enhanced education and outreach to target audiences: | | | | | | | | | | | | | | | | | | |
| 29 | Equestrian community | ● | | | | ● | | | ● | ● | | | | | | | | |
| 31 | On-site agricultural practices (e.g. chickens, compost) | ● | | ● | ● | ● | | | ● | | | | | | | | | |
| 32 | General/other | *Varies by focus area* | | | | | | | | | | | | | | | | |
| *MS4 Maintenance* | | | | | | | | | | | | | | | | | | |
| 33 | Optimized or enhanced catch basin inlet cleaning and management | | ● | ● | ● | | ● | ● | | ● | ● | ● | ● | | ● | | | ● |
| 34 | Proactive MS4 repair and replacement | | ● | ● | ● | | ● | ● | | ● | ● | ● | ● | | ● | | | ● |

| BMP | | Land Use | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Agriculture | Commercial | HD Residential | LD Residential | Rural Residential | Institutional | Military | Open Space | Recreation | Freeway | Road | Transportation | Water | Industrial | Heavy Industry | Extraction/Landfill | Shopping Center |
| 35 | Increased channel cleaning and scour pond repair to improve MS4 function | | 💧 | 💧 | 💧 | | 💧 | 💧 | | 💧 | 💧 | 💧 | 💧 | | 💧 | | | 💧 |
| Street sweeping enhancements and expansion: | | | | | | | | | | | | | | | | | | |
| 36 | Increased sweeping frequency or routes | | | | | | | | | | 💧 | 💧 | 💧 | | | | | |
| 37 | Sweeping medians on high-volume segments | | | | | | | | | | 💧 | 💧 | 💧 | | | | | |
| 38 | Upgraded sweeping equipment | | | | | | | | | | 💧 | 💧 | 💧 | | | | | |
| 39 | Sweeping of private roads and parking lots | | 💧 | 💧 | | | 💧 | 💧 | | 💧 | | | | | 💧 | | | 💧 |
| Erosion repair and slope stabilization: | | | | | | | | | | | | | | | | | | |
| 40 | Public property and right of way | | | | | | | | 💧 | 💧 | 💧 | 💧 | 💧 | | | | | |
| 41 | Enforcement on private properties | 💧 | 💧 | 💧 | 💧 | 💧 | 💧 | | | | | | | | 💧 | 💧 | 💧 | |
| *Capital Improvement Projects* | | | | | | | | | | | | | | | | | | |
| 42 | Dry-weather flow separation | *Capital improvement project; not tied to land use setting* | | | | | | | | | | | | | | | | |
| 43 | Sewer pipe replacement | *Capital improvement project; not tied to land use setting* | | | | | | | | | | | | | | | | |
| 44 | Reducing groundwater infiltration | *Capital improvement project; not tied to land use setting* | | | | | | | | | | | | | | | | |
| 45 | Mitigation and conservation initiatives | *Capital improvement project; not tied to land use setting* | | | | | | | | | | | | | | | | |

Because not all pollutant sources are defined land uses, the relationship between and PGAs must be considered. Table F-4 presents the expected relationships between BMP types and PGAs. Table F-4 lists the PGAs as columns, with the BMPs as rows. The BMPs that might reasonably be applied to reduce pollutant loads generated by the PGAs are indicated by a water drop in the associated cell.

## Table F-4. Nonstructural BMP types and their application to PGAs

| BMP | | Pollutant-Generating Activities (PGAs) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AWM Fueling | Airplane Repair | Animals | Auto Body Paint | Auto Repair | Boat Repair | Cemeteries | Corporate Yards | Equipment Repair | Food Facilities | Golf Courses | Industrial Facilities | Municipal Airfield | Municipal Landfills | Nurseries | POTWs | Paintball Fields | Zoos |
| *Development Review Process* | | | | | | | | | | | | | | | | | | | |
| 1 | Amend zoning and other development regulations to facilitate LID implementation | | | ● | ● | ● | ● | | ● | | ● | ● | ● | ● | | ● | | ● | ● |
| 2 | Develop design standards/manuals to facilitate LID implementation | | | ● | | | | | ● | | ● | ● | ● | ● | | ● | | ● | ● |
| 3 | Train staff and boards to facilitate LID implementation and source control | | | ● | ● | ● | ● | | ● | | ● | ● | ● | ● | | ● | | ● | ● |
| *Enhanced Inspections and Enforcement* | | | | | | | | | | | | | | | | | | | |
| 4 | Training or certification requirements for mobile businesses | | | | | ● | | | | ● | | | | | | ● | | | |
| 5 | Inspection/enforcement of power washing discharges | ● | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | ● | | ● | ● |
| 6 | Enhanced IC/ID reporting and enforcement | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 7 | Property-based inspections | | | ● | | | | | ● | | ● | | ● | | | ● | | | ● |
| 8 | Supplemental inspection standards for PGAs of concern | Varies - see SUSMP requirements below | | | | | | | | | | | | | | | | | |
| *SUSMP and Regulatory Enhancement* | | | | | | | | | | | | | | | | | | | |
| Amend SUSMP, other code and zoning requirements, including the addition of retrofit requirements, to reduce pollutants from: | | | | | | | | | | | | | | | | | | | |
| 9 | Trash enclosure and storage areas | | | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| 10 | Animal-related facilities | | | ● | | | | | | | | | | | | | | | ● |
| 11 | Keeping of large animals | | | ● | | | | | | | | | | | | | | | ● |
| 12 | Nurseries and garden | | | | | | | | | | | | | | | ● | | | |

| BMP | | AWM Fueling | Airplane Repair | Animals | Auto Body Paint | Auto Repair | Boat Repair | Cemeteries | Corporate Yards | Equipment Repair | Food Facilities | Golf Courses | Industrial Facilities | Municipal Airfield | Municipal Landfills | Nurseries | POTWs | Paintball Fields | Zoos |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Pollutant-Generating Activities (PGAs)** | | | | | | | | | | | | | | | | | |
| | centers | | | | | | | | | | | | | | | | | | |
| 13 | Auto-related uses | | | | ● | ● | | | | ● | | | | | | | | | |
| 14 | Vehicle washing areas | | ● | | ● | ● | ● | | | ● | | | ● | ● | ● | ● | | | ● |
| 15 | Update minimum BMPs | *Varies by SUSMP and Regulatory Enhancement* | | | | | | | | | | | | | | | | | |
| *New/Expanded Initiatives* | | | | | | | | | | | | | | | | | | | |
| 16 | Partnerships to address bacteria and trash impacts of homelessness | Not related to PGAs | | | | | | | | | | | | | | | | | |
| 17 | Pilot projects disconnecting impervious surfaces from the MS4 (e.g. rain barrels, downspout disconnection) | Relates to structures and applies to multiple settings | | | | | | | | | | | | | | | | | |
| 18 | Mapping and risk assessment of agricultural operations | | | ● | | | | | | | | | | | | | | | |
| 19 | Mapping and risk assessment of on-site wastewater treatment systems | Relates to structures and applies to multiple settings | | | | | | | | | | | | | | | | | |
| 20 | Support for Brake Pad Partnership | | ● | | | ● | | | | ● | | | | | | | | | |
| 21 | Additional source reduction initiatives | *Varies by initiative* | | | | | | | | | | | | | | | | | |
| *Landscape Practices* | | | | | | | | | | | | | | | | | | | |
| Landscape BMP incentives, rebates, and training: | | | | | | | | | | | | | | | | | | | |
| 22 | Residential properties | | | ● | | ● | | | | | | | | | | | | | |
| 23 | Homeowners' associations/property managers | | | ● | | ● | | ● | ● | | ● | ● | ● | | | | | | ● |
| 24 | Nonresidential properties | | | ● | | | | | ● | | ● | ● | ● | ● | | | | | ● |
| 25 | Reducing over-irrigation | | | ● | | ● | | ● | ● | | ● | ● | ● | ● | | ● | | | ● |
| 26 | Xeriscaping, turf conversion and other | | | ● | | | | | ● | | | ● | ● | | | ● | | | ● |

| BMP | | Pollutant-Generating Activities (PGAs) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AWM Fueling | Airplane Repair | Animals | Auto Body Paint | Auto Repair | Boat Repair | Cemeteries | Corporate Yards | Equipment Repair | Food Facilities | Golf Courses | Industrial Facilities | Municipal Airfield | Municipal Landfills | Nurseries | POTWs | Paintball Fields | Zoos |
| | irrigation, pesticide and fertilizer reduction | | | | | | | | | | | | | | | | | | |
| *Education and Outreach* | | | | | | | | | | | | | | | | | | | |
| 27 | Enhanced and expanded trash cleanup programs | | | ● | | | | | ● | | ● | ● | ● | | | ● | ● | | ● |
| 28 | Improved Web resources promoting reporting of enforceable discharges | | | ● | ● | ● | ● | | ● | ● | ● | ● | ● | | | ● | ● | ● | ● |
| Refocused or enhanced education and outreach to target audiences: | | | | | | | | | | | | | | | | | | | |
| 29 | Equestrian community | | | ● | | | | | | | | | | | | | | | |
| 31 | On-site agricultural practices (e.g. chickens, compost) | | | ● | | | | | | | | | | | | | | | |
| 32 | General/other | *Varies by focus area* | | | | | | | | | | | | | | | | | |
| *MS4 Maintenance* | | | | | | | | | | | | | | | | | | | |
| 33 | Optimized or enhanced catch basin inlet cleaning and management | N/A, BMPs address public MS4 | | | | | | | | | | | | | | | | | |
| 34 | Proactive MS4 repair & replacement | N/A, BMPs address public MS4 | | | | | | | | | | | | | | | | | |
| 35 | Increased channel cleaning and scour pond repair to improve MS4 function | N/A, BMPs address public MS4 | | | | | | | | | | | | | | | | | |
| Street sweeping enhancements and expansion: | | | | | | | | | | | | | | | | | | | |
| 36 | Increased sweeping frequency or routes | Not related to PGAs | | | | | | | | | | | | | | | | | |
| 37 | Sweeping medians on high-volume segments | Not related to PGAs | | | | | | | | | | | | | | | | | |
| 38 | Upgraded sweeping equipment | Not related to PGAs | | | | | | | | | | | | | | | | | |
| 39 | Sweeping of private roads and parking lots | | | | ● | ● | ● | | ● | ● | ● | ● | ● | | | ● | | ● | ● |
| Erosion repair and slope stabilization: | | | | | | | | | | | | | | | | | | | |
| 40 | Public property and | | | | | | | | | | | | | ● | ● | ● | ● | | |

| BMP | | Pollutant-Generating Activities (PGAs) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **AWM Fueling** | **Airplane Repair** | **Animals** | **Auto Body Paint** | **Auto Repair** | **Boat Repair** | **Cemeteries** | **Corporate Yards** | **Equipment Repair** | **Food Facilities** | **Golf Courses** | **Industrial Facilities** | **Municipal Airfield** | **Municipal Landfills** | **Nurseries** | **POTWs** | **Paintball Fields** | **Zoos** |
| | right of way | | | | | | | | | | | | | | | | | | |
| 41 | Enforcement on private properties | | | | ♦ | | | ♦ | | | | ♦ | | | | | ♦ | | ♦ |
| *Capital Improvement Projects* | | | | | | | | | | | | | | | | | | | |
| 42 | Dry-weather flow separation | N/A, BMPs address public MS4 | | | | | | | | | | | | | | | | | |
| 43 | Sewer pipe replacement | N/A, BMPs address public MS4 | | | | | | | | | | | | | | | | | |
| 44 | Reducing groundwater infiltration | N/A, BMPs address public MS4 | | | | | | | | | | | | | | | | | |
| 45 | Mitigation and conservation initiatives | N/A, BMPs address public MS4 | | | | | | | | | | | | | | | | | |

# Appendix G. Literature Reviewed

An extensive number and variety of documents were reviewed and personal communications undertaken in preparing the CLRP. This appendix presents a structured bibliography of the sources from which much of the critical data or background information was obtained.

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# Appendix H. Screening Structural Solutions

## Identification of Distributed BMP Opportunities

### Review of Documents for RP's Recently Implemented, Proposed, and Planned Projects

To explore current and future water management projects that can be beneficial in terms of pollutant load reductions in CLRP watersheds, Tetra Tech collaborated with the RPs to collect and summarize available information regarding structural BMP control measures that have been recently implemented, as well as those planned and proposed for implementation across the region. Studies, such as the annual Watershed Urban Runoff Management Reports of Watershed Management Areas (WMAs) in San Diego County, the Integrated Regional Water Management Plan for San Diego, Stormwater Management Work Plans of the State of California Department of Transportation, Jurisdictional Water Resources Restoration and Enhancement Programs, and other reports regarding proposed local retrofit and greening projects provided essential information for this task. In addition to those reports, recent studies completed in the cities of San Diego, La Mesa, Poway, Escondido, Lemon Grove, and San Diego County were reviewed along with their development program and planning activities websites. Tetra Tech developed maps and lists of BMPs that have been recently implemented or proposed, and based on RP review, updated the information for this Report according to new data provided.

### Screening Methodology for New Potential Distributed BMP Sites

The first step in selecting the best potential new locations for distributed BMPs was a site-selection and prioritization analysis. This analysis began by assessing landscape characteristics, jurisdictional attributes, water quality needs, and general site sustainability. The site screening and prioritization process systematically evaluated and prioritized potential sites in each jurisdiction of the watershed. This screening and prioritization process included geographic information system (GIS)-based analyses using the best available landscape and water quality data, and reconnaissance level aerial imagery survey. Approximately 2,690 parcels were screened for BMP opportunities.

The advantage of this prioritization process is the ability to select BMP locations that are best suited for maximum cost-effectiveness, resulting in the greatest pollutant load reductions per dollar. Because structural BMPs at any scale involve identifying and setting aside land for stormwater treatment, assessing opportunities on existing, publicly owned lands is especially important. Structural treatment often can be integrated into parks or playing fields and street rights-of-way or medians without compromising function, so opportunities for incorporating BMPs in recreation areas, streets, and other public open spaces are typically prioritized and used as a first step in evaluating available sites.

#### *Data Summary*

To support the site-selection process, several geospatial, tabular, and time-series data sets were used, including parcels, slopes, soils, land use, topography, regional watersheds, existing BMP locations, schools, parks, aerial imagery, groundwater/soil contamination sites, and land-based pollutant loadings from the CLRP Task 2 Pollutant Source Characterization modeling results. The majority of the data were obtained through the San Diego Association of Governments (SANDAG), San Diego Geographic Information Source (SanGIS), Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO), California State Water Resources Control Board (SWRCB) Geotracker, and the ESRI Maps and Data server. Pollutant loading from land-based sources was quantified by simulating the watersheds using the Loading Simulation Program in C++ (LSPC) model.  Table H-1 summarizes the data used in the site-selection process.

### Table H-1. Summary of data used for site selection

| Data set | Type | Description | Source |
|---|---|---|---|
| Wet-weather and Dry-weather pollutant Loading | GIS Shapefile of Modeling Results | Areal loading from the CLRP Task 2 Pollutant Source Characterization and Prioritization modeling results | CLRP Task 2 Pollutant Source Characterization and Prioritization |
| Parcels | GIS Shapefile | Parcel boundaries, ownership, and the Nucleus Use Code (a description of the use of the property) from the county assessor's data | SanGIS |
| Slopes | GIS Shapefile | Slopes derived from 1999 orthophotos and updated in 2004 and countywide DEM | SanGIS<br>SANDAG |
| Soils | GIS Shapefile | Spatial extents of hydrologic soils groups (HSG) | NRCS SSURGO |
| Land use | GIS Shapefile | Land use categories defined by municipalities | SANDAG |
| Topography | GIS Shapefile | Elevation contours at 2-foot intervals for City of San Diego and countywide DEM | SanGIS |
| Watersheds | GIS Shapefile | Extent of regional watersheds | SanGIS |
| BMP locations | GIS Shapefile | Existing BMP locations | Shapefile created using existing BMP locations provided by the RPs and identified in existing studies |
| Schools | GIS Shapefile | School locations and acreage, extracted from the land use shapefile | SANDAG |
| Active parks | GIS Shapefile | Active parks in San Diego County | SanGIS |
| Impervious Area | GIS Shapefile | Percent imperviousness for parcel data and percent impervious in a raster grid | City of San Diego and NRCS |
| Waterbodies | GIS Shapefile | Streams, rivers, lakes and other waterbodies | SANDAG<br>SanGIS |
| Groundwater/soil contamination | Point Data | Past and current groundwater/soil remediation sites | California SWRCB Geotracker |
| Stormwater Data | | Storm drain structures and pipe characteristics | SanGIS |
| ESA | GIS Shapefile | Jurisdictional Environmentally Sensitive Areas (ESAs) for San Diego County | SanGIS |
| Public Utilities | GIS Shapefile | Sewer main and water main locations and characteristics | SanGIS |
| Vegetation | GIS Shapefile | Existing vegetation type, existing vegetation canopy cover, and existing vegetation height | LandFire<br>U.S. Department of Agriculture Forest Service<br>U.S. Department of Interior |
| Geohazard Risk | GIS Shapefile | Geohazard codes and characteristics | SanGIS |
| MHPA | GIS Shapefile | Location of Multi Habitat Planning Areas | SanGIS |
| MSCP | GIS Shapefile | Location of Multi Species Conservation Program areas | SanGIS |

### *Primary Screening and Prioritization*

In 2009 the City of San Diego performed the *Parcel Evaluation for BMP Implementation Study* that provided a GIS analysis and decision criteria for selecting parcels for BMP implementation in the city's jurisdiction. The study methodology served as a starting point in developing the prioritization and screening process. The process was further refined based on the experience of the RP jurisdictions and of Tetra Tech, and based on the CLRP Task 2 Pollutant Source Characterization data.

The site-selection process identified parcels potentially suitable for BMP implementation through two steps:

1. A primary screening to eliminate unsuitable parcels on the basis of physical and jurisdictional characteristics; and
2. A separate site prioritization process for distributed and centralized BMPs, to rank the suitability of the remaining parcels, using a methodology derived from the characteristics listed in Table H-1.

The primary screening identified parcels potentially suitable for BMP implementation at both distributed and centralized scales. Note: Section 3 discusses additional screening criteria used for the centralized BMP sites. The primary screening for potential BMP opportunities was based on two parameters:

- **Parcel Ownership and Zoning/Landuse**: Land costs generally are minimized by using existing public lands; therefore, all privately owned parcels were eliminated as potential BMP sites. All classifications of zoning, land use, and indication of public ownership for public parcels were considered.
- **Slope**: Parcels with a slope greater than 15 percent were not considered for BMP opportunities, other than parcels located in canyon areas. The screening was expanded to include areas in and around canyons for centralized BMPs. For this analysis, slope was determined on the basis of Digital Elevation Maps (DEM) or other available topography data sets. In areas where the overall slope of the parcel was in question, slope was verified through review of aerial imagery. Parcels where the slope exceeds 15 percent were eliminated.

The results of the primary screening provided a base list of parcels potentially suitable for BMP implementation. A GIS analysis was performed on the parcels remaining after the primary screening to identify the potential sites for distributed BMP placement and to rank their potential suitability. The following characteristics were used in this ranking:

- **Pollutant Loading:** Parcels where estimated pollutant loadings are greatest were given a higher priority. Land-based pollutant loadings were obtained from the CLRP Task 2 Pollutant Source Characterization modeling results (CLRP Section 3.3 and 3.4). Pollutant loading percentile was determined on a watershed basis, and represents the average pollutant loading score. A composite wet- and dry-weather areal loading score was developed for each applicable TMDL pollutant in each watershed. Subwatersheds with the top 40$^{th}$ percentile pollutant loading were considered High Priority Management Areas due to their potential to make the most difference in comprehensive load reduction.
- **Infiltration capacity**: The mapped hydrologic soils groups were used as an initial estimate for the infiltration rate and storage capacity of the soils. Sites where mapped hydrologic soils groups have infiltration rates suitable for infiltration BMPs received higher priority for further investigation.
- **Contaminated sites**: Areas near contaminated sites received lower priority because of the potential for increased costs and complications during implementation.

- **Environmentally sensitive areas**: Areas where runoff can be treated before draining to an ESA were given a higher priority.
- **Total impervious area**: Parcels representing a larger total impervious area typically generate more runoff and greater pollutant loads and were given a higher priority. Impervious area was estimated using aerial imagery in areas where impervious data was not available.
- **Percent impervious**: Parcels with a higher percentage of impervious area relative to the size of the parcel also typically produce more runoff and were targeted on the basis of the greater potential to achieve volume reduction and water quality improvements.
- **Space requirements**: To determine if sufficient space is available to implement an appropriately sized BMP, the potentially available space on a parcel was evaluated on the basis of the size of the parcel and the amount of existing impervious area.
- **Proximity to existing BMPs**: To distribute treatment opportunities effectively throughout the watershed, areas in close proximity to existing or planned future BMPs were given a lower priority.
- **Proximity to parks and schools**: Areas closest to parks and schools were given a higher priority, in part to provide a greater opportunity for public outreach and education. The proximity to schools and active use parks was used as an indication or proxy for high public use and activity.
- **Proximity to the storm drainage network:** Areas in close proximity to the storm drain network were given a higher priority. Distributed BMPs on poor draining soils require underdrain systems that tap into existing infrastructure, and siting these in proximity to the storm drain network can minimize cost.
- **Multi-benefit use**: BMP implementation can achieve multiple purposes. For instance, some stormwater practices, such as infiltration basins or vegetated swales, can serve a dual purpose of stormwater management and community park space. Sites that offer multi-benefit opportunities received higher priority in the ranking.

Potential sites were prioritized using a scoring methodology developed in conjunction with the RPs and presented in Table H-2. This scoring methodology puts an equally high emphasis on municipal or public ownership and areas most affected by land-based pollutant loadings (wet- and dry-weather loading combined). Ownership and pollutant loading can each receive a maximum score of 10, while the remaining scoring criteria can achieve a maximum score of 5. Therefore, this methodology not only prioritizes locations where distributed BMPs are practically feasible but allows for the selection of BMPs in public parcels where the load reduction would be potentially most effective. The top ranked sites in each hydrologic or watershed area for each RP were also identified.

### Table H-2. Prioritization criteria for potential distributed BMP locations

| Factor | Score (1 = Worst, 5 = Best) | | | | |
|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 |
| Wet-weather areal pollutant loading | >80th percentile | 80-60th percentile | 60-40th percentile | 40-20th percentile | <20th percentile |
| Dry-weather areal pollutant loading | >80th percentile | 80-60th percentile | 60-40th percentile | 40-20th percentile | <20th percentile |
| Parcel zoning, landuse and Ownership | City- or county-owned public parcels and rights of way were given a priority score of 10. | Other-owned public parcels (schools and universities, state and federal facilities, utilities, etc.) were given | | | |

| Factor | Score (1 = Worst, 5 = Best) | | | | |
|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 |
| | | a priority score of 8 | | | |
| HSG soil type | A, B | | C | | D |
| Proximity to wells, water supplies, contaminated soils (feet) | | | > 100 | | < 100 |
| Proximity to ESA (optional) | Adjacent | Drains to | | | |
| Impervious area (acres) | > 1 | > 0.5 | > 0.25 | > 0.1 | |
| % Imperviousness | 60%–80% | 80%–90% | | | < 50% |
| Existing/proposed BMP Site Proximity (miles) | > 5 | 4–5 | 3–4 | 2–3 | < 2 |
| Proximity to parks and schools (feet) | | | < 1,000 | | > 1,000 |
| Proximity to storm drainage network (feet) | | | < 100 | < 300 | > 300 |

## Identification of Centralized BMP Opportunities

### Review of Documents for RP's Proposed and Planned Centralized BMP Projects

As noted above, Tetra Tech collaborated with the RPs to collect and summarize available information regarding centralized BMP control measures that are planned and proposed for implementation across the region. That included reviewing multiple plans and reports, local Capital Improvement Programs and local websites. Some of the most important information was gleaned from the annual Watershed Urban Runoff Management Reports of WMAs in San Diego County, the Integrated Regional Water Management Plan for San Diego, and the Jurisdictional Water Resources Restoration and Enhancement Programs.

### Screening Methodology for New Potential Centralized BMP Sites (excluding Canyon Areas)

Potential sites for centralized BMPs were prioritized on the basis of the parcel characteristics listed above, plus additional considerations and different numerical criteria for centralized BMPs that were developed and reviewed in discussions with the RPs. The additional considerations for identifying potential sites for centralized BMPs mainly regarded the use of open space and contributing watershed characteristics (see list below). The agreed-upon weighting for each factor is listed in Table H-3.

- **Impervious area**: Parcels with the least amount of impervious area are given the highest priority to identify areas with the greatest available space for implementing a centralized BMP. Impervious area was estimated using aerial imagery in areas where impervious data was not available.
- **Proximity to parks and schools**: Parks typically have the largest available open area, with the lowest percent imperviousness, and are well suited for centralized BMP implementation. Schools also tend to have large open areas providing opportunities for BMP implementation. All areas classified as parks, including open space parks, were given the highest priority, followed by schools. Other areas closest to active parks and schools were given higher priority because of the opportunity for public outreach and education.

- **Proximity to the storm drainage network**: Because centralized BMPs are especially effective where runoff can be diverted from the existing drainage network for treatment and control, areas in close proximity to the storm drainage network received higher priority.
- **Multi-benefit use**: Centralized BMPs are often well suited to co-location with parks and playing fields. These received higher prioritization in this analysis.
- **Watershed treatment area**: The size of the drainage area that could be diverted and treated at each potential site was evaluated, and areas that capture and effectively treat runoff from the largest drainage areas were given higher priority.
- **Percent impervious**: Contributing drainage areas with a higher percentage of imperviousness produce increased runoff relative to the watershed size during storms. Higher impervious drainage areas were targeted for greater potential volume reduction and water quality improvements.
- **Proximity to corrugated metal pipe systems**: To incorporate future upgrades to the storm drainage network in the City of San Diego, the proximity to a corrugated metal pipe system was considered and ranked on the basis of the necessity for rehabilitation (for City of San Diego jurisdictional area only).

### Table H-3. Prioritization criteria for centralized BMP implementation

| Factor | Score (1 = Worst, 5 = Best) | | | | |
|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 |
| Parcel type | City- or county-owned public parcels were assigned a priority score of 10. | Other-owned public parcels (schools/ universities, state and federal facilities, utilities) were assigned a priority score of 8. | | | |
| HSG soil type | A, B | | C | | D |
| Proximity to wells and water supplies, contaminated soils (feet) | | | > 100 | | < 100 |
| Proximity to ESA | Adjacent | Drains to | | | |
| % Imperviousness | ≤ 30% | 30%–40% | | | > 40% |
| Parcel size (acres) | ≥ 200 | 150–200 | 100–150 | 1–100 | < 1 |
| Existing/proposed BMP site proximity (miles) | > 5 | 4–5 | 3–4 | 2–3 | < 2 |
| Proximity to parks and schools (feet) | Park | School | < 1,000 | | > 1,000 |
| Proximity to storm drainage network (feet) | | | < 100 | < 300 | > 300 |
| Contributing area (acres) | > 250 | > 150 | > 100 | > 50 | < 50 |
| % Imperviousness of contributing area | > 70% | > 60% | > 50% | > 40% | < 40% |
| Proximity to corrugated metal pipe systems (applied only to City of San Diego jurisdiction) | CMP needing replacement | | CMP needing rehabilitation | | CMP requiring no action |

After the priority parcels were determined, each was reviewed using aerial photography to assess the validity of the site. Sites that were feasible after the aerial photography review were used to target parcels where field investigations would be conducted. On the basis of the field evaluations, the sites were ranked according to implementation feasibility. Once feasible sites were screened based on field evaluation, High Priority Management Areas were further used to rank the sites. A high ranking was assigned where the site is located in a High Priority Management Area. A medium ranking was assigned where the site is located outside a High Priority Management Area and there is no need for pumping. (Note: during the field investigations it was noted that many of the storm drains are a significant depth below the surface which would require either significant excavation or pumping in some areas. Based on best professional judgment, it is recommended to consider pumping the stormwater to a BMP on the surface.) A low ranking was assigned where the site is located outside High Priority Management Area and a pump discharge might be required (either from or to a BMP).

## Screening Methodology for New Potential Centralized BMP Sites in Canyon Areas

To augment the potential locations for centralized BMPs, parcels were further screened in more steeply sloped canyons and surrounding areas. Implementation of centralized BMPs within canyons allows for the use of areas that are not developed or planned for future development areas where site characteristics would not compromise the functions of the stormwater BMPs. Centralized BMPs, such as surface or subsurface infiltration systems, detention systems, or wetland systems, can treat stormwater from an existing storm drain network or outfall before it enters the canyon. These potential BMP sites would be optimal in that they allow the treatment of larger drainage areas without compromising developed areas.

The site selection process identified parcels potentially suitable for BMP implementation through two steps:

1. a primary screening to eliminate unsuitable parcels based on physical and jurisdictional characteristics; and
2. a separate site prioritization process for centralized BMPs, to rank the suitability of the remaining parcels, using a methodology derived from the characteristics listed in Table H-1.

Several additional data sources were used to assist in the screening for potential locations for centralized BMPs in canyon areas. These include public utilities, existing vegetation, stormwater outfalls, and the geohazard risk (see Table H-4).

### Table H-4. Additional data used for site selection in canyon areas

| Data set | Type | Description | Source |
|---|---|---|---|
| Public Utilities | GIS Shapefile | Sewer main and water main locations and characteristics | SanGIS |
| Vegetation | GIS Shapefile | Existing vegetation type, existing vegetation canopy cover, and existing vegetation height | LandFire<br>U.S. Department of Agriculture Forest Service<br>U.S. Department of Interior |
| Stormwater Outfalls | GIS Shapefile | Existing stormwater outfall locations and characteristics | City of San Diego |
| Geohazard Risk | GIS Shapefile | Geohazard codes and characteristics | SanGIS |
| MHPA | GIS Shapefile | Location of Multi Habitat Planning Areas | SanGIS |
| MSCP | GIS Shapefile | Location of Multi Species Conservation Program areas | SanGIS |

### Primary Screening for Canyon Areas

The primary screening identified parcels that are located within canyon areas and are potentially suitable for centralized BMP implementation. The primary screening for potential BMP opportunities was based on three parameters:

- **Parcel Ownership, Zoning, and Land use**: Land costs generally are minimized by using existing public lands; therefore, private parcels were removed from the list of potential sites. All zoning and land use classifications for public parcels were considered.
- **Slope**: For BMP opportunity consideration, parcels must have at least 15 percent slope. Slope was determined on the basis of DEM or other available topography data sets. In areas where the overall slope of the parcel was in question, slope was verified through review of aerial imagery Parcels where the slope exceeds 15 percent were eliminated.
- **Location**: Parcels outside of canyons were not considered in this BMP selection scheme as they were evaluated and prioritized in the prioritization methodology for centralized BMPs. For this analysis, determination of canyon areas was based on slope analysis of DEM datasets and proximity to hydrologic features. The MHPA GIS shapefile was also used as a guide in canyon areas as many canyon areas are designated as a MHPA.

The results of the primary screening provided a base list of parcels potentially suitable for BMP implementation within canyon areas.

### Prioritization Methodology for Centralized BMPs in Canyon Areas

A GIS analysis was performed on the parcels remaining after the primary screening to identify the potential sites for centralized BMP placement and to rank their potential suitability based on the characteristics listed below. Potential sites in canyon areas were then prioritized using the scoring methodology presented in Table H-5.

- **Environmentally Sensitive Areas**: Areas located outside a designated ESA were favored over areas within ESAs.
- **Space requirements**: To determine if sufficient space with appropriate slope is available, the potentially available space on a parcel was evaluated based on the parcel acreage that has less than 15 percent slope. Parcels with greater acreage of land that is less than 15 percent slope were given a higher priority.
- **Contaminated Sites**: Areas near contaminated sites receive lower priority due to the potential for increased costs and complications during implementation.
- **Proximity to the Storm Drainage and Outfall Network:** Areas in close proximity to the storm drain network or an existing storm drain outfall were given a higher priority. Potential BMP opportunities in close proximity to existing storm drain outfall were given a higher priority over those close to storm drain networks requiring re-routing current flow lines.
- **Utilities:** Areas in low proximity to existing public utilities (sewer mains and water mains) were given a higher priority.
- **Infiltration capacity**: The mapped hydrologic soils groups were used as an initial estimate for the infiltration rate and storage capacity of the soils. Sites where mapped hydrologic soils groups have infiltration rates suitable for infiltration BMPs received higher priority for further investigation.
- **Percent Impervious**: Parcels with the least percent imperviousness were given a higher priority. This criteria allowed the selection to focus on areas that are least developed.
- **Geohazard Risk:** Areas of low geo-hazardous risk were given higher priority. The geohazard risk was determined by the geological hazard code of the area.

### Table H-5. Prioritization criteria for centralized BMP implementation in canyon areas

| Factor | Score (1=Worst, 5= Best) | | | | |
|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 |
| Parcel Type | City- or County-owned public parcels (These parcels were assigned a priority score of 10) | Other-owned public parcels (schools/universities, state and federal facilities, utilities) (These parcels were assigned a priority score of 8) | | | |
| Proximity to ESA | Outside ESA boundaries | | | | Within ESA boundaries |
| Available area (acreage of parcel that is < 15%) | >2 | | >1 | >0.5 | <1 |
| Proximity to wells and water supplies, contaminated soils (feet) | | | > 100 | | < 100 |
| Proximity to storm drainage network (feet) | | | < 100 | < 300 | > 300 |
| Proximity to existing storm drain outfall (ft) | | <100 | <300 | >300 | |
| Proximity to utilities (sewer, water) (ft) | | | >300 | <300 | <100 |
| HSG Soil Type | A, B | | C | | D |
| % Imperviousness | < 30 | 30-40 | | | > 40 |
| Geohazard Risk | Low | Low-Medium | Medium | Medium-high | High |

Assessment of BMP opportunities in canyon areas broadens the opportunities for centralized BMP implementation. Compared to the assessment of centralized BMP opportunities prescribed above, focusing BMP implementation in canyon areas expands the assessment of parcels that may have been originally excluded due to strict sloping criteria. For instance, this assessment was not exclusive to parcels where at least 90 percent of the parcel has less than 15 percent slope. For the selection of BMP sites in canyon areas, this criterion was relaxed to include all parcels where at least a 15 percent slope was present at any extent. The acreage of the parcel with a 15 percent slope or less was calculated to determine the area of potentially level space that would be available for BMP implementation and incorporated as a ranking factor. Using the best available GIS data, this acreage of level land available for BMP implementation is an estimate and field investigations would be necessary to verify the applicability of the site for BMP implementation in regards to available space and slope stability.

The canyon area sites that appear to have the strongest potential for implementation will undergo further evaluation in the initial stage of CLRP program implementation in order to quantify the impacts and the necessary level of BMP implementation to meet the WLA in each watershed.

## References

Westin Solutions 2009. Parcel Evaluation for BMP Implementation Study for City of San Diego. February 13, 2009.

# Appendix I. Menu of Preferred Structural BMPs

## Menu of Preferred Distributed BMPs

### I.1.1. Bioretention Area and Rain Garden

Bioretention BMPs are small-scale, shallow, vegetated, depressed areas with a soil (often engineered soil) media and plant-based filtration devices that remove pollutants through a variety of physical, biological, and chemical treatment processes. Such BMPs usually consist of a grass buffer strip, media bed, ponding area, mulch layer, and planting soil media. The depressed area is planted with small- to medium-sized vegetation including trees, shrubs, and groundcover that can withstand urban environments and tolerate periodic inundation and dry periods. Pretreatment of stormwater flowing into bioretention BMPs is recommended to remove large debris, trash, and larger particulates. Ponding areas can be designed to increase flow retention and flood control capacity.

Rain gardens are shallow planted depressions that retain or detain stormwater before it is infiltrated or discharged. The terms *bioretention* and *rain garden* are often used interchangeably; however, rain gardens tend to be less engineered than a bioretention area (e.g., no underdrain and no tie into the storm drain system) and typically serve a smaller drainage area such as an individual homeowner’s lot. Bioretention areas and rain gardens are the primary BMP for integration into existing or converted landscaping areas.

Primary Pollutant Reduction: Bacteria, Sediment, Nutrients, and Trash

**Figure I-1. Parking lot median bioretention area**

### I.1.2. Infiltration Trench

Infiltration trenches are narrow, linear BMPs that have similar functions as bioretention areas with variable surface materials, including rock or decorative stone, designed to allow stormwater to infiltrate into subsurface soils. Runoff infiltrates into the soils and is stored in the void space between the stones. Infiltration trenches can reduce runoff volume and remove fine sediment and associated pollutants. Pretreatment using vegetated buffer strips or vegetated swales and bioswales is important for limiting the amount of coarse sediment entering the trench that can clog and render the trench ineffective. Infiltration trenches are designed to reduce the volume of runoff while enhancing water quality through pollutant-removal mechanisms such as filtration and sorption. Infiltration trenches use similar functions as a bioretention area for pollutant reduction including sedimentation, filtration, and sorption, but they are typically designed to be narrow and linear to fit within specific site constraints.

Primary Pollutant Reduction: Bacteria, Sediment, Nutrients, and Trash

**Figure I-2. Infiltration trench**

### I.1.3. Bioswale

Bioswales are shallow, open channels, often referred to as linear bioretention, that are designed to treat runoff primarily through infiltration that remove larger pollutants by filtering water through vegetation in the channel. Bioswales can serve as conveyance for stormwater and can be used in place of traditional curbs and gutters; however, when compared to traditional conveyance systems, the primary objective of bioswales is infiltration and water quality enhancement rather than conveyance (except for excessive flow). Bioswales can have ranges of design variations with or without check dams, subsurface storage media, and underdrains. Bioretention media can be added to a bioswale to improve water quality, reduce the runoff volume, and modulate the peak runoff rate, while also providing conveyance of excess runoff.

Primary Pollutant Reduction: Bacteria, Sediment, Nutrients, and Trash

**Figure I-3. Road median bioswale**

### I.1.4. Planter Box

A planter box is a precast concrete box containing soil media and vegetation that functions similarly to a small biofiltration BMP but is completely lined and must have an underdrain. Planter boxes have been implemented around paved streets, parking lots, and buildings to provide initial stormwater treatment to runoff from the impervious areas. Roof downspouts are directed to planter boxes, which then attenuate and filter the runoff. Planter boxes provide on-site stormwater treatment options, green space, and natural aesthetics in tightly confined urban environments. Planter boxes are usually implemented around buildings and along sidewalks. They intercept and filter runoff from adjacent impervious areas before it enters the stormwater conveyance system. Such an application offers an ideal opportunity to minimize directly connected impervious areas in highly urbanized areas. The vegetation and soil media in the planter box provide similar functionalities of bioretention BMPs.

Primary Pollutant Reduction: Bacteria, Sediment, Nutrients, and Trash

Figure I-4. Planter box adjacent to building

### I.1.5. Permeable Pavement

Permeable pavements work by allowing streets, parking lots, sidewalks, and other impervious covers to retain their natural infiltration capacity while maintaining the structural and functional features of the materials they replace. Permeable pavements contain small voids that allow water to drain through the pavement to an aggregate reservoir and then infiltrate into the soil. If the native soils below the permeable pavements do not have enough percolation capacity, underdrains can be included to direct the stormwater to other downstream stormwater control systems. Permeable pavement BMPs can be developed using modular paving systems (e.g., concrete pavers, grass-pave, or gravel-pave) or poured in place solutions (e.g., porous concrete or permeable asphalt). Permeable pavement can be used as an option in areas that require a hard paved surface.

Primary Pollutant Reduction: Bacteria, Sediment, Nutrients

Figure I-5. Permeable pavement parking area in the right-of-way

### I.1.6. Sand Filter

A sand filter is a treatment system that is used to remove particulates and solids from stormwater runoff by facilitating physical filtration. It is a flow-through system designed to improve water quality from impervious drainage areas by slowly filtering runoff through sedimentation and filtration chambers. With increased detention time, the sedimentation chamber allows larger particles to settle to the bottom of the chamber. The filtration chamber removes pollutants and enhances water quality as the stormwater is strained through a layer of sand. The treated effluent is collected by underdrain piping and discharged to the existing stormwater collection system or another BMP.

Primary Pollutant Reduction: Bacteria, Sediment, Oil and Grease, and Trash

Figure I-6. Sand filter

### I.1.7. Vegetated Swales

Vegetated swales are shallow, open channels that are designed to remove pollutants by physically straining/filtering water through vegetation in the channel. Swales can also serve as conveyance for stormwater and can be used in place of traditional curbs and gutters. When compared to traditional conveyance systems, the primary objective of vegetated swales is filtration and water quality enhancement rather than conveyance. An effective vegetated swale achieves uniform sheet flow through densely vegetated areas. When soil conditions allow, infiltration and volume reduction are enhanced by adding a gravel drainage layer underneath the swale. Vegetated swales are well suited for use in the right-of-way of linear transportation corridors and can provide a conveyance system with the added benefits of filtration and infiltration of runoff, depending on the design. Vegetated swales with subsurface bioretention media provide enhanced infiltration, water retention, and pollutant-removal capabilities. Vegetated swales remove sediment and particulate-bound pollutants by filtration through the vegetation. The effectiveness of vegetated swales can be enhanced by adding check dams or appropriate trees at approximately 50-foot increments along their length.

Primary Pollutant Reduction: Sediment, Trash, Nutrients

Source: CASQA Stormwater BMP Handbook: Municipal

**Figure I-7. Vegetated swale**

### I.1.8. Vegetated Filter Strips

Vegetated filter strips are bands of dense, permanent vegetation with a uniform slope, designed to provide pretreatment of runoff generated from impervious areas before flowing into another BMP as part of a treatment train. When on soils with high percolation rates, vegetated filter strips can also provide infiltration, improving volume reduction. Vegetated filter strips are implemented for improving stormwater quality and reducing runoff flow velocity. As water flows in a sheet across the vegetated filter strip, the vegetation filters out and settles the particulates and constituents, especially in the initial flow of stormwater. Removal efficiency is often dependent on the slope, length, gradient, and biophysical condition of the vegetation in the system. Vegetated filter strips are often used as a pretreatment for other BMPs such as bioretention or permeable pavement.

Primary Pollutant Reduction: Sediment

**Figure I-8. Vegetated filter strip**

## I.1.9. Water Harvesting

Cisterns are containers, generally larger than 100 gallons that can capture rooftop runoff and store it for future use. With control of the timing and the volume released, the captured rainwater can be more effectively released for irrigation or alternative grey water uses between storm events. For the San Diego region, cisterns primarily provide control of stormwater runoff; however, treatment can be successful when used in a treatment train along with BMPs such as bioretention. Rain water in cisterns can be controlled by permanently open outlets or operable valves depending on project specifications. Cisterns can be a useful method of reducing stormwater runoff volumes in urban areas where site constraints limit the use of other BMPs.

Primary Pollutant Reduction: Sediment

**Figure I-9. Metal cistern**

## I.1.10. Green Roof

Green roofs are roofing systems that layer a soil/vegetative cover over a waterproofing membrane. They fall into two general categories: intensive and extensive. Intensive roofs are designed with a relatively deep soils profile and are often planted with ground covers, shrubs, and trees. Extensive vegetative roofs are designed with shallow, lightweight soil profiles and ground cover plants adapted to the harsh conditions of the rooftop environment. Stormwater benefits include reduction of annual stormwater runoff and peak flows.

Primary Pollutant Reduction: Nutrients

Figure I-10. Extensive green roof

### I.1.11. Trash Segregation

Inlet trash and debris segregation can be used in conjunction with targeted street sweeping. Inlet devices are installed to capture trash and debris before conveyance into local waterbodies. Areas where trash accumulates can potentially have favorable conditions for bacteria breeding if not fully drained or regularly maintained. The use of trash screens typically traps trash in the gutter where it can be fully drained and then removed by regular street sweeping. These practices reduce the chance for bacteria breeding.

Primary Pollutant Reduction: Trash

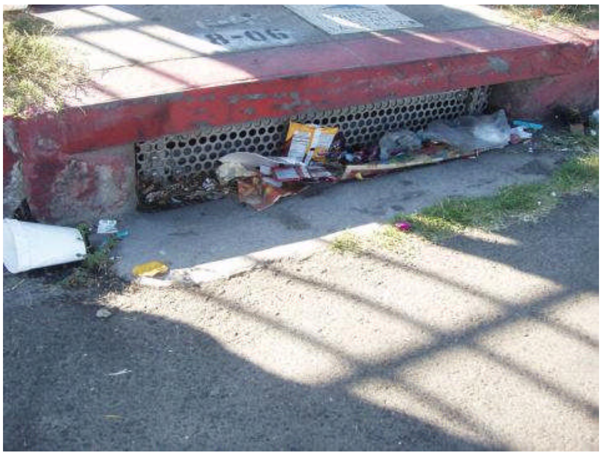

Figure I-11. Trash segregation

### I.1.12. Proprietary BMPs

Proprietary devices are commercial products that typically aim to provide stormwater treatment in space-limited areas, often using patented, innovative technologies. The most commonly encountered classes of proprietary stormwater management controls include hydrodynamic separations, catch basin insert technologies, cartridge filters, and biotreatment devices.

### I.1.13. Green Streets

Green streets are often referred to as BMPs, but actually employ multiple of the BMPs discussed above in a linear (rather than parcel-based) fashion. The green street BMP configuration strategy implements BMPs within the street right-of-way with designs that reduce runoff volume and improve water quality of the runoff both from the street and adjacent parcels. Green Street features can include vegetated curb extensions incorporating bioretention, sidewalk planters, landscaped medians, vegetated swales, permeable paving, and street trees. The most common approaches include bioretention areas located between the edge of the pavement and the edge of the right-of-way and permeable pavement installed in the parking lanes.

## Menu of Preferred Centralized BMPs

### Surface Infiltration Basin

A surface infiltration basin is a shallow impoundment that is designed to infiltrate stormwater into the soil. Infiltration practices are designed to enhance water percolation through a media matrix and native soils that slow runoff, partially hold and reduce the volume of stormwater runoff, and facilitate pollutant removal from the runoff. This practice can have water quality benefits through pollutant-removal mechanisms such as filtration and sorption and can help recharge the groundwater, thus increasing baseflow to stream systems. Infiltration basins can be challenging to apply on many sites, requiring soil, groundwater, and geotechnical studies to verify the appropriateness of the practice.

Primary Pollutant Reduction: Bacteria, Metals, Sediment, Trash


Figure I-12.Typical surface infiltration basins

### Subsurface Infiltration Galleries

A subsurface infiltration basin is an underground detention system that is designed to infiltrate stormwater into the soil, reducing runoff volume. As with surface infiltration basins, subsurface galleries are specifically designed to enhance water percolation through a media or gravel matrix and native soils that slow, hold stormwater runoff, and facilitate pollutant removal from the runoff. The practice can have water quality benefits through pollutant-removal mechanisms such as filtration and sorption and can help recharge the groundwater, thus increasing baseflow to stream systems. Also, like infiltration basins, subsurface infiltration galleries can be challenging to apply on many sites, requiring soil, groundwater, and geotechnical studies to verify the appropriateness of the practice. In addition, regular inspection is necessary to gauge maintenance frequency and avoid failure.

Primary Pollutant Reduction: Bacteria, Sediment

**Figure I-13. Example of an infiltration gallery during construction**

## Dry Extended Detention Basins

Dry extended detention basins (also known as dry ponds, dry detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain stormwater runoff for a minimum time (e.g., 24 hours) to allow particles and associated pollutants to settle to the system bottom. This practice can have water quality benefits through pollutant-removal mechanisms such as settling. These facilities often have a dry-weather flow channel and do not have a permanent pool of water. However, they can be designed with small forebay pools at the inlet and outlet of the basin to reduce required maintenance across the system. They can also be used to provide flood control by including additional flood detention storage.

Primary Pollutant Reduction: Bacteria, Organics, Sediment, Oil and Grease, Trash

**Figure I-14. Examples of dry extended detention basins**

## Subsurface Detention Systems

Subsurface detention systems are similar to infiltration galleries but provide detention in pipes, vaults, or other created voids beneath the ground. These systems are designed similar to extended detention basins in that outflow is controlled by outlets designed to detain stormwater runoff for a minimum time (e.g., 24 hours). Pretreatment for water quality purposes is critical for detention systems to reduce required maintenance. Pretreatment can include hydrodynamic separators or other filtration systems. These are often included in design to reduce solids before entering the subsurface detention system. These systems can also be designed to provide flood control by including additional flood detention storage, but adequate space must be available.

Primary Pollutant Reduction: Bacteria, Sediment

Figure I-15. Examples of subsurface detention systems

## Constructed and Pocket Wetland Systems

Constructed wetlands are created, shallow, marsh systems designed and placed to control stormwater volume and facilitate pollutant removal. As engineered constructed facilities, wetlands have less biodiversity than natural wetlands but still require a baseflow to support the aquatic vegetation present. Pocket wetlands tend to be smaller wetland systems and can be deeper and have open water with fringe wetland vegetation. Pollutant removal in wetland systems occurs through the settling of larger solids and course organic material and through uptake in the aquatic vegetation. Biotransformation of pollutants can also reduce metals and nutrients. Wetlands are among the most effective stormwater practices in terms of pollutant removal and offer aesthetic and habitat value. Wetlands can intersect groundwater to maintain wet conditions; however, they can also be designed in association with low-flow diversion systems that divert dry-weather flow to maintain a baseflow to the system.

Primary Pollutant Reduction: Bacteria, Metals, Organics, Sediment, Pesticides, Nutrients, Oil and Grease, Dissolved Minerals

Figure I-16. Examples of constructed (left) and pocket wetland (right) systems

## Subsurface Flow Wetland Systems

Subsurface flow wetland systems are similar to the constructed and pocket wetlands with the exception that they do not contain open or exposed water. In this design, runoff flows through a rock filter with wetland plants at the surface. Pollutants such as solids are removed through filtration and settling while nutrients, metals, and bacteria are reduced through biological activity on the surface of the rocks and pollutant uptake by the plants. This practice functions similar to filtering systems but offers some volume control with a vegetated component that can increase evapotranspirative losses. Subsurface flow wetlands can also provide flood control with additional flood detention storage.

Primary Pollutant Reduction: Bacteria, Metals, Organics, Sediment, Pesticides, Nutrients, Oil and Grease, Dissolved Minerals

**Figure I-17. Example of a subsurface flow wetland**

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# Appendix J. Detailed Evaluation of Centralized BMPs Sites

Detailed evaluation of identified opportunities for centralized BMPs was performed at several sites in the watershed. Descriptions of these evaluations are provided below for the following sites:

- La Jolla Community Park
- Pacific Beach Elementary Schoo
- Bird Rock Elementary School and Bird Rock Park
- Kellogg Park

## La Jolla Community Park

***Priority:*** Low – Due to the potential need to pump stormwater to the BMP and the small catchment area.

Figure J-1. La Jolla Community Park

### Catchment Characteristics

***Municipality:*** City of San Diego

***Size:*** 19.3 acres

***Location:*** The catchment is located in the west central portion of the Scripps Watershed just south of Prospect Street.

***Land Use Description:*** The catchment is comprised of an urban business district and La Jolla Community Park. The park includes tennis courts, basketball courts, and a small athletic field. The only green space is the athletic field and the yard at the park. The catchment is approximately 73 percent impervious.

***Potential Sources of Pollution:*** Based on the nature of the property, there is potential for nutrients and bacteria in the stormwater runoff. The concentration of nutrients would be linked to fertilization of the athletic field and yard at the park. Due to the daily dense population of people on the site, higher bacteria counts are anticipated in the runoff.

***Soil Characteristics:*** The soils in the area are listed as Hydrologic Soil Group (HSG) U soils by NRCS soil survey maps. This indicates predominantly urban fill. There is a wide range of possible infiltration rates for urban soils, from well-drained to very poorly-drained, which makes it necessary to test the soils in the proposed BMP locations prior to design.

***Drainage Characteristics:*** The catchment drains via surface flow to an inlet at the intersection of Draper Avenue and Prospect Street. La Jolla Community Park drains into a storm pipe at the intersection of Culver Street and Prospect Street.

### Best Management Practice Options

***Available BMP Area:*** 3.3 acres (park)

***BMP Parcel Owner:*** City of San Diego

***Potential BMP Types:*** A Subsurface Infiltration Gallery or a Subsurface Detention Gallery would be suitable for this site.

***Constructability:*** Because the soil characteristics are unknown, a soil analysis and infiltration test will be necessary to determine whether an infiltration BMP is suitable. With the lack of unaccounted for space, a subsurface BMP beneath the athletic field and/or yard would be suitable allowing for continued use of the space. It will likely be necessary to pump stormwater from the receiving storm pipe, which is across the street from the park. This would add cost for materials, installation, electricity, and maintenance. There are no apparent environmental concerns in the area, although soil contamination potential should be investigated based on the history of the site and surrounding land uses.

With the available BMP area proposed on public property, maintenance access is not an issue. Physically the site appears to be easily accessible as well, although it should be recognized that a subsurface BMP is less accessible and more maintenance-intensive than a surface BMP due to the potential for confined space entry and the need for heavy equipment such as a Vactor truck.

***Implementation Requirements:*** hydraulic analysis of watershed; engineered plans, details, and specifications; CARB regulations for construction; local sedimentation and erosion control permits; zoning regulations; general land use plan requirements; setback requirements; soil analysis and infiltration testing

***Benefits of Multi-Use:*** Locating a BMP at a park would provide an educational opportunity for children as well as adults through signage. A subsurface detention gallery would provide an opportunity to use the stored water for irrigating the athletic field and yard.

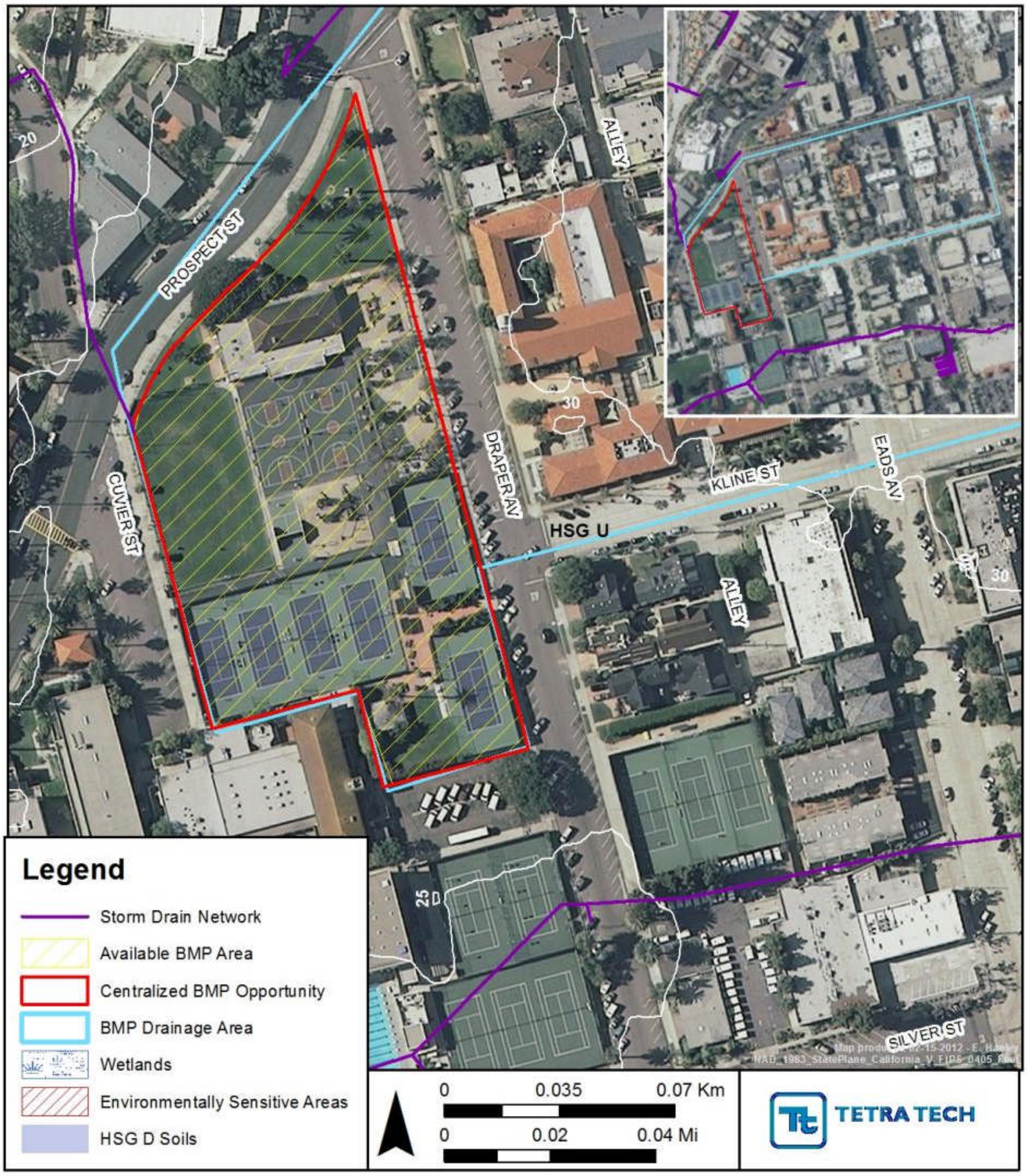


**Figure J-2. La Jolla Community Park available BMP area**

## Pacific Beach Elementary School

***Priority:*** Low – Due to the potential need to pump stormwater to the BMP and the larger catchment area.

### Catchment Characteristics

***Municipality:*** City of San Diego

***Size:*** 389 acres

***Location:*** The catchment is located in the southern portion of the Scripps Watershed, west of Interstate 5 and east of Cardeno Drive.

***Land Use Description:*** The catchment is predominantly single-family residential on 1/8-acre lots. There are also two elementary schools, a church, and open space. Green space includes the open space, which is a waterway through the center of the catchment, small residential yards, and the athletic fields at the schools. The catchment is approximately 42 percent impervious.

**Figure J-3. Athletic field at the Pacific Beach Elementary School**

***Potential Sources of Pollution:*** Based on regional monitoring in residential areas, there is an expectation that nutrients, total suspended solids (TSS), and bacteria will be prevalent in stormwater runoff. Relative to other residential areas, it is anticipated that there will be lower nutrients due to small yards; higher TSS due to a significant open space; and higher bacteria due to the potential for pet waste and concentration of people in the residential area.

***Soil Characteristics:*** The soils in the area are listed as Hydrologic Soil Group (HSG) U soils by NRCS soil survey maps. This indicates predominantly urban fill. There is a wide range of possible infiltration rates for urban soils, from well-drained to very poorly-drained, which makes it necessary to test the soils in the proposed BMP locations prior to design.

***Drainage Characteristics:*** The catchment drains via a mixture of surface flow and storm pipe to the open space, which eventually drains back into a storm pipe and then towards the Pacific Beach Elementary School. The storm pipe runs adjacent to the school along Turquoise Street and continues into the downstream catchment.

### Best Management Practice Options

***Available BMP Area:*** 4.6 acres (school)

***BMP Parcel Owner:*** San Diego Unified School District

***Potential BMP Types:*** A Subsurface Infiltration Gallery or a Subsurface Detention Gallery would be suitable for this site.

***Constructability:*** Because the soil characteristics are unknown, a soil analysis and infiltration test will be necessary to determine whether an infiltration BMP is suitable. With the lack of unaccounted for space, a subsurface BMP beneath the athletic field and/or paved areas would be suitable allowing for continued use of the space. It will likely be necessary to pump stormwater from the receiving storm pipe, along Turquoise Street. This would add cost for materials, installation, electricity, and maintenance. There are no apparent environmental concerns in the area, although soil contamination potential should be investigated based on the history of the site and surrounding land uses.

With the available BMP area proposed on public property, maintenance access is not an issue. Physically the site appears to be easily accessible as well, although it should be recognized that a subsurface BMP is less accessible and more maintenance-intensive than a surface BMP due to the potential for confined space entry and the need for heavy equipment such as a Vactor truck.

***Implementation Requirements:*** hydraulic analysis of watershed; engineered plans, details, and specifications; CARB regulations for construction; local sedimentation and erosion control permits; zoning regulations; general land use plan requirements; setback requirements; soil analysis and infiltration testing

***Benefits of Multi-Use:*** Locating a BMP at a school would provide an educational opportunity for children as well as adults through signage. A subsurface detention gallery would provide an opportunity to use the stored water for irrigating the athletic field.

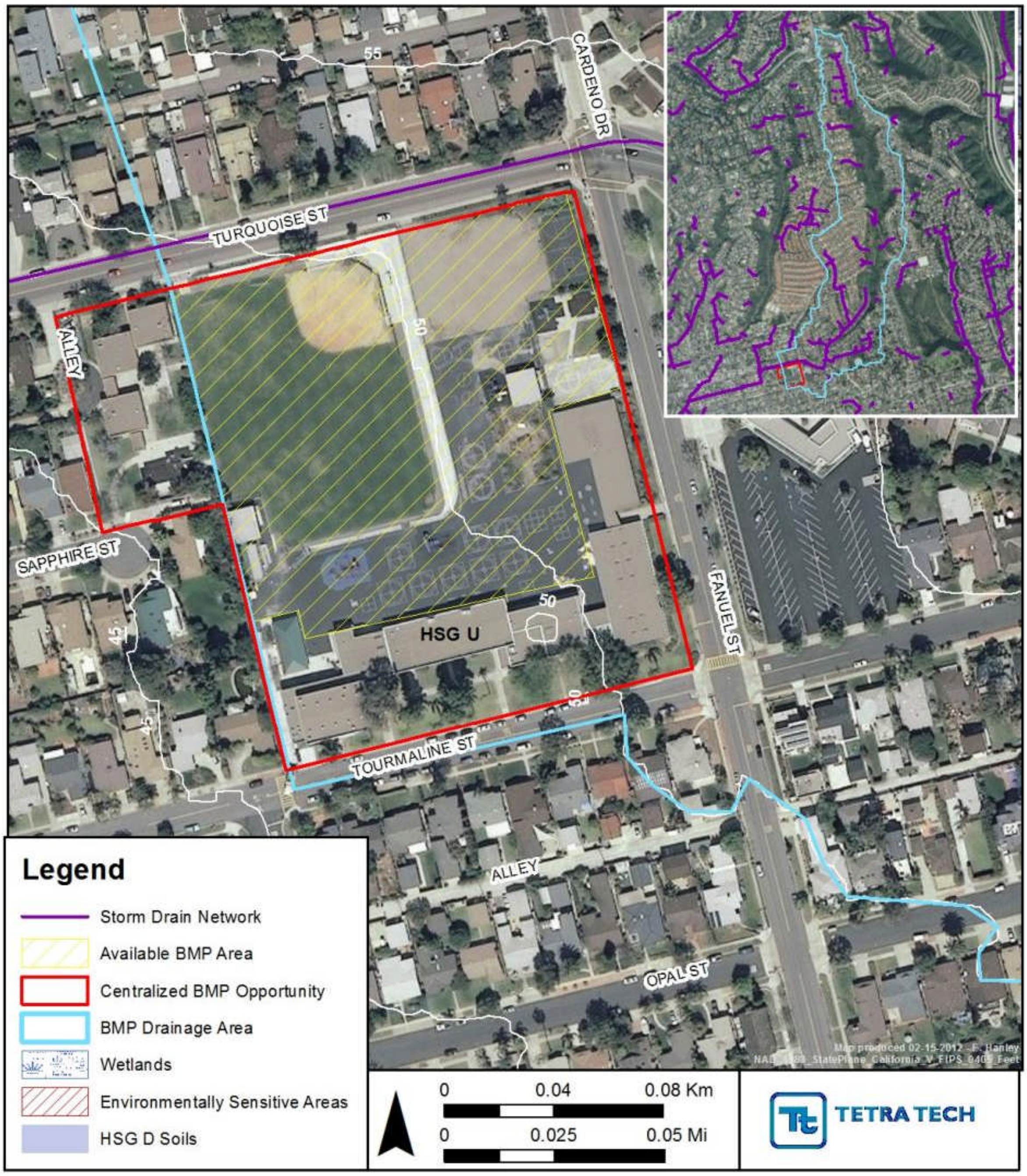


**Figure J-4. Pacific Beach Elementary School available BMP area**

## Bird Rock Elementary School and Bird Rock Park

***Priority:*** High – Due to the location in a High Priority Management Area.

### Catchment Characteristics

***Municipality:*** City of San Diego

***Size:*** 81 acres

***Location:*** The catchment is located in the ssouthern portion of the Scripps Watershed and is roughly bound by La Jolla Mesa Drive on the west and Rutgers Road on the east.

Figure J-5. Athletic field at Bird Rock Park

***Land Use Description:*** The catchment is primarily single-family residential on lots ranging from less than 1/8-acre to nearly 3/4-acre, but also includes Bird Rock Elementary School, Bird Rock Park, and significant open space. Green space includes the open space, which is a waterway through the center of the catchment, small residential yards, and the baseball field at the park. The catchment is approximately 43 percent impervious.

***Potential Sources of Pollution:*** Based on regional monitoring in residential areas, there is an expectation that nutrients, total suspended solids (TSS), and bacteria will be prevalent in stormwater runoff. Relative to other residential areas, it is anticipated that there will be lower nutrients due to small yards; higher TSS due to a significant open space; and higher bacteria due to the potential for pet waste and concentration of people in the residential area.

***Soil Characteristics:*** The soils in the area are listed as Hydrologic Soil Group (HSG) U soils by NRCS soil survey maps. This indicates predominantly urban fill. There is a wide range of possible infiltration rates for urban soils, from well-drained to very poorly-drained, which makes it necessary to test the soils in the proposed BMP locations prior to design.

***Drainage Characteristics:*** The catchment drains via a mixture of surface flow and storm pipe to the open space, which eventually drains back into a storm pipe and then towards the Bird Rock Elementary School and Bird Rock Park. The storm pipe runs south beneath the vicinity of the wall on the east side of the park and continues along an alley within the downstream catchment.

### Best Management Practice Options

***Available BMP Area:*** 1.9 acres (school and park)

***BMP Parcel Owner:*** San Diego Unified School District

***Potential BMP Types:*** A Subsurface Infiltration Gallery or a Subsurface Detention Gallery would be suitable for this site.

***Constructability:*** Because the soil characteristics are unknown, a soil analysis and infiltration test will be necessary to determine whether an infiltration BMP is suitable. With the lack of unaccounted for space, a subsurface BMP beneath the athletic field and/or paved areas would be suitable allowing for continued use of the space. It is possible that the stormwater could be diverted from the pipe along the wall to the subsurface BMP without pumping, but inverts would need to be checked. To discharge a subsurface basin if infiltration is not feasible, the detained stormwater will likely need to be pumped up to the storm pipe. This would add cost for materials, installation, electricity, and maintenance. There are no apparent environmental concerns in the area, although soil contamination potential should be investigated based on the history of the site and surrounding land uses.

With the available BMP area proposed on public property, maintenance access is not an issue. Physically the park appears to be easily accessible as well, but the courtyard within the school bounds is less accessible due to fences, buildings, and children at play. It should also be recognized that a subsurface BMP is less accessible and more maintenance-intensive than a surface BMP due to the potential for confined space entry and the need for heavy equipment such as a Vactor truck.

***Implementation Requirements:*** hydraulic analysis of watershed; engineered plans, details, and specifications; CARB regulations for construction; local sedimentation and erosion control permits; zoning regulations; general land use plan requirements; setback requirements; soil analysis and infiltration testing

***Benefits of Multi-Use:*** Locating a BMP at a school or park would provide an educational opportunity for children as well as adults through signage. A subsurface detention gallery would provide an opportunity to use the stored water for irrigating the athletic field.

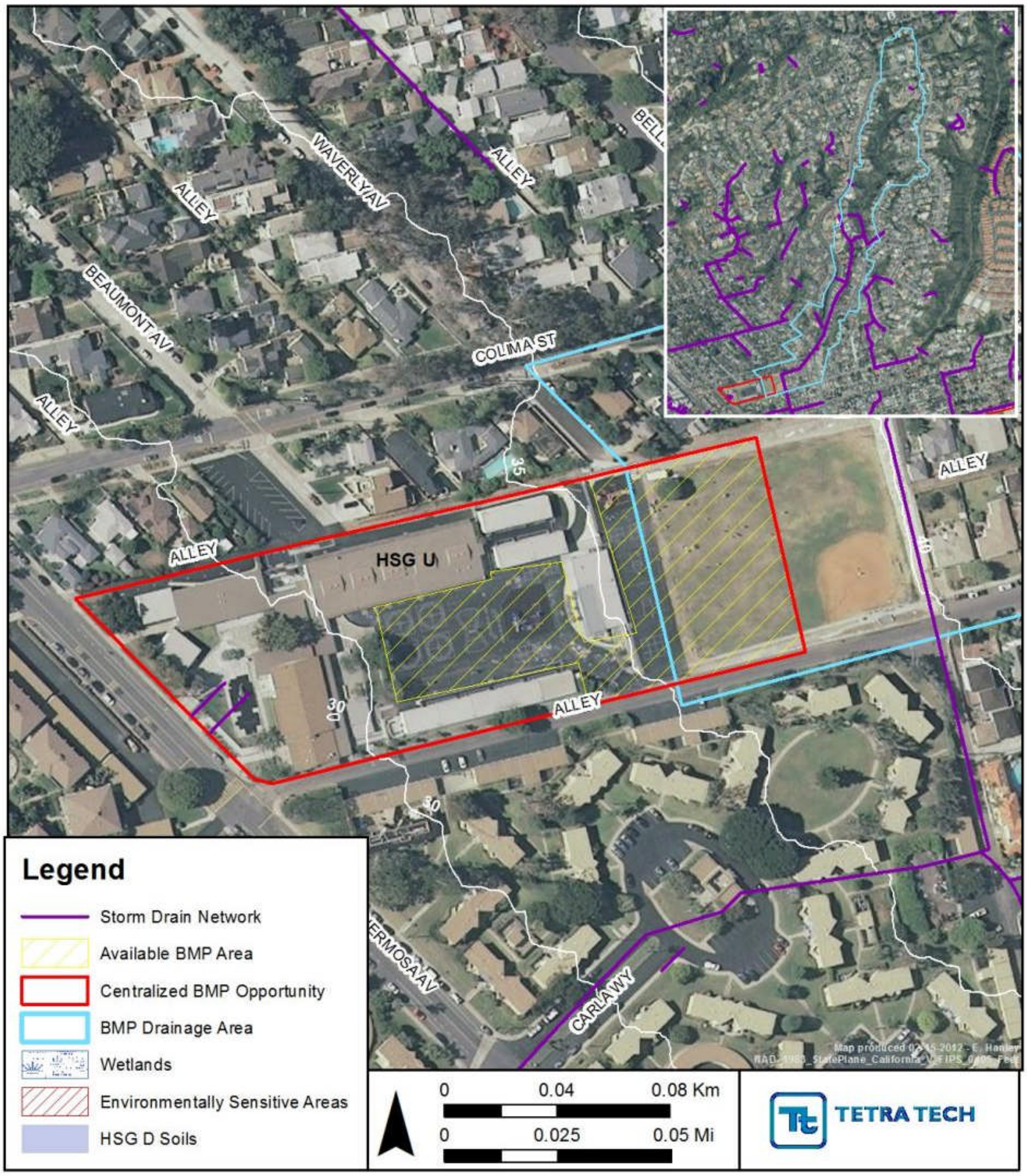


**Figure J-6. Bird Rock Elementary School and Park available BMP area**

## Kellogg Park

***Priority:*** Low – Due to the potential need to pump stormwater to the BMP, the small catchment area, and the low flow diversion system already in place in the area.

### Catchment Characteristics

***Municipality:*** City of San Diego

***Size:*** 99 acres

***Location:*** The catchment is located in the northwest portion of the Scripps Watershed and extends east from the Pacific Ocean shoreline to Torrey Pines Road.

**Figure J-7. Kellogg Park**

***Land Use Description:*** Land use in the catchment is predominantly single-family residential on lots ranging from 1/8-acre to 1/2-acre. Kellogg Park is located at the downstream end of the catchment along with some beach parking, a multi-family development, and a hotel.

***Potential Sources of Pollution:*** Based on regional monitoring in residential areas and the characteristics of the catchment, there is an expectation that nutrients, total suspended solids (TSS), and bacteria will be prevalent in stormwater runoff. Relative to similar drainage areas, it is anticipated that there will be lower nutrients due to a lack of fertilized areas, higher TSS because of its proximity to the sandy beach, and higher bacteria due to the dense housing configuration and potential for pet waste.

***Soil Characteristics:*** The soils in the area are listed as Hydrologic Soil Group (HSG) A soils by NRCS soil survey maps. The infiltration rate range for HSG A soils is suitable for infiltration BMPs, although soil infiltration testing is still necessary at the potential BMP sites in order to properly design an infiltration BMP.

***Drainage Characteristics:*** The majority of the catchment drains by surface flow to a storm pipe network on La Jolla Shores Drive and Vallecitos. The pipe on Vallecitos runs past Kellogg Park on the south side and discharges to the ocean through a flow gate. The pipe on Vallecitos is buried approximately 6 feet.

### Best Management Practice Options

***Available BMP Area:*** 3.2 acres (park)

***BMP Parcel Owner:*** City of San Diego

***Potential BMP Types:*** A Subsurface Infiltration Gallery or a Subsurface Detention Gallery would be suitable for this site.

***Constructability:*** The anticipated soil characteristics of the site provide an opportunity to use infiltration BMPs, which allows for groundwater recharge. Detention could be used as well, which relies less on infiltration as an outlet and thus has a different design and maintenance focus than an infiltration BMP.

Because this park appears to be busy with little unaccounted for space, a subsurface gallery would work well. It is likely that stormwater will need to be pumped up to the BMP following collection on Vallecitos, which adds cost for materials, installation, electricity, and maintenance. There are no apparent environmental concerns in the area.

With the available BMP area proposed on public property, maintenance access is not an issue. Physically the site appears to be easily accessible as well. It should be recognized that a subsurface BMP will require a certain amount of confined space entry and the need for heavy equipment such as a Vactor truck to conduct maintenance.

***Implementation Requirements:*** hydraulic analysis of watershed; engineered plans, details, and specifications; CARB regulations for construction; local sedimentation and erosion control permits; zoning regulations; general land use plan requirements; setback requirements; soil analysis and infiltration testing

***Benefits of Multi-Use:*** Locating any BMP in the park would provide an educational opportunity for children as well as adults through signage. If detention were to be implemented, there would be an opportunity to use that stored water for irrigation.


**Figure J-8. Kellogg Park available BMP area**

# Appendix K. BMP Fact Sheets

Fact sheets for the centralized BMPs are presented below along with a fact sheet for a pilot distributed BMP. These include:

# Appendix L. CLRP Task 3 Report (Identifying Water Resources and Other Opportunities)

Tetra Tech supported the RPs during CLRP development by preparing several interim deliverables. The deliverable associated with *Task 3: Identifying Water Resources and Other Opportunities* and its associated appendices are provided in this appendix for the Scripps watershed.

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# Appendix M. Cost Assumptions and Methodology

## Methods for Developing Unit Costs for Structural and Non-Structural BMPs

### Structural BMP Unit Cost Estimates

A range of general, planning level cost estimates for newly identified distributed and centralized BMPs was developed based on several BMP cost studies in Southern California (see Table1). The cost-range estimates were derived by generating construction costs per acre treated from previously developed detailed cost estimates for the City of San Diego Conceptual Designs (2011), the Los Angeles County TMDL Implementation Plan (2010), and the Los Angeles Water Augmentation Study (Dewoody et al 2006; SCWC 2012). It is expected that some of the structural BMP retrofits identified will require subsurface treatment options. Therefore, the Sun Valley Park centralized underground infiltration vault (SCWC 2012) and Hillery T. Broadous Elementary School projects (Dewoody et al. 2006) were also used to establish the upper limits of the estimated centralized BMP unit costs.

Several centralized BMPs have large watersheds draining to the parcels that may exceed the area that could reasonably be treated in the available BMP areas. For these sites it was assumed, based on the available BMP area and best professional judgment that maximum area that could be treated in a typical centralized BMP is approximately 200 acres. This drainage area was then used to estimate costs. For potential sites where the watershed is less than 200 acres the actual watershed area was used.

The cost range varies widely to account for all the possible configurations including sites with poor soils requiring underdrains, subsurface BMPs to maintain current parcel use, parking lots that require asphalt removal, and utility conflicts in the right-of-way. The distributed costs are also based on bioretention and permeable pavement configurations. The construction costs of the distributed and centralized BMPs are the baseline used to estimate planning, design, and operations and maintenance costs. The Water Environment Research Foundation User's Guide to the BMP and LID Whole Life Cost Models (WERF2009) and the other referenced studies were then used to develop estimated costs for planning, design, and operations/maintenance. Based on these cost studies, the planning and design costs were assumed to be 10% and 40% of construction costs, respectively. Operation and maintenance costs were estimated to be 4% (CASQA, 2003) of construction costs for distributed BMPs and 6.72% (CASQA, 2003; Cutter et al., 2008; FHA, 2003) for centralized BMPs. Table M-1 provides the estimated unit costs calculated for the distributed and centralized BMPs. This range of unit costs is provided for general planning purposes only. A more detailed cost analysis should be performed during the conceptual design phase of each project prior to implementation. The median value in the cost range was used to develop the cost estimates for implementing the BMPs. All unit costs approximately reflect 2012 dollars.

**Table M-1. Range of estimated unit costs for new identified distributed and centralized BMPs**

| BMP | | Planning $ per acre treated | Design $ per acre treated | Construction $ per acre treated | O&M $ per acre treated |
|---|---|---|---|---|---|
| Distributed | Range | $4,700 - $11,430 | $18,800 - $45,720 | $47,000 - $114,300 | $1,880 - $4,572 |
| | Median | $8,065 | $32,260 | $80,650 | $3,226 |
| Centralized | Range | $2,250 - $5,778 | $9,000 - $23,111 | $22,500 - $57,778 | $1,512 - $3,883 |
| | Median | $4015 | $16,060 | $40,150 | $2,698 |

Cost estimates were also developed for planned BMPs. Due to the lack of information about the drainage area to and costs for these planned BMPs, estimates were derived from available data regarding new identified BMPs. Specifically, the average drainage area was determined for the newly identified distributed BMP opportunities (7.4 acres) and centralized BMP opportunities (122 acres), and assumed for the planned distributed and planned centralized BMPs. The median value of the unit costs in Table M-1 was then applied to the planned BMPs to generate estimated costs.

An iterative and adaptive framework is essential to ensuring that the CLRP remains viable and cost-effective throughout its entire implementation period. Therefore, the BMP Implementation Schedule includes periodic program reviews. These program reviews will account for new findings from activities of the CLRP Implementation Program, and accommodate modifications and improvements of BMPs. A more detailed quantification of the pollutant load reductions, design sizes, and costs will be developed in the initial phase of CLRP Implementation Program, including optimization modeling and assessment. Subsequent CLRP revisions will be contingent on the results from the periodic program reviews.

Through the implementation period, the effectiveness of structural BMPs will be tracked for CLRP reporting and through continuous monitoring. As noted above, BMP assessments will be periodically performed to provide meaningful information for needed CLRP revisions, or adjustments to the structural BMPs planned. As structural BMPs are implemented, assessment methods that can be employed include pre- and post-construction monitoring, and tracking of costs of planning, permitting, design, construction, operation, and maintenance. The estimated ongoing operations and maintenance costs for structural BMPs include this continuous assessment, adaptation, and reporting. Estimated operation and maintenance costs also reflect the need and mechanism for continuous budget and funding.

## Nonstructural BMP Unit Cost Estimates

Cost estimates for nonstructural BMPs were developed collaboratively with the City of San Diego and reflect detailed, thorough assessments of both existing municipal programs, and the level of financial effort required to initiate and sustain implementation of each recommended BMP. As discussed in Section 44, the BMP recommendations and cost estimates were developed recognizing that implementation will depend on the final form of program development, the availability of staff and financial resources, and in many cases, on decisions made in the political sphere, particularly ordinance adoption or amendments and partnerships with third-party agencies. All unit costs approximately reflect 2012 dollars.

To establish the implementation schedules and associated costs, detailed program reviews and interviews were conducted with storm water program staff and, as needed, with other municipal and agency officials responsible for different aspects of program implementation. The City reviewed a prospective five-year program development schedule for each BMP and assigned costs by year, followed by an estimated annual cost to sustain the BMP once the five-year program development period was completed. The estimated annual costs in the prospective program schedules, which will necessarily be adjusted as the City implements its programs, reflect direct input from the City based on its existing program budget, staffing, and experience, along with extensive research and input on comparable programs, pilot and "best practice" programs in other jurisdictions, and typical costs for projects done by outside contractors versus municipal staff. This level of detail is intended to ensure that the prospective program schedules and costs are as realistic as possible, recognizing that implementation is dependent on financial and political factors that can change over time.

As costs were developed, the City estimated the amount of personnel time required in terms of Full Time Equivalent (FTE) effort, representing approximately 2,000 work hours per twelve-month period. The City then considered whether the BMP would involve additional costs for materials or equipment, such as public outreach materials or advertising airtime, or new street sweeping equipment. Costs for rebate programs under the Landscape Practices category, as another example, include an allowance for direct rebates to customers. For other BMPs, such as enhanced trash clean-ups and partnerships to manage trash and bacteria aspects of homelessness, each RP estimated an appropriate level of contribution or sponsorship based on local policies and practices, and other municipal partnerships in place.

The cost in each program year represents the total level of financial effort expected to be required to implement a BMP. This cost effort can consist of any combination of personnel costs, material and equipment costs, outside services, or contributions and sponsorships of third party agencies, all of which were estimated for each BMP and for each program year to arrive at a total cost. This approach anticipates that the City may choose to substitute sponsorships or contracts for outside services (e.g. consulting) for in-house staff time as best suits .its programs and initiatives. This flexibility is particularly important for BMPs that require specialty qualifications, or do not amount to a full or half-time FTE position, and to deal with common issues such as municipal or agency limitations on hiring or changes to staff job descriptions. Therefore, the annual costs thus should be seen as a total level of effort which can be translated into an FTE equivalent for comparison purposes, but which does not imply a specific plan for staff or staff positions.

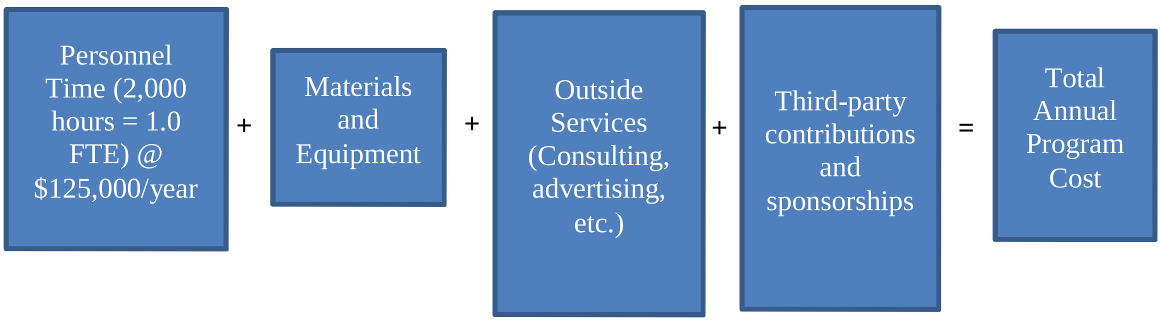


**Figure M-1. Annual Program Cost Components**

## Methods for Total Present Value Cost

Costs are estimated in present value (PV) terms. The PV is the 2012 value of the projected stream of costs over the TMDL implementation time period. The process of calculating PV is known as discounting. Discounting is important because it accounts for how monetary values differ over time compared to a specific reference year and reflects the time preference for consumption. Although it is not synonymous with the interest rate, for governments, it often reflects the rate at which funds can be borrowed and loaned. A discount rate of 5 percent was used.

A period of 18 years was selected as reasonable project duration for BMPs, going forward from 2013 (this corresponds to the 20-year CLRP implementation period beginning April 4, 2011 and ending April 3, 2031). The period of duration varies for individual structural and nonstructural BMPs depending on the implementation date outlined in the BMP Implementation Schedule. For example, if a BMP's implementation is completed in the $16^{th}$ year of the period, BMP operation and maintenance costs were included for the remaining 2 years of the period. The total present value costs do not reflect operation and maintenance costs occurring beyond the 18-year period.

Costs after 2012 are discounted according to the year the costs occur as specified in the implementation schedule. Upfront implementation periods were assumed as three years for centralized structural BMPs, and two years for distributed structural BMPs. The typical implementation period for non-structural BMPs was five years. Upfront implementation cost's include any costs occurring before operation begins (program startup and implementation for non-structural BMPs, and planning, design and construction for structural BMPs). Implementation cost for structural BMPs were summed and discounted in the last year of the implementation period. Implementation costs for non-structural BMPS were applied by year according to the information provided by the responsible party. Operation and maintenance costs for both structural and non-structural BMPs were discounted on an annual basis following the implementation period.

## Estimated Implementation Costs

For each of the nonstructural BMPs and structural BMPs on public land included in the BMP Implementation Schedule, preliminary present value cost estimates were developed to support future planning and securing of funds for implementation. This excludes the potential need for structural BMPs on private land that may be needed in the later phase of the BMP Implementation Schedule. The refined structural and nonstructural BMP analysis and periodic BMP assessment and optimization adjustments will continue to assess the degree to which centralized and distributed BMPs would need to be implemented on private land in order to meet required load reductions. Implementation actions and cost estimates for recommended nonstructural and structural BMPs are presented in the table below.

**Table M-2. Estimated present value cost of potential nonstructural and structural BMPs over 20-year timeframe**

| Watershed Implementation Categories | Present value cost* |
|---|---|
| **Nonstructural BMPs** | |
| Development Review Process | $811,802 |
| Enhanced Inspections and Enforcement | $4,055,472 |
| SUSMP and Regulatory Enhancement | $1,111,872 |
| New/Expanded Initiatives | $2,248,413 |
| Landscape Practices | $5,696,024 |
| Education and Outreach | $6,218,724 |
| MS4 System Maintenance | $172,744,368 |
| Capital Improvement Projects | $5,202,266 |
| Subtotal | $198,088,940 |
| **Structural BMPs** | |
| New Identified Centralized BMPs | $19,204,881 |
| New Identified Distributed BMPs | $8,563,198 |
| Planned/Implement Centralized BMPs | $13,387,217 |
| Planned/Implement Distributed BMPs | $3,802,081 |
| Subtotal | $44,957,376 |
| **Total present value cost** | **$243,046,317** |

*These are preliminary estimated costs subject to refinement and improvements as a result of further analyses and assessments performed as part of the CLRP Implementation Program. Implementation of BMPs are subject to available resources.

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# Appendix N. Monitoring Plan

The Responsible Parties developed a monitoring plan to address CLRP monitoring requirements. The final Monitoring Plan and QAPP are incorporated directly from this effort on the final 100 pages of this appendix.

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