Geosyntec Consultants, "Newhall Ranch Specific Plan Sub-Regional Stormwater Mitigation Plan" (April 2008)

Prepared for

Los Angeles County
Department of
Public Works

NEWHALL LAND SPECIFIC PLAN SUB-REGIONAL STORMWATER MITIGATION PLAN

Prepared by

Geosyntec
consultants

engineers | scientists | innovators

April 2008

Prepared for

Newhall Land
23823 Valencia Boulevard
Valencia, California 91355

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2566 Overland Avenue, Suite 670
Los Angeles, California 90064

Project Number PW0114

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Table of Contents

List of Tables

List of Figures

(all figures follow text)

Acronyms

ASCE:	American Society of Civil Engineers
BAT:	Best Available Technology
BCT:	Best Conventional Technology
BMP:	Best Management Practice
BOD:	Biochemical Oxygen Demand
Cd:	Cadmium
CACO3:	Calcium Carbonate
CASQA:	California Stormwater Quality Association
CDFG:	California Department of Fish and Game
CEQA:	California Environmental Quality Act
CLWA:	Castaic Lake Water Agency
CNLM:	Center for Natural Lands Management
CTR:	California Toxics Rule
Cu:	Copper
CWA:	Clean Water Act
CWP:	Center For Watershed Protection
DCIA:	Directly Connected Impervious Area
DDT:	Dichlorodiphenyltrichloroethane
DLWC:	Department of Land and Water Conservation
EIR:	Environmental Impact Report
EMC:	Event Mean Concentration
Ep:	Erosion Potential
EPA:	Environmental Protection Agency
ETo:	Reference Evapotranspiration Rate
FIB:	Fecal Indicator Bacteria
HOA:	Home Owners Association
IPM:	Integrated Pest Management
IRWD:	Irvine Ranch Water District
JPA:	Joint Powers Authority
LACDPW:	Los Angeles County Department of Public Works
LARWQCB:	Los Angeles Regional Water Control Board
LID:	Low Impact Development
LMD:	Local Maintenance District
LSAA:	Lake and Streambed Alteration Agreement
MBAS:	Methylene Blue Activated Substances
MEP:	Maximum Extent Practicable
MGD:	Million Gallons per Day
mg/L:	Milligrams per Liter
MPN:	Most Probable Number
MS4:	Municipal Separate Storm Sewer System
NCDC:	National Climatic Data Center
NPDES:	National Pollutant Discharge Elimination System

NRSP :	Newhall Ranch Specific Plan
NSWQ:	National Storm Water Quality Database
O&M:	Operations and Maintenance
PAH:	Polycyclic Aromatic Hydrocarbons
Pb:	Lead
PCB:	Polychlorinated Biphenyl
PDF:	Project Design Feature
PIPP:	Public Information and Participation Program
RMDP:	Resource Management and Development Plan
RWQCB:	Regional Water Quality Control Board
SAR:	Sodium Adsorption Ratio
SCR:	Santa Clara River
SEA:	Significant Ecological Area
SMA:	Special Management Area
SWMP:	Stormwater Mitigation Plan
SQMP:	Stormwater Quality Management Plan
SUSMP:	Standard Urban Stormwater Mitigation Plan
SWPPP:	Storm Water Pollution Prevention Plan
SWRCB:	State Water Resources Control Board
TDS:	Total Dissolved Solids
TKN:	Total Kjeldahl Nitrogen
TMDL:	Total Maximum Daily Load
TN:	Total Nitrogen
TP:	Total Phosphorus
TPH:	Total Petroleum Hydrocarbons
TRM:	Turf Reinforcement Mat
TSS:	Total Suspended Solids
USEPA:	United States Environmental Protection Agency
USGS:	United States Geological Survey
WEF:	Water Environment Federation
WDR:	Waste Discharge Requirements
WHO:	World Health Organization
WMA:	Watershed Management Area
WMC:	Watershed Management Committee
WRP:	Water Reclamation Plant
WQTR:	Water Quality Technical Report
Zn:	Zinc

1. INTRODUCTION

This sub-regional Stormwater Mitigation Plan (SWMP) was developed by Newhall Land, consistent with the Los Angeles County Municipal Separate Storm Sewer System (MS4) National Pollutant Discharge Elimination System (NPDES) Permit and the Standard Urban Stormwater Mitigation Plan (SUSMP), to set forth the urban runoff management program that will be implemented for the Newhall Ranch Specific Plan (NRSP) subregion. Stormwater management, including planning for water quality and hydromodification control, is central to assuring the long-term viability of beneficial uses, including important habitat systems and species dependent upon those systems. This sub-regional SWMP assesses potential water quality and hydromodification impacts associated with the proposed specific plan development and proposes control measures to address those potential impacts.

The Los Angeles Regional Water Quality Control Board (LARWQCB) has established a program for implementing federal stormwater/water quality management requirements, including the implementation of the SUSMP. In 2001, the LARWQCB (LARWQCB, 2001) issued an NPDES Permit and Waste Discharge Requirements (Order No. 01-182) under the CWA and the Porter-Cologne Act for discharges of urban runoff in municipal separate storm drain systems (MS4) in Los Angeles County (herein referred to as the "MS4 Permit"). The MS4 Permit requires implementation of a development-planning program for managing the effects of new development and redevelopment projects, as outlined in the Permit and the County of Los Angeles' "Manual for the Standard Urban Stormwater Mitigation Plan." The Manual is a model guidance document for use by Permittees and individual project owners to select post-construction best management practices (BMPs) and otherwise comply with the SUSMP requirements. It addresses water quality and drainage issues by specifying design standards for structural or treatment control BMPs that infiltrate or treat stormwater runoff and control peak flow discharge. BMPs are defined in the Manual and SUSMP requirements as any program, technology, process, sizing criteria, operational methods or measures, or engineered systems, which, when implemented, prevent, control, remove, or reduce pollution. The MS4 Permit and SUSMP Manual provided the overall context for the preparation of this document.

MS4 Permit §4.D(9) allows for the development of a regional or sub-regional stormwater mitigation program to substitute in part or wholly for SUSMP requirements. This NRSP sub-regional mitigation program must be approved by the Regional Board, and shall:

1. Result in equivalent or improved stormwater quality;

2. Protect stream habitat;

3. Promote cooperative problem solving by diverse interests;

4. Be fiscally sustainable and have secure funding; and

5. Construction of regional treatment facilities shall be completed prior to the use of the facility by any project within the subregion for post-development runoff treatment.

At 11,999 acres, the Newhall Ranch Specific Plan subregion is among the largest of the land holdings in the region having a single owner or small number of owners. The size and single ownership of the site provide a unique opportunity to develop a comprehensive, master-planned stormwater mitigation approach.

This NRSP Sub-Regional SWMP is the first of three levels of stormwater plan preparation. These levels include the Sub-Regional SWMP, which applies to the entire Newhall Ranch Specific Plan area; the Project Water Quality Technical Report, which will provide the project-level impact analysis for each of the villages within the Specific Plan area; and the final Project SUSMP, which will be prepared prior to the recordation of any final subdivision map (except those maps for financing or conveyance purposes only) or the issuance of any grading or building permit (whichever comes first). The NRSP Sub-Regional SWMP sets the framework for the future levels of stormwater plan preparation.

This NRSP Sub-Regional SWMP has been developed using a watershed-based approach that addresses pollutants of concern and hydrologic conditions of concern that can affect aquatic and riparian habitat and natural resources, including species associated with these habitats and natural communities. The Sub-Regional SWMP includes concept-level site design, source control, treatment control, and hydromodification control BMPs, consistent with the Los Angeles County SUSMP, that will be incorporated into each development area within the Newhall Ranch Specific Plan subregion.

This SWMP and the water quality and hydromodification control measures specified in it complement the avoidance, minimization, mitigation, restoration, and enhancement measures required by and evaluated in the Newhall Ranch Resource Management and Development Plan (RMDP). Implementation of this SWMP will assure that potential water quality and hydromodification impacts will not adversely affect Newhall Ranch Specific Plan area receiving waters or implementation of the RMDP.

Prior to the approval of a stormwater plan for each project within the NRSP, a Project Water Quality Technical Report (WQTR) will be prepared consistent with the terms and content of this Sub-Regional SWMP. The Project WQTR will provide more specific information and detail concerning how the provisions of the NRSP Sub-Regional SWMP will be implemented within the area covered by the individual Project WQTR. At a minimum, each Project WQTR will provide supplemental and refined information concerning: (1) how site design, source control, treatment control, and hydromodification control BMPs will be implemented at the project level for the area in question; (2) potential facility sizing and location within the subject project area; and (3) monitoring and operation and maintenance of stormwater BMPs within the relevant project area.

A final Project SUSMP will be prepared, consistent with the terms and content of both the Sub-Regional SWMP and Project WQTR, that specifically identifies the BMPs to be used on site. The Project SUSMP will be submitted to the Los Angeles County Department of Public Works (LACDPW) for review prior to the recordation of any final subdivision map (except those maps for financing or conveyance purposes only) or the issuance of any grading or building permit (whichever comes first). The Project SUSMP will identify: (1) site design BMPs (as appropriate); (2) source control BMPs; (3) treatment control BMPs; (4) hydromodification control BMPs; (5) whether long-term operation and maintenance of structural BMPs will be public or private; and (6) structural BMP sizing.

This report also addresses the potential impacts of the proposed Newhall Ranch Specific Plan project on water quality and hydromodification in local surface water bodies, including the Santa Clara River and its tributaries within the subregion. Potential changes in water quality and hydrology are addressed for pollutants of concern and hydrologic conditions of concern based on runoff water quality and quantity modeling, literature information, and best professional judgment. The level of significance of impacts is evaluated using a weight of evidence approach considering significance criteria that include predicted runoff quality for proposed versus existing conditions; MS4 Permit, Construction General Permit, and General Dewatering Permit water quality requirements; and reference to receiving water quality benchmarks, including Total Maximum Daily Load (TMDL) waste load allocations and water quality standards from the Basin Plan and California Toxics Rule.

2. ENVIRONMENTAL SETTING

2.1. Project Description

After conducting additional analysis, the County of Los Angeles Board of Supervisors approved the NRSP in May 2003 to guide development of Newhall Ranch projects. The NRSP covers a total of approximately 11,999 gross acres, the majority of which (8,334 acres) consists of high country, river corridor, open area, open space, and slopes that will remain undeveloped (Table 2-1). The Specific Plan contains the land use plan, development regulations, design guidelines, and implementation program for the long-term development of NRSP projects. Subsequent development plans and tentative tract maps are required to be consistent with the NRSP (as amended), the County of Los Angeles General Plan, and the Santa Clarita Valley Area Plan.

The NRSP subregion is located in the unincorporated area of Los Angeles County west of Interstate 5 and east of the Los Angeles/Ventura County line (Figure 2-1). The subregion is adjacent to and bisected by the Santa Clara River. The NRSP subregion currently consists of primarily agricultural land uses (farming and grazing), oil and gas operations, and undeveloped property.

The Specific Plan allows for a broad range of residential, mixed-use, and non-residential land uses within five villages (Table 2-1, Figure 2-2). The build-out of the Specific Plan is projected to occur over approximately 25 to 30 years, depending upon economic and market conditions.

Table 2-1: Newhall Ranch Specific Plan Proposed Development

Land Use Designation	Area (Acres)
Business Park	135.2
Commercial	228.9
Commercial Park	63.0
Estate	352.6
Elementary School	38.5
Fire Station	2.2
Golf Course	172.5
High Density Residential	151.2
High Country	4234.3
High School	41.1
Junior High School	20.9
Low Density Residential	419.3
Library	1.0
Lake	24.2
Low-Medium Density Residential	978.4
Medium Density Residential	610.9
Neighborhood Park	52.3
Open Area	763.3

Land Use Designation	Area (Acres)
Open Space	1,354.8
River Corridor	761.9
Road	340.0
Sub-Station	2.2
Slope	1,219.8
Visitor Serving	15.8
Water Reclamation	14.9
Total	11,999.2

2.1.1. Circulation Plan

The roadway network for Newhall Ranch is set forth in the Master Circulation Plan (NRSP, Section 2.4). Primary access to the Specific Plan site is currently provided via State Route 126 (SR-126), which is presently a four-lane highway between the Los Angeles County/Ventura County line and its connection to Interstate 5 (I-5), located approximately one mile east of the Specific Plan site.

In addition, Chiquito Canyon Road/Del Valle Road is an existing two-lane road designated as a Limited Secondary Highway in the Santa Clarita Valley Area Plan. San Martinez Grande Road is an existing local road, which provides access to portions of the Specific Plan site north of SR-126. The Specific Plan calls for improvements to several existing roadways in the Specific Plan area, including SR-126, Magic Mountain Parkway, Potrero Valley Road, Commerce Center Drive, Chiquito Canyon Road/Del Valle Road, San Martinez Grande Road, Valencia Boulevard, and Pico Canyon Road. These roadway improvements, as well as the other NRSP internal roadways, have been included in the project impact analysis presented in this report.

2.1.2. Trails Plan

The Master Trails Plan (NRSP Section 2.4) provides a comprehensive bicycle, pedestrian, and equestrian trails system throughout the Specific Plan area, and includes potential connections to regional trail systems within the Santa Clarita Valley. Portions of the proposed trail system would cross drainage channels or be located in areas under the jurisdiction of the Corps and CDFG. Construction details for the approved trails system are depicted on Exhibits 2.4-6, 2.4-7, and 2.4-8 of the approved Specific Plan.

The trails system would extend the existing planned regional trails into the Specific Plan site and provide additional recreational opportunities for both local and regional residents. The trails would provide access to Open Areas and the River Corridor and High Country SMAs, and connections between living areas, shopping, employment, entertainment, schools, and civic and recreational facilities. The trails system provides a hierarchy of trails, including the Regional River Trail, community trails, local trails, pathways, and unimproved trails.

2.1.3. Water Plan and Sewer Plan

The Conceptual Backbone Water Plan, (NRSP Section 2.5), identifies conceptual onsite water storage and distribution systems to provide adequate fire and domestic water service to the Specific Plan site. The Specific Plan site is within the service area of the Castaic Lake Water Agency (CLWA), a wholesale water agency in the Santa Clarita Valley. Valencia Water Company, which currently serves Valencia and parts of the Newhall and Castaic communities, would provide retail water service to the Specific Plan. The domestic water demands for the Specific Plan are based on the projections for the specific land uses and their intensities, balanced with historical use factors.

The two sources of non-potable supplies needed to meet the Specific Plan's non-potable demand are recycled water from the Specific Plan's WRP and from existing upstream WRPs. The Specific Plan WRP's treatment capacity is planned to be 6.8 mgd of wastewater generated by the Specific Plan, all of which would be treated at the WRP, and upon tertiary treatment, reclaimed for landscape irrigation purposes (except for wet winters when irrigation demands would be lower, requiring the discharge of unused reclaimed water to the Santa Clara River during periods of high river flow). Recycled water from the WRP would be used to partially meet the non-potable water demands (e.g., irrigation) of the Specific Plan. The WRP, to be located along the Santa Clara River in the western edge of the Specific Plan site, is planned to be constructed in stages as the Specific Plan is developed over time. Construction of the WRP will require outfall facilities in and near the Santa Clara River.

CLWA also would serve the Specific Plan site with recycled water from existing upstream WRPs, consistent with CLWA's draft "Reclaimed Water System Master Plan." CLWA's master plan is being implemented in stages. CLWA's recycled water source would meet the remaining non-potable water demand of the Specific Plan.

Since approval of the Specific Plan by Los Angeles County, the Los Angeles County Local Area Formation Commission completed formation of the Newhall Ranch County Sanitation District. The new County sanitation district was formed effective July 27, 2006.

The Conceptual Backbone Sewer Plan (NRSP Section 2.5) sets forth a conceptual system for sewage collection that includes the Newhall Ranch WRP, a collection system with pump stations, and both gravity and force mains/siphons. All facilities of the sanitary sewer system would be designed and constructed for maintenance by the County of Los Angeles and/or the Sanitation Districts in accordance with their criteria, procedures, and requirements.

The Newhall Ranch Revised Draft EIR (March 8, 1999) contains a project-level analysis of the potential significant environmental impacts associated with construction and operation of the approved Newhall Ranch WRP. This report addresses the potential impacts of reclaimed water use for irrigation on groundwater quality and considers the potential cumulative impacts of WRP discharges on water quality and hydromodification in the Santa Clara River.

2.1.4. Recreational and Open Areas

The land resources devoted to passive and active recreational uses, as well as environmental preservation, make up over one-half, (6,170 acres) of the NRSP area (see the Open Areas, Habitat Management Areas, and Parks Plan, NRSP Section 2.6). NRSP components comprising parks, recreational uses, open areas, and habitat management areas are summarized below.

Neighborhood and Community Parks. The Specific Plan Land Use Plan features 10 neighborhood parks dispersed throughout the Specific Plan and sited to meet the anticipated needs of Newhall Ranch residents. In addition, there are three approved community parks. The community parks include the 141-acre Oak Valley community park, the 16-acre Landmark Village community park, and the approximately 20-acre Mission Village community park.

Community Lake/Golf Course. A man-made community lake and golf course are approved as part of the Potrero Valley Village. The 15-acre lake and 180-acre golf course are to be situated in the central portion of the Potrero Valley Village to provide recreational amenities for the entire community. Scenic views of the lake would be provided from both commercial and residential areas. A pedestrian pathway along the lake would provide residents and Potrero Valley Village visitors with active and passive recreation opportunities.

Open Area. The approved Specific Plan's Open Area land use designation provides opportunities for active and passive recreation within the Specific Plan site. The Open Area designation encompasses approximately 1,010 acres of land through the central portion of the Specific Plan's development areas. The Open Area includes community parks, significant landforms and ridges, creeks and drainages, oak woodland and savannahs, utility and trail system easements, and often functions as a transition between Specific Plan development areas to the River Corridor and High Country SMAs.

2.1.5. Conservation and Special Management Areas

The Specific Plan Land Use Plan (Figure 2.0-7) designates a total of approximately 5,172 acres for the River Corridor and High Country Special Management Areas (SMAs). The River Corridor SMA is generally 1,500 to 2,000 feet wide and is located along the north and south sides of the Santa Clara River. The High Country SMA is located in the southern portion of the Specific Plan site. The SMAs are designed primarily to protect the existing natural resources within Los Angeles County's Significant Ecological Areas (SEA), SEA 20 and SEA 23. Limited public access through the SMAs would be provided by the trail system to be developed, consistent with the Specific Plan Master Trails Plan. Additional information regarding the two SMA/SEA areas is included in the Newhall Ranch Revised Draft EIR (March 8, 1999), Section

4.6, Biota, and the Newhall Ranch Revised Additional Analysis, Volume VIII (May 2003), Section 2.4, SEA General Plan Consistency. The two SMAs/SEAs, and other important preserve/conservation areas on and adjacent to the Specific Plan site, are summarized below.

River Corridor SMA. The 975-acre River Corridor SMA/SEA 23 includes the Santa Clara River within the Specific Plan site and associated habitats. The value of the River Corridor SMA/SEA 23 is derived from the inherent value of its wetland and riparian habitats and associated species, and from its function as a regional east-west wildlife corridor. Four federally-listed endangered species and numerous other sensitive species have been observed or detected in riparian habitats of the River. These wildlife species include the state and federally-listed endangered unarmored three-spine stickleback (Gasterosteus aculeatus williamsoni), Southwestern willow flycatcher (Empidonax traillii extimus), and least Bell's vireo (Vireo bellii pusillus); and the federally-listed endangered arroyo toad (Bufo californicus). The Santa Clara River is also an important migration and genetic dispersion corridor for many wildlife species, including aquatic taxa, riparian-obligate species (resident and migratory), and larger more mobile terrestrial animals.

The Specific Plan's previously adopted Resource Management Plan requires a permanent, non-revocable conservation and public access easement to be offered to the County of Los Angeles over the portion of the River Corridor SMA/SEA 23 within each Newhall Ranch subdivision. The easement is to be offered upon completion of development of all land uses, utilities, roads, flood control improvements, bridges, trails, and other improvements necessary for implementation of the Specific Plan within that subdivision allowing construction within or adjacent to the River Corridor SMA/SEA 23. The Resource Management Plan also contains a mitigation and habitat management program for the River Corridor SMA/SEA 23. Mitigation for the Specific Plan's impacts on riparian resources includes habitat restoration and enhancement activities. Habitat restoration refers to the revegetation of native plant communities on sites that have had the habitat removed due to past activities. Enhancement refers to the rehabilitation of areas of native habitat that have been moderately disturbed by past activities. A new Regional River Trail providing limited public access would be established on the north side of the River.

Prior to recording the River Corridor SMA/SEA 23 conservation and public access easement to Los Angeles County, the applicant is to provide a plan for the permanent ownership and management of the River Corridor SMA/SEA 23, including any necessary funding. This plan is to include the transfer of ownership of the River Corridor SMA/SEA 23 to the Center for Natural Lands Management. Long-term management strategies for the River Corridor SMA/SEA 23 include limitations on grazing, prohibition of agriculture, and limiting recreational activities to the use of the established trail system. The conservation and public access easement must be consistent with any other conservation easements to state or federal resource agencies, which may have been granted as part of the mitigation actions required by state and federal permits.

High Country SMA. The largest land use designation of the Newhall Ranch Specific Plan Land Use Plan is the 4,185-acre High Country SMA/SEA 20. The High Country SMA/SEA 20 is located in the southern portion of the site and includes oak savannahs, high ridgelines, and various canyon drainages, including the Salt Creek watershed in Los Angeles County. Salt Creek is a regionally significant wildlife corridor that provides an important habitat link to the Santa Clara River. As previously discussed, the Santa Clara River is an important east-west riparian corridor within the Specific Plan site. This corridor also serves as an important connection between the upland habitats to the north and south of the River. Specifically, large expanses of undeveloped land (i.e., Salt Creek in Los Angeles County) allow for the movement of wildlife to the River and back. Salt Creek also provides wildlife movement connectivity between the River Corridor SMA/SEA 23 and the High Country SMA/SEA 20.

The Specific Plan's previously adopted Resource Management Plan requires the High Country SMA/SEA 20 to be dedicated in fee to a Joint Powers Authority (JPA) consisting of representatives from the Los Angeles County (four members), the City of Santa Clarita (two members), and the Santa Monica Mountains Conservancy (two members). The JPA would have overall responsibility for recreation within and conservation of the High Country SMA/SEA 20. The Center for Natural Lands Management would be responsible for resource conservation and management in the High Country SMA/SEA 20. An assessment district would be formed under the authority of the Los Angeles County Board of Supervisors to generate revenue to be distributed to the JPA for recreation, maintenance, construction, conservation, and related activities within the High Country SMA/SEA 20.

Prior to dedication in fee of the High Country SMA/SEA 20, the Specific Plan requires that a conservation and public access easement be offered to the County of Los Angeles and that a conservation and management easement be offered to the Center for Natural Lands Management. The Specific Plan also requires that the County's conservation and public access easement be consistent with any other conservation easements to state or federal resource agencies, which may have been granted as part of the mitigation actions required by state and federal permits. In addition, the conservation and public access easement is to prohibit grazing within the High County SMA/SEA 20, except for those grazing activities associated with long-term resource management plans; and restrict recreation to the established trail system.

Pursuant to the Specific Plan, the High Country SMA/SEA 20's dedication in fee is to occur in three approximately equal phases of about 1,400 acres each, proceeding from north to south within the Specific Plan site, as follows: (a) the first offer of dedication would take place with issuance of the 2,000th residential building permit of the Specific Plan; (b) the second offer of dedication would take place with issuance of the 6,000th residential building permit; and (c) the remaining offer of dedication would be completed by the 11,000th residential building permit.

Salt Creek Dedication and Management Area. As part of its approval of the Specific Plan in 2003, the Los Angeles County Board of Supervisors imposed an off-site condition requiring the applicant to dedicate to the public the remaining 1,517-acre portion of the Salt Creek watershed in Ventura County, adjacent to the western boundary of the Specific Plan site. The applicant is required to satisfy this condition by dedicating the Salt Creek area in fee and/or by conservation easement to the JPA, which is responsible for overall recreation and conservation of the High Country SMA/SEA 20. The Salt Creek area will be transferred upon approval of the first tract map adjacent to Ventura County in the Oak Valley (Potrero) Village portion of the Newhall Ranch Specific Plan. The Salt Creek area is to be managed in conjunction with and in the same manner as the High Country SMA/SEA 20. Protection of the Salt Creek area in both Los Angeles County and Ventura County enhances the Specific Plan's compatibility with animal movement in the region.

San Fernando Valley Spineflower CDFG Conservation Easements. Two conservation easements have been granted to CDFG for the purpose of conserving populations of spineflower found on the Specific Plan site. The easements are located on the south side of the River, and include a 20-acre preserve at Airport Mesa (east of Middle Canyon), and a 44-acre preserve at Grapevine Mesa (east of Humble Canyon). The conservation easements granted to CDFG are found in the approved Specific Plan (Appendix Volume II, Section 7.8).

2.1.6. Infrastructure Improvements

2.1.6.1. Conceptual Backbone Drainage Plan

The Conceptual Backbone Drainage Plan for the Specific Plan site is found on Exhibit 2.5-1 of the approved Specific Plan. From a sub-watershed standpoint, post-construction drainage basins will largely conform to the existing drainage areas onsite; project-related grading will not significantly alter the sub-watershed boundaries on Newhall Ranch. Storm flows through the site will largely follow existing drainage patterns, and will be conveyed through the site in open, soft bottom stream channels and closed drainage systems. A full description of the drainage facilities can be found in the Newhall Ranch Specific Plan (SCH # 95011015, May 2003).

Biological impacts associated with physical alterations to drainages in the Santa Clara River in connection with the construction of drainage and flood control facilities were evaluated in the Newhall Ranch Revised Draft EIR (March 8, 1999), Section 4.6, Biota. Biological impacts were further assessed in the Newhall Ranch Revised Additional Analysis (May 2003), Section 2.3, Floodplain Modifications, Volume VIII. Biological impacts associated with physical alterations to drainages and the Santa Clara River in connection with the construction of drainage facilities described in the RMDP are addressed in the Newhall Ranch Resource Management and Development Plan and Spineflower Conservation Plan Draft Joint Environmental Statement and Environmental Impact Report (SCH #2000011025), Section 4.5, Biological Resources, and Section 4.6, Jurisdictional Waters and Streams, and related biotechnical reports.

2.1.6.2. RMDP Infrastructure Improvements

The proposed RMDP infrastructure improvements to implement the approved Specific Plan are described in further detail in Section 2.6 of the Newhall Ranch Resource Management and Development Plan and Spineflower Conservation Plan Draft Joint Environmental Statement and Environmental Impact Report (SCH #2000011025) . The proposed RMDP infrastructure improvements are briefly summarized as follows:

Bridges and Road Crossing Culverts. Three bridges and sixteen new road crossing culverts would be installed to serve the Specific Plan and to accommodate future traffic associated with development of the Specific Plan and the region. There are two proposed bridges, Potrero Canyon Bridge and Long Canyon Road Bridge, and one previously approved bridge, Commerce Center Drive Bridge. [1] The three bridges would be located over the main stem of the Santa Clara River. The bridges are proposed to be constructed of conventional concrete girders placed over concrete filled piers. Fifteen of the 16 new road crossing culverts would cross five tributaries to the Santa Clara River. A sixteenth road crossing culvert would cross Ayers Canyon, near Potrero Mesa. The road crossings would be constructed of earthen fill and pre-fabricated arched culverts.

Bank Stabilization. Bank stabilization/protection would be installed along portions of the Santa Clara River and its tributary drainages within the RMDP site. Bank protection would include buried soil cement, grouted and ungrouted rock riprap, turf reinforcement mats, and limited gunite slope lining in and around bridge abutments. Building pad elevation of the ground surface also would occur in areas along the Santa Clara River and major tributary drainages in order to protect land uses from flooding.

Drainage Facilities. Drainage facilities would be installed and include open and closed drainage systems, inlets, outlets, bank stabilization, and water quality basins. The proposed drainage structures focus on minimizing the amount of debris that would enter the drainage system and maintaining the quality of water within the system.

Water Quality Control Facilities. Pursuant to regulatory requirements (see Section 3.6), urban runoff treatment control BMPs would be implemented. Proposed treatment control BMPs are described in Section 5.3 of this report.

Tributary Drainages. In order to accommodate the Specific Plan development, some of the existing major tributary drainages within the Specific Plan site (Chiquito Canyon and San Martinez Grande Canyon) would require stabilizing treatments to protect the channel and surrounding development from excessive vertical scour and lateral channel migration. The

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[1] The Commerce Center Drive Bridge was previously analyzed in the Final EIS/EIR prepared and approved by the Corps and CDFG in connection with the previously adopted NRMP (SCH No. 1997061090, August 1998).

existing drainages would remain intact, but would sustain permanent and temporary impacts from construction of stabilization elements, including buried bank stabilization and grade stabilization structures.

Due to the existing conditions within portions of some drainages in the Specific Plan site (portions of Long, Lion, and Potrero canyons), stabilization of the existing drainages is not feasible; and, therefore, in order to meet the County's flood protection objectives, these drainages would be graded, and a new drainage would be constructed in the same or similar location. The new drainages would be designed to incorporate buried bank stabilization and grade stabilization, and would have sufficient hydrologic capacity to pass the Los Angeles County Capital Flood without the need for clearing vegetation from the channels. The new channel banks would be planted with riparian vegetation following construction.

Among the minor tributary drainages within the RMDP site, some are located in areas where no impacts are proposed, and are distant enough from surrounding development that bank stabilization is not required. These drainages would remain in their existing condition; the RMDP does not propose to impact or enhance these drainages. In most situations, unmodified drainages would be located within future open space areas and maintain their current hydrologic functions, as well as providing linkages for wildlife movement to and from the Santa Clara River.

Some of the drainages within the Specific Plan site, including many of the smallest, ephemeral streams, would be graded as part of the grading operations required to facilitate build-out of the Specific Plan. Flows in these drainages meet the Los Angeles County flood criteria (less than 2,000 cfs) to be conveyed by storm drain. Because of the small, ephemeral nature of these drainages, the RMDP does not proposed to create new drainage channels to replace these impacted drainages. Rather, the wet-weather flows that currently occupy the drainages would be routed into the development's storm drain system, and would be discharged to the Santa Clara River via the proposed storm drain outlets.

Grade Stabilization Structures. Grade stabilization structures would be installed on five existing tributaries (Chiquito Canyon, Long Canyon, Potrero Canyon, San Martinez Grande Canyon, and Lion Canyon) to the main stem of the Santa Clara River. The grade stabilization structures are designed to contain the hydraulic "jump" that occurs when there is a significant drop in streambed elevation, so that higher velocities are dissipated within the area; the structures would help control erosion and changes to the configuration of the bed of the stream channel. Such structures would be constructed of soil cement, sheet piles, or reinforced concrete.

Utility Crossings. Various electrical, sewer, water, gas, and communications lines would be installed across the Santa Clara River, Chiquito Canyon, San Martinez Canyon, Potrero Canyon, and Long Canyon to serve the Specific Plan. Typically, the utility lines would be installed in rights-of-way adjacent to bridges where access for installation and maintenance can be easily accommodated.

Temporary Haul Routes for Grading Equipment. Temporary haul routes across the Santa Clara River would be used during construction to move equipment and excavated soil to locations in the RMDP site where fill is needed.

WRP Outfall Construction Activities. An effluent outfall pipeline would be constructed from the Newhall Ranch WRP through the bank stabilization to the bed of the Santa Clara River. An earthen channel and adjacent walkway also would be constructed to reach the actual flow path of the river.

Maintenance Activities. DPW or other management entity would conduct regular and ongoing maintenance of flood, drainage, and water quality protection facilities on the RMDP site. Such activities would include periodic inspection of structures and monitoring of vegetation growth and sediment buildup to ensure that the integrity of the structures is maintained and that planned conveyance capacity is present, routine repairs and maintenance of bridges and bank protection, and emergency maintenance activities.

Recreation Facilities. In addition to the comprehensive system of bicycle, pedestrian, and equestrian trails that would be implemented by the adopted Specific Plan Master Trails Plan, the RMDP proposes to construct up to eight nature viewing platforms that would be located in jurisdictional areas along the Santa Clara River.

Habitat Enhancement and Restoration Activities. The RMDP incorporates a variety of design features that minimize impacts to riparian and upland resources along and within the Santa Clara River and its tributary drainages, including avoidance, minimization, restoration, and enhancement activities. In addition, the RMDP includes enhancement design features, such as removal of grazing to enhance riparian habitat, and rehabilitating native habitat areas that have been disturbed by past activities or invaded by non-native plant species.

Consistent with the resource management objectives, a multi-disciplinary approach was used to design the RMDP. This approach includes factors such as biology, land use, geology, topography, hydrology, soils, and infrastructure. By incorporating design considerations and resource preservation methods, implementation of the RMDP would result in a conservation strategy to allow for development of the Specific Plan in a way that avoids or minimizes the Specific Plan's significant impacts on waters, jurisdictional streams and drainages, and sensitive biological resources. RMDP implementation also would build upon the preserve assembly process that originated with the Specific Plan's Resource Management Plan. This preserve assembly process involves the dedication of the High Country SMA/SEA 20, River Corridor SMA/SEA 23, Salt Creek, and Open Areas.

The RMDP also proposes mitigation and management activities to address the significant impacts on jurisdictional waters/drainages and sensitive biological resources resulting from the Specific Plan. The impacts and mitigation and management measures identified in the RMDP are discussed in both Section 7.0 of the RMDP and Section 4.5, Biological Resources, of the Newhall Ranch Resource Management and Development Plan and Spineflower Conservation Plan Draft Joint Environmental Statement and Environmental Impact Report (SCH # 2000011025).

The RMDP includes plans for monitoring and management. In addition, the RMDP provides an adaptive management program and remedial measures for the River Corridor SMA/SEA 23, High Country SMA/SEA 20, Salt Creek, and Open Areas. The RMDP includes reporting requirements associated with the River Corridor SMA/SEA 23, High Country SMA/SEA 20, Salt Creek, Open Area, and oak resources, and it describes the funding mechanisms that would be utilized to implement the plan.

2.2. Receiving Waters

2.2.1. Santa Clara River

2.2.1.1. Watershed Description

The 11,999-acre NRSP subregion is located within the Santa Clara River Hydrologic Basin and associated watershed, which is 1,634 square miles in area. The portion of the Santa Clara River watershed that is located generally upstream or east of the Ventura County/Los Angeles County jurisdictional line is approximately 640 square miles in size, and drains portions of the Los Padres National Forest from the north, the Angeles National Forest from the north and northeast, and the Santa Susana Mountains from the south and southeast. The NRSP subregion intersects 18 tributary drainage areas, all of which drain into the Santa Clara River (Figure 2-4). The Santa Clara River extends approximately 5.5 miles east to west across the NRSP subregion. The NRSP subarea comprises 2.9 percent of the Santa Clara River watershed upstream of the Los Angeles/Ventura County Line, 1.1 percent of the total Santa Clara River watershed, and approximately 58 percent of the 20,724-acre tributary drainage area.

The Santa Clara River (SCR) watershed drains an area in the Transverse mountain range of southern California. The SCR flows generally west from its headwaters near Acton to the Pacific Ocean near the City of Ventura, approximately 40 miles downstream of the NRSP subregion. The river exhibits some perennial flow in its eastern-most stretches within the Angeles National Forest then flows intermittently westward within Los Angeles County. The principal tributaries of the upper river watershed in Los Angeles County are Castaic Creek, Bouquet Canyon Creek, San Francisquito Creek, and the South Fork of the Santa Clara River. Placerita Creek is a large tributary draining the western-most end of the San Gabriel Mountains; it joins the South Fork, which flows directly into the Santa Clara River. Castaic Creek is a southtrending creek that confluences with the Santa Clara River downstream of the City of Santa Clarita. Castaic Lake is a DWR-owned reservoir located on Castaic Creek. San Francisquito Canyon Creek is an intermittent stream in the watershed adjacent to Bouquet Canyon to the southeast. Elevations within the watershed range from sea level at the river mouth to 8,800 feet at the summit of Mount Pinos in the northwest corner of the watershed.

The principal sources of water contributing to the base flow of the Santa Clara River are: (a) groundwater from the Alluvial aquifer basin in Los Angeles County, which seeps into the riverbed near, and downstream of, Round Mountain (located just below the mouth of San Francisquito Creek); (b) tertiary-treated water discharged to the Santa Clara River from two existing Los Angeles County Sanitation District WRPs -- the Saugus WRP, located near Bouquet Canyon Road bridge and the Valencia WRP, located immediately downstream of I-5 (for locations, see Figure 2-1); and (c) in some years, DWR-released flood flows from Castaic Lake into Castaic Creek during winter and spring months (CH2M Hill, 2005). The Saugus Water Reclamation Plant, located near Bouquet Canyon Road bridge, has a permitted dry weather average design capacity of 6.5 million gallons per day (mgd) creating surface flows from the outfall to near Interstate 5. The Valencia Water Reclamation Plant outfall is located immediately downstream of the Interstate 5 bridge and has a permitted dry weather average design capacity of 21.6 mgd, creating surface flows extending through the Project area and into the far eastern portion of Ventura County. The combined average treated discharge from both WRPs between January 2004 and June 2007 was approximately 20 mgd.

The reach of the SCR within and adjacent to the NRSP subregion has multiple channels (braided). This kind of system is characterized by high sediment loads, high bank erodibility, and intense and intermittent runoff conditions. Combined with the relatively flat gradient of the SCR at this point (less than one percent), the SCR has a high potential to aggrade (deposit sediment) at low flow velocities (PACE, 2006).

The following description of the physiography, climate, flows, and vegetation of the Santa Clara River are summarized primarily from <u>Assessment of Potential Impacts Resulting from Cumulative Hydromodification Effects, Selected Reaches of the Santa Clara River, Los Angeles County, California</u> (Balance Hydrologics, provided in Appendix F).

2.2.1.2. Physiography

The Santa Clara River flows through a complex, tectonically-active trough. Some of the most rapid rates of geologically-current uplift in the world are reported from the Ventura anticline and San Gabriel Mountains, just to the northwest and southeast, respectively, of the river. Slopes are very steep, with local relief of 3,000 to 4,000 feet being common. These faults bring harder, more resistant sedimentary rocks over softer and younger sedimentary formations, but all formations are fundamentally soft and erodible. On either side of the faults, sandstone and mudstones prevail. The northeastern and southeastern corners of the watershed are underlain by deeply-weathered granitic and schistose rocks, which produce sands that are coarser than those of other rock units when they weather and erode. The San Gabriel fault crosses the valley, bringing slightly more resistant rock to the surface and creating a local base level reflected as a slight rise or 'bump' on the river's longitudinal profile.

Most geologic materials in the watershed decompose mainly to silts, clays, and sand, with some coarser materials. Most sediment moved by the Santa Clara River and its main tributaries is fine, with less than 5 percent bedload-sized material (>0.25 mm, or about 0.01 inches in diameter). Some gravels and cobbles do occur within the beds of the stream and in their alluvium. Nonetheless, both the bed and the sediment transported by the river tend to be finer than in most Southern California watersheds.

2.2.1.3. Flows

Downstream of the Valencia WRP, the SCR is perennial past the Los Angeles/Ventura County line to approximately Rancho Camulos. Flows in the SCR can also be affected by groundwater dewatering operations or by diversions for agriculture or groundwater recharge. Throughout the Santa Clara River channel, there are complex surface water/groundwater interactions where both gaining and losing river segments are found. Downstream of the County line, however, the Santa Clara River flows through the Piru groundwater basin, which represents a "Dry Gap" where dry-season surface flows are interrupted and streamflow is lost to groundwater.

The SCR is underlain by several distinct alluvial groundwater basins in Ventura County—the Piru, Fillmore, and Santa Paula Basins. These basins are divided longitudinally by sills or ridges of bedrock that support areas of locally-high (shallow) groundwater, including the area upstream from the County line (above the Piru Basin), and upstream from the mouth of Sespe Creek (the transition between the Piru and Fillmore Basins). This locally-high groundwater sustains summer baseflow and riparian vegetation within the SCR corridor even through relatively dry climatic cycles.

Flows in the SCR, as in most southern California streams, are highly episodic. For the gaged period between 1953 and 1996, annual flow at the Los Angeles/Ventura County line gage ranged between 253,000 acre-feet (1969) and 561 acre-feet (1961). Annual peak flows at the County line between 1953 and 1996 ranged from 68,800 cfs (1969) to 109 cfs (1960). Of note is that the second highest annual peak (32,000 cfs in 1966) was less than half of the highest peak (68,800 in 1969). These large episodic events have a significant impact on the geomorphic characteristics of the Santa Clara River mainstem.

After studying the response of the river to several different anthropogenic and natural disturbances, Balance Hydrologics (2005) concluded that the Santa Clara River, as with many streams in semi-arid southern California, is highly episodic. Concepts of "normal" or "average" sediment-supply and flow conditions have limited value in this "flashy" environment, where episodic storm and wildfire events have enormous influence on sediment and storm flow conditions. In these streams, a large portion of the sediment movement events can occur in a matter of hours or days. Other perturbations which can potentially affect channel geometry appear to have transitory or minor manifestations. For example, effects on SCR channel width due to the 1980s levee construction was barely discernible by the first few years of the 21st century, probably mostly due to morphologic compensation associated with the storm events in the mid- to late-1990s. As a result, channel morphology, stability, and character of the Santa Clara River is almost entirely determined by the "reset" events that occur within the watershed.

2.2.1.4. Vegetation and Habitat Types

Much of the watershed upstream of the Newhall Ranch Specific Plan area receives rainfall averaging about 18 to 25 inches per year. As throughout Southern California, rainfall in the Santa Clara watershed alternates between wet and dry periods, a variation that is central to understanding the geomorphic history of the watershed. Wet cycles tend to persist for several years, sometimes for periods of 6 or 8 years, during which rainfall, although variable, may average about 140 to 150 percent of the long-term average. For the woody riparian vegetation along the banks and on islands in the braided channels, these are crucial periods for establishment and growth. During dry cycles, the roots of the riparian vegetation must grow downward to the water table or perched zones, and where it cannot do so, this band of vegetation will die back.

The existing SCR channel contains a variety of vegetation types (Impact Sciences, 2003). The active SCR channel is mostly barren due to scouring by seasonal storm flows. However, vegetation types on the adjacent terraces vary based on elevation relative to the active channel bottom and the frequency of flooding. The following series of vegetation types occur along a vertical gradient from the channel bottom to the highest SCR terrace on the floodplain: emergent herbaceous, woody shrubs, and trees.

The Santa Clara River corridor at the NRSP site supports three general categories of habitat (Impact Sciences, 2003): (1) aquatic habitats, consisting of flowing or ponded water; (2) wetland habitats, consisting of emergent herbs rooted in ponded water or saturated soils along the margins of the active channel; and (3) riparian habitat, consisting of woody vegetation along the margins of the active channel and on the floodplain. Both year-round and seasonal aquatic habitats are provided and are subject to periodic disturbances from winter flood flows. These flows inundate areas that are dry most of the year. They also carry and deposit sediment, seeds, and organic debris; form new sandbars and destroy old ones; and erode stands of vegetation. New stands of vegetation are created where vegetation becomes established by seeds or buried stems. Thus, the aquatic habitats of the river are in a constant state of creation, development, disturbance, and destruction.

2.2.2. Santa Clara River Reaches

The SCR is divided into reaches for purposes of establishing beneficial uses and water quality objectives (Figure 2-5). However, there are two reach classifications, one established by the Los Angeles Regional Water Quality Control Board (LARWQCB), and one established by the United States Environmental Protection Agency (USEPA). Both of these reach classifications are used by the LARWQCB and the USEPA in various documents, which at times is a source of confusion. This report will use the LARWQCB reach numbers.

Table 2-2 lists the LARWQCB and USEPA reaches, respectively. Figure 2-5 illustrates both reach designations. The reach boundaries are mostly identical in the two classifications, except that the third and fourth LARWQCB Reaches are each subdivided into two reaches in the USEPA reach designation. The NRSP subregion is located along LARWQCB Reach 5 (USEPA Reach 7).

Table 2-2: LARWQCB Santa Clara River Reaches

LARWQCB Reach	Corresponding USEPA Reach	Boundary Description
1	1	Santa Clara Estuary to Highway 101
2	2	Highway 101 to Freeman diversion dam
3	3 & 4	Freeman diversion dam to Fillmore "A" Street
4	5 & 6	Fillmore "A" St to Blue Cut gaging station
5	7	Blue Cut gaging station to West Pier Highway 99 (NRSP Subregion Location)
6	8	West Pier Highway 99 to Bouquet Canyon Road
7	9	Bouquet Canyon Road to Lang gaging station
8	10	Above Lang gaging station

2.2.3. Santa Clara River Tributaries

The existing drainages within the subregion consist of Castaic Creek and the drainage courses of: Chiquito Canyon; San Martinez Grande Canyon; Homestead Canyon; Off-Haul Canyon; Mid-Martinez Canyon; Middle Canyon; Magic Mountain Canyon; Dead End Canyon; Exxon Canyon; Lion Canyon; Humble Canyon; Long Canyon; Ayers Canyon; Potrero Canyon; Salt Creek Canyon; and other unnamed drainage courses tributary to the Santa Clara River (Figure 2-4). Combined, the tributary drainage watersheds comprise 20,724 acres, 11,963 acres of which are within the NRSP subregion boundary. The drainage watersheds are located within an area that is generally delineated by SR-126 and lower portions of San Martinez Grande and Chiquito Canyons on the north, the Magic Mountain Theme Park on the east, the crest of the Santa Susana Mountains on the south, and the Los Angeles/Ventura County line on the west.

With the exception of drainage crossings under SR-126, all of the tributaries within the NRSP subregion boundary are unimproved. Each of the tributaries have been mapped as blue-line streams by the U.S. Geologic Survey (USGS). While it is the intent of the USGS to indicate that blueline streams are flowing perennial streams, in arid states such as California, and particularly in Southern California, this is not always the case. For example, the blueline stream in upper Potrero Canyon contains water only during the rainy periods; during non-rainy periods this stream contains no water and is an ephemeral drainage. Aside from the lower portions of Salt and Potrero Canyons, each of the tributaries within the NRSP subregion is classified as an intermittent or ephemeral drainage[2] (URS, 2006).

Post-developed stormwater runoff will flow to four of the tributary drainages within the NRSP subregion boundary: Chiquito Canyon, San Martinez Grande Canyon, Long Canyon, and Potrero Canyon. Middle Canyon, Magic Mountain Canyon, Homestead Canyon and other small ephemeral drainages located within the Newhall Ranch area will be incorporated into the storm drain system in the post-development condition (Figure 2-3). The tributary drainages are described below.

The majority of the tributaries' watersheds are characterized by both rugged and steeply developed foothills that have numerous smaller tributary canyons that dissect the watershed, connecting to the narrow alluvial valley associated with the main stem drainage. Approximately 90 percent or more of the watersheds' area consists of rugged foothill topography with the remainder being the narrow valley floor. Generally, the soils in the watersheds are characterized as silty clay loams from both the Castaic and Saugus formations. Also, the soils within the watersheds can be predominately classified as being in hydrologic soil group C (higher runoff potential) with exception of areas adjacent to the main stem drainages that are Type A (lower runoff potential) and Type B in the lower reaches.

The 4.85 square mile (3,106 acre) Chiquito Canyon watershed is a tributary to the northern bank of the Santa Clara River. Approximately 490 acres of Chiquito Canyon, or only 16% of the watershed area, is located within the NRSP boundary, with the majority being upstream of the NRSP boundary in the developed Val Verde community (PACE, 2006). The upper portion of the drainage is aligned in a general west to east direction while the lower portion of the drainage flows in a north to south direction. The linear distance from the upper headwaters to the canyon mouth is approximately 28,318 feet, with an average overall slope of 0.031. The major natural main stem drainage course within the watershed has an average slope through the NRSP area of approximately 0.025. The topography for the watershed varies from a maximum elevation of 1,800 feet in the headwaters to a low elevation of 925 feet near the mouth of the canyon at the Santa Clara River valley. The area surrounding the upper channel in Chiquito Canyon within the

[2] Intermittent drainages carry flows due to seasonal high groundwater in addition to storm flows, while ephemeral drainages flow only in response to storm events.

Newhall Ranch project area is primarily comprised of agricultural land (URS, 2003). In contrast to the vegetation found in the upper portion of Chiquito Canyon within the project area, the vegetation found in the downstream portion of the drainage within the project area is quite diverse, supporting scalebroom scrub, coast live oak woodlands, and Great Basin scrub.

The 0.16 square mile (105 acre) Mid-Martinez Canyon watershed is a tributary to the northern bank of the Santa Clara River within the Newhall Ranch. Approximately 67 acres of the watershed or 64% of the watershed area is located within the Newhall Ranch property boundary. The creek flows in a general north to south direction, similar in alignment to Grande Canyon and joining the Santa Clara River floodplain valley. The distance from the upper headwaters to the canyon mouth is approximately 6,803 feet with an average overall slope of 0.07. The majority of the Mid-Martinez Canyon watershed is characterized by both rugged and steeply developed foothills. Generally, the soils in the watershed are characterized as Zamora Loam. Also, the soils within the Mid-Martinez Canyon watershed can be predominately classified as being in hydrologic soil group B (lower runoff potential). The associated vegetative cover within the watershed varies, but primarily consists of California sagebrush scrub and agriculture.

The four square mile (2,569 acre) San Martinez Grande Canyon watershed is also tributary to the northern bank of the Santa Clara River. Approximately 473 acres of San Martinez Grande Canyon, or only 18% of the watershed area, is located within the NRSP boundary, with the majority being upstream of the NRSP boundary. The drainage in the headwaters is aligned in a general west to east direction, while the lower portion of the drainage flows in a north to south direction, similar in alignment to Chiquito Canyon. The linear distance from the upper headwaters to the canyon mouth is approximately 20,000 feet, with an average overall slope of 0.059 (PACE, 2006). The major natural main stem drainage course within the watershed has an average slope in the lower reaches of the watershed of approximately 0.022. The topography for the watershed varies from a maximum elevation of 2,062 feet in the headwaters to a low elevation of 890 feet near the mouth of the canyon at the Santa Clara River. The San Martinez Grande watershed contains a diverse variety of habitats including Great Basin scrub, mule fat scrub, coastal sage scrub, and some grassland (URS, 2003). Two small patches of elderberry scrub exist near the northern boundary of the project footprint. The area just upstream of the Santa Clara River confluence is dominated by arrow weed scrub. San Fernando Valley spineflower was also found to be present within this watershed. The northern, upstream reaches of the drainage are dominated by coastal sage scrub on the west bank, and by grassland on the east. The channel then flows through areas of alluvial scrub and coastal sage scrub, and through agricultural fields to the Santa Clara River.

The 0.92 square mile (587 acre) Off-Haul Canyon watershed is a tributary to the northern bank of the Santa Clara River within the Newhall Ranch. Approximately 470 acres of the watershed or 80% of the watershed area is located within the Newhall Ranch property boundary. The creek flows in a general north to south direction, similar in alignment to Grande Canyon and joining the Santa Clara River floodplain valley. The distance from the upper headwaters to the canyon mouth is approximately 9,094 feet with an average overall slope of 0.12. The majority of the Off-Haul Canyon watershed is characterized by both rugged and steeply developed foothills. Generally, the soils in the watershed are characterized as Castaic-Balcom silty clay loams. Also, the soils within the Off-Haul Canyon watershed can be predominately classified as being in hydrologic soil group C (higher runoff potential). The associated vegetative cover within the watershed varies, but primarily consists of California annual grassland and agriculture.

The 0.12 square mile (75 acre) Homestead Canyon watershed is a tributary to the northern bank of the Santa Clara River within the Newhall Ranch. Approximately 75 acres of the watershed or 100% of the watershed area is located within the Newhall Ranch property boundary. The creek flows in a general north to south direction, similar in alignment to San Martinez Grande Canyon and joining the Santa Clara River floodplain valley. The distance from the upper headwaters to the canyon mouth is approximately 3,606 feet with an average overall slope of 0.65. The majority of the Homestead Canyon watershed is characterized by both rugged and steeply developed foothills. Generally, the soils in the watershed are characterized as Castaic-Balcom silty clay loams. Also, the soils within the Homestead Canyon watershed can be predominately classified as being in hydrologic soil group C (higher runoff potential). The associated vegetative cover within the watershed varies, but primarily consists of California annual grassland and agriculture.

The 1.32 square mile (847 acre) Magic Mountain Canyon watershed is a tributary to the southern bank of the Santa Clara River within the Newhall Ranch. Approximately 178 acres of the watershed or 27% of the watershed area is located within the Newhall Ranch property boundary. The creek flows in a general south to north direction and joining the Santa Clara River floodplain valley. The distance from the upper headwaters to the canyon mouth is approximately 13,700 feet with an average overall slope of 0.02. The majority of the Magic Mountain Canyon watershed is characterized by both rugged and steeply developed foothills. Generally, the soils in the watershed are characterized as Castaic and Saugus soils and Castaic-Balcom silty clay loams. Also, the soils within the Magic Mountain Canyon watershed can be predominately classified as being in hydrologic soil group C (higher runoff potential). The associated vegetative cover within the watershed varies, but primarily consists of California sagebrush scrub and disturbed land.

The 0.53 square mile (340 acre) Middle Canyon watershed is a tributary to the southern bank of the Santa Clara River within the Newhall Ranch. Approximately 272 acres of the watershed or 80% of the watershed area is located within the Newhall Ranch property boundary. The creek flows in a general east to west direction, similar in alignment to Long Canyon and joining the Santa Clara River floodplain valley. The distance from the upper headwaters to the canyon mouth is approximately 9,952 feet with an average overall slope of 0.05. The majority of the Middle Canyon watershed is characterized by both rugged and steeply developed foothills. Generally, the soils in the watershed are characterized as Castaic-Balcome silty clay loams. Also, the soils within the Middle Canyon watershed can be predominately classified as being in hydrologic soil group C (higher runoff potential). The associated vegetative cover within the watershed varies, but primarily consists of California sagebrush scrub and disturbed land.

The 0.19 square mile (124 acre) Dead-End Canyon watershed is a tributary to the southern bank of the Santa Clara River within the Newhall Ranch. Approximately 124 acres of the watershed or 100% of the watershed area is located within the Newhall Ranch property boundary. The creek flows in a general east to west direction, similar in alignment to Long Canyon and joining the Santa Clara River floodplain valley. The distance from the upper headwaters to the canyon mouth is approximately 3,173 feet with an average overall slope of 0.13. The majority of the Dead-End Canyon watershed is characterized by both rugged and steeply developed foothills. Generally, the soils in the watershed are characterized as Castaic-Balcom silty clay loams. Also, the soils within the Dead-End Canyon watershed can be predominately classified as being in hydrologic soil group C (high runoff potential). The associated vegetative cover within the watershed varies, but primarily consists of California sagebrush scrub and disturbed land.

The 0.03 square mile (16 acre) Exxon Canyon watershed is a tributary to the southern bank of the Santa Clara River within the Newhall Ranch. Approximately 16 acres of the watershed or 100% of the watershed area is located within the Newhall Ranch property boundary. The creek flows in a general east to west direction, similar in alignment to Long Canyon and joining the Santa Clara River floodplain valley. The distance from the upper headwaters to the canyon mouth is approximately 1,876 feet with an average overall slope of 0.22. The majority of the Exxon Canyon watershed is characterized by both rugged and steeply developed foothills. Generally, the soils in the watershed are characterized as Saugus loam. Also, the soils within the Exxon Canyon watershed can be predominately classified as being in hydrologic soil group B (lower runoff potential). The associated vegetative cover within the watershed varies, but primarily consists of California sagebrush scrub and disturbed land.

The 1.8 square mile (1,124 acre) Lion Canyon watershed is tributary to the southern bank of the Santa Clara River. Approximately 859 acres of Lion Canyon, or 76% of the watershed area, is located within the NRSP boundary, with the remainder being upstream in the Legacy Village subregion (see Figure 2-1). The drainage in the headwaters is aligned in a general southwest to northeast direction. The distance from the upper headwaters to the canyon mouth is approximately 7,900 lineal feet with an average overall slope of 0.057 (PACE, 2006). The major natural main stem drainage course within the watershed has an average slope in the lower reaches of the watershed of approximately 0.049. The topography for the watershed varies from a maximum elevation of 1,400 feet in the headwaters to a low elevation of 946 feet near the mouth of the canyon at the Santa Clara River valley. The upper reaches of the Lion Canyon watershed, which contains several branches, contains mostly mixed chaparral and coastal sage scrub habitat (URS, 2003). Along the channel, alluvial scrub, live oak woodland, grassland, scalebroom scrub, and chamise chaparral are present. The two easternmost branches of this drainage also contain great basin scrub, which is absent from the watershed of the western branch.

The 0.41 square mile (261 acre) Humble Canyon watershed is a tributary to the southern bank of the Santa Clara River within the Newhall Ranch. Approximately 253 acres of the watershed or 97% of the watershed area is located within the Newhall Ranch property boundary. The creek flows in a general east to west direction, similar in alignment to Long Canyon and joining the Santa Clara River floodplain valley. The distance from the upper headwaters to the canyon mouth is approximately 5,919 feet with an average overall slope of 0.10. The majority of the Humble Canyon watershed is characterized by both rugged and steeply developed foothills. Generally, the soils in the watershed are characterized as Castaic and Saugus soils. Also, the soils within the Humble Canyon watershed can be predominately classified as being in hydrologic soil group C (higher runoff potential). The associated vegetative cover within the watershed varies, but primarily consists of agriculture and chaparral.

The two square mile (1,295 acre) Long Canyon watershed is also tributary to the southern bank of the Santa Clara River. Approximately 845 acres of Long Canyon, or 65% of the watershed area, is located within the NRSP boundary, with the remainder being upstream in the Legacy Village subregion (see Figure 2-1). The drainage in the headwaters is aligned in a general west to east direction. The distance from the upper headwaters to the canyon mouth is approximately 18,350 lineal feet, with an average overall slope of 0.052 (PACE, 2006). The major natural main stem drainage course within the watershed has an average slope in the lower reaches of the watershed of approximately 0.11. The topography for the watershed varies from a maximum elevation of 2,600 feet in the headwaters to a low elevation of 930 feet near the mouth of the canyon at the Santa Clara River valley. Both sides of this watershed contain habitat types comprised primarily of coastal sage scrub, with small pockets of chamise chaparral, and grassland present (URS, 2003). Within the stream channel, there is a mixture of grassland, elderberry scrub, live oak woodland, alluvial scrub, great basin scrub, mixed chaparral, and alluvial scrub.

The 0.2 square mile (147 acre) Ayres Canyon watershed is a tributary to the southern bank of the Santa Clara River within the Newhall Ranch. Approximately 147 acres of the watershed or 100% of the watershed area is located within the Newhall Ranch property boundary. The creek flows in a general east to west direction, similar in alignment to Potrero Canyon and joining the Santa Clara River floodplain valley. The distance from the upper headwaters to the canyon mouth is approximately 6,972 feet with an average overall slope of 0.01. The majority of the Ayres Canyon watershed is characterized by both rugged and steeply developed foothills. Generally, the soils in the watershed are characterized as Castaic and Saugus soils. Also, the soils within the Ayres Canyon watershed can be predominately classified as being in hydrologic soil group B/C (moderate runoff potential). The associated vegetative cover within the watershed varies, but primarily consists of California sagebrush scrub (black sage) and agriculture.

The 4.7 square mile (3,034 acre) Potrero Canyon watershed is also tributary to the southern bank of the Santa Clara River. Approximately 2,643 acres of Long Canyon, or 87% of the watershed area, is located within the NRSP boundary, with the remainder being upstream in the Legacy Village subregion. The lower Potrero Canyon drainage extends approximately 18,270 feet upstream from the canyon mouth at the Santa Clara River valley to the NRSP boundary. The geomorphology of the active drainage reflects a more highly variable and sinuous alignment that reflects the influence of the physical and topographic features (PACE, 2006). There is also a steady variation of the active channel geometry (i.e. width and depth) along this relatively short reach of channel, with the active portion of the drainage being more deeply incised below the canyon valley floor. The floodplain is generally entirely contained within the active drainage banks and there is little overbank flow. The changes in drainage geometry and form may indicate influences from the upper watershed that affect the sediment delivery. The changes in channel geometry are also reflected in coincidental variations of the streambed slope. The slope variations are generally higher in the contractions of the channel geometry and flatter in the expansion areas, upstream and downstream. The average streambed slope of the channel indicated by the topographic data is approximately 0.024. The average slopes ranges from 0.055 in the contraction to 0.011. The upstream 500 feet has a less defined active channel and a much wider canyon floor that reflects depositional area, also the increased floodplain vegetation within this zone. Habitat types in the Potrero Canyon drainage are comprised primarily of grassland and coastal sage scrub, although a wide variety of habitat is represented (URS, 2003). Live oak woodland, mule fat scrub, great basin scrub, mesic meadow, elderberry scrub, and valley oak woodland are all present within the Potrero watershed, along with agricultural land.

The 9.2 square mile (5,859 acre) Salt Creek Canyon watershed is a tributary to the southern bank of the Santa Clara River within the Newhall Ranch. Approximately 3808 acres of the watershed or 65% of the watershed area is located within the Newhall Ranch property boundary. The creek flows in a general east to west direction, similar in alignment to Potrero Canyon and joining the Santa Clara River floodplain valley. The distance from the upper headwaters to the canyon mouth is approximately 205,701 feet with an average overall slope of 0.10. The majority of the Salt Creek Canyon watershed is characterized by both rugged and steeply developed foothills. Generally, the soils in the watershed are characterized as Gaviota rocky sandy loam. Also, the soils within the Salt Creek Canyon watershed can be predominately classified as being in hydrologic soil group C/D (higher runoff potential). The associated vegetative cover within the watershed varies, but primarily consists of burned California sagebrush scrub and burned chaparral.

2.2.4. Receiving Water Beneficial Uses

The Water Quality Control Plan for the Los Angeles Region (Basin Plan) (LARWQCB, 1994, as amended) lists beneficial uses of major water bodies within this region (Table 2-3). The Santa Clara River Reach 5 is listed and has specific beneficial uses assigned to it. As identified in Table 2-3, the existing beneficial uses of Santa Clara River Reach 5 include the following:

- MUN*: Conditional potential municipal and domestic water supply

- IND: Industrial activities that do not depend primarily on water quality
- PROC: Industrial activities that depend primarily on water quality
- AGR: Agricultural supply waters used for farming, horticulture, or ranching
- GWR: Groundwater recharge for natural or artificial recharge of groundwater
- FRSH: Natural or artificial maintenance of surface water quantity or quality
- REC1: Water contact recreation involving body contact with water and ingestion is reasonably possible
- REC2: Non-contact water recreation for activities in proximity to water, but not involving body contact
- WARM: Warm freshwater habitat to support warm water ecosystems
- WILD: Wildlife habitat waters that support wildlife habitats
- RARE: Waters that support rare, threatened, or endangered species and associated habitats
- WET: Wetland ecosystems

Table 2-3: Beneficial Uses of Surface Receiving Waters

Water Body	MUN	IND	PROC	AGR	GWR	FRSH	REC1	REC2	WARM	WILD	RARE	WET[1]
Santa Clara River (Hydrologic Unit 403.51)	P*	E	E	E	E	E	E	E	E	E	E	E

[1]Waterbodies designated as WET may have wetlands habitat associated with only a portion of the waterbody. Any regulatory action would require a detailed analysis of the area.
E – Existing beneficial use; P * – Asterixed MUN designations are conditional potential MUN designations[3].
Source: Water Quality Control Plan for the Los Angeles Region (Basin Plan) (LARWQCB, 1994, as amended)

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[3] On December 5, 2001, the U.S. Federal District Court issued an order that effectively invalidated EPA's requirement that the asterisked MUN designated uses (MUN* uses) in the Los Angeles Basin Plan be immediately enforced. See Order granting plaintiffs' motion for summary judgment and remanding action to EPA, No. CV 00-08919 R(RZx), City of Los Angeles et al. v. United States Environmental Protection Agency…, dated December 18, 2001. See also letter dated February 15, 2002, from Alexis Strauss, USEPA Region IX, to Celeste Cantu, Executive Director, California SWRCB: "…waters identified with an ("*") in Table 2-1 do not have an MUN as a designated use until such time as the State undertakes additional study and modifies its Basin Plan." EPA also stated that this conditional use designation has no legal effect.

2.3. Existing Surface Receiving Water Quality

Due to the size of the study area and the highly variable nature of wet weather surface water quality in the Santa Clara River throughout the study area, it was not appropriate to summarize water quality data for a single timeframe or location in order to establish baseline water quality conditions. As discussed above, flows in the Santa Clara River are highly episodic in nature and this characteristic can affect surface water quality considerably. The data summarized below, however, is recent and provides an accurate and reasonable characterization of existing water quality conditions that exist in the Project area. Data collected by the USGS at the Ventura/Los Angeles County line also summarized below provides historical perspective of water quality within the Santa Clara River at the downstream Project boundary.

Wet and dry weather surface water quality in the Project area was characterized from available water quality monitoring data obtained from the following four sources:

1. Newhall Ranch Tributary Stormwater Monitoring. Two storm events in March 2000 were monitored by the Newhall Ranch in five tributaries to the Santa Clara River within the NRSP area: Potrero Canyon, Long Canyon, San Martinez Grande Canyon, Middle Canyon, and Chiquito Canyon. Although limited, this data is relevant in terms of characterizing the existing stormwater runoff within the Santa Clara River tributaries within the NRSP area as the conditions within these watersheds have not been altered since 2000. Four of the five tributaries (all but Middle Canyon) will receive post-developed flows from the NRSP area.

2. Newhall Ranch WRP. The Newhall Ranch is required by the LARWQCB to conduct pre-startup water quality monitoring at upstream and downstream locations from the outfall of the approved Newhall Ranch WRP for the Newhall Ranch WRP individual NPDES Permit and Waste Discharge Requirements (WDRs) application. Summarized wet weather monitoring data were collected from two stations in the Santa Clara River from the spring of 2004 until the spring of 2006: one station is near the downstream boundary of the NRSP area near to the proposed WRP outfall location, and the second is about 2.5 miles further downstream.

3. LA County Monitoring. The County of Los Angeles conducts in-stream water quality monitoring on the mainstem of the Santa Clara River at a mass emission station located at The Old Road, at the upstream boundary of the Project area. Wet weather monitoring data are available from November 2002 through February 2007. The Los Angeles County monitoring data are the most current and are the only source of wet weather monitoring in the Santa Clara River immediately upstream of the NRSP area.

4. USGS Monitoring. The USGS collected a large number of water quality data in the Santa Clara River near the Ventura/Los Angeles County line from 1951 through 1995.

These data provide a historical perspective of wet weather water quality in the Santa Clara River immediately downstream of the NRSP area.

2.3.1. Wet Weather Water Quality Monitoring

2.3.1.1. Wet Weather Monitoring Locations and Rainfall Conditions

NRSP Area Stormwater Monitoring. Newhall Land conducted stormwater monitoring of tributary streams in the NRSP area to characterize the existing surface water quality during wet weather conditions (the monitoring data is provided in Appendix C). Stormwater samples were collected during two storm events in March 2001 at five monitoring locations (Stations A-E) shown on Figure 2-1. Three of the five monitoring stations were located at the mouths of SCR tributaries in Potrero Canyon (Sta. A), San Martinez Grande Canyon (Sta. B), and Middle Canyon (Sta. D). The other two monitoring stations were located on tributaries upstream from the mainstem of the SCR; one was just downstream of the community of Val Verde in Chiquito Canyon (Sta. E) and one was on an unnamed tributary in Long Canyon, ¼ mile upstream of the 'Onion Field' (Sta. C). Aside from Station E, which is downgradient of existing residential development, the land uses in the areas tributary to the Stations A, B, C, and D are predominately open space with some agriculture and oil and gas operations.

Table 2-4 lists the rainfall depth and duration of the two monitored storm events. The first storm was a small event (0.2 inches) that was likely just large enough to result in stormwater runoff. The depth of the second event was larger and slightly larger than the median storm depth (0.6 inches) at the nearby National Climatic Data Center (NCDC) Newhall rain gauge (see location on Figure 2-1). The median depth of 0.6 inches is based on a storm event analysis which identified 543 storms exceeding 0.1 inches that occurred from October 1968 to December 2006. The average storm duration in the 38-year Newhall gage rainfall record is 11.3 hours.

Table 2-4: Depth and Duration of Storms Monitored at Project Site

Date	Depth (in)[1]	Duration (hours)[1]
03/06/01	0.2	3
03/08/01	0.7	10

[1] Based on rainfall measured at the Newhall rain gauge.

Newhall Ranch WRP Pre-Startup Monitoring. Newhall Land has conducted pre-startup receiving water quality monitoring for the approved Newhall Ranch WRP (Newhall, 2006) at two locations in the SCR (see Figure 2-1):

- NR1 is located in the SCR 300 feet upstream of the WRP outfall location, and

- NR3 is located in the SCR approximately 7,500 feet downstream of the WRP outfall.

Five storms with rainfall depths ranging from 0.1 to 0.6 inch were sampled at NR1 and NR3 and one very large storm with a depth of 4.45 inches was sampled at NR3 (Table 2-5). Grab sampling methods were used.

Table 2-5: Depth and Duration of Storms Monitored for Newhall Ranch WRP

Date	Storm Depth (in)	Duration (hours)
12/07/04(1)	0.12	6
2/17/05(2)	0.60	12
2/18/05 (2)	4.45	12
11/9/05(1)	0.12	6
11/10/05(2)	0.20	1
2/17/06(1)	0.32	7

[1]Depth and duration measured at the Newhall rain gauge, [2] Estimated due to lack of gage data

LA County Department of Public Works Monitoring Data. The Los Angeles County Department of Public Works (LACDPW) has conducted dry and wet weather monitoring in the Santa Clara River for five wet seasons - from 2002 through 2007 (LACDPW, 2003 - 2007). The monitoring station (S29) is located in the Santa Clara River at The Old Road (Figure 2-1). It is approximately two miles upstream from the eastern boundary of the NRSP area. The monitoring station is downstream of the Saugus Water Reclamation Plant and the City of Santa Clarita and upstream of the Valencia Water Reclamation Plant. The monitoring station is intended to provide long-term information about water quality trends in areas with heterogeneous land uses and has a tributary area of 411 square miles.

Monitoring at the mass emission station included nineteen storm events. Composite samples were collected for most parameters, except grab sampling was used for bacteria, oil and grease, and cyanide analyses. The Santa Clara River Station is not automated so composite samples were obtained by sampling discretely every twenty minutes for the first three hours of the storm, and then mixing the discrete samples in the laboratory in proportion to the measured flow rates. Table 2-6 lists the rainfall depths and durations of the nineteen monitored storm events based on hourly rainfall measurements at the Newhall rain gage. The depth of eight of the ten storms was greater than the median storm depth for the Newhall rain gage (0.60 inches). In particular, storm events beginning on 2/11/03 and 1/7/05 were very large events, with total storm depths of 8.0 and 9.99 inches, respectively.

Table 2-6: Depth and Duration of Storms Monitored by LACDPW at S29

Date	Depth (inches)[1]	Duration (hours)[1]
11/8/02	1.6	21
12/16/02	1.9	5
2/11/03	8.0	32
3/15/03	2.0	16
10/31/03	0.30	4
12/25/03	1.80	14
1/2/04	0.4	9
10/17/04	0.64	7
10/26/04	2.22	13
1/7/05	9.99	92
10/17/05	1.61	14
12/31/05	0.6	4
1/14/06	0.08	2
2/17/06	0.32	7
12/9/06	0.47	2
12/16/06	0.12	2
1/30/07	0.44	16
2/19/07	0.24	5
2/22/07	0.32	3

[1] Based on rainfall measured at the Newhall rain gage

USGS Water Quality Monitoring Data. The US Geological Survey (USGS) has collected stream flow and water quality data at a number of locations in the SCR watershed (http://waterdata.usgs.gov/nwis). Among the largest data sets are flow and water quality data collected at USGS station 11108500 located on the Santa Clara River just downstream of the Los Angeles / Ventura County Line. This station is located approximately one mile downstream of the NRSP area (Figure 2-1), and downstream of both existing Water Reclamation Plants. The USGS collected water quality data between April 1951 and October 1995, probably using depth integrated sampling. These data thus provide a historical perspective of water quality in the SCR within the NRSP area.

Data presentation. To facilitate interpretation, the wet weather water quality data were grouped into two categories depending on the depth of 2-day antecedent rainfall measured at the Newhall rain gauge:

1. ***0.1 – 1 inches***. Rainfall depths that would likely produce runoff volumes characteristic of more frequent, smaller storm events.

2. ***> 1 inch***. Rainfall depths that would likely produce runoff volumes characteristic of larger, less frequent storm events.

2.3.1.2. Selected General Constituents

The selected general constituents examined were total suspended solids (TSS), total dissolved solids (TDS), hardness, and chloride (see Section 4 for a discussion of pollutant selection). TSS is a measure of the particulate matter suspended in water. Total dissolved solids (TDS) are a measure of the dissolved cations and anions, primarily inorganic salts (calcium, magnesium, potassium, sodium, chlorides and sulfates). TDS is an impairing pollutant in Reach 3 of the SCR as listed in the State's 2006 303(d) list of impaired water bodies. High TDS levels can impair agricultural, municipal supply, and groundwater recharge beneficial uses.

Hardness and chloride are important components of TDS. Hardness is a measure of the polyvalent cations, primarily calcium and magnesium. It is expressed as an equivalent concentration of calcium carbonate ($CaCO_3$). Hardness measurements are important because the toxicity of metals (and the associated water quality objectives) decreases as hardness increases. Chloride comprises a large proportion of the TDS. High levels of chloride in Santa Clara River Reaches 3, 5, and 6 are causing impairment of listed beneficial uses for agricultural irrigation. Irrigation of salt sensitive crops, such as avocados and strawberries, with water containing elevated levels of chloride can result in reduced crop yields

Results for concentrations of TSS, TDS, chloride, and hardness for the four datasets are listed in Tables 2-7 through 2-10. Rather than measuring TDS, the USGS station has recorded specific conductance (that is, the extent to which the sample conducts an electric current), which is related to TDS concentration. TDS concentration can be estimated as 0.55 to 0.9 times the specific conductance (Sawyer et al, 1994).

Table 2-7: Average Concentrations of Selected Constituents from Newhall Ranch Tributary Stormwater Monitoring, March 2001

Constituent	Site A Mouth of Potrero	Site B Mouth of San Martinez Grande	Site C Long Canyon Upstream of Onion Field	Site D Mouth of Middle Canyon	Site E Middle of Chiquito
TSS (mg/L)	835	41,100	36,000	5,650	6,645
TDS (mg/L)	7,380	2,825	190	160	205
Hardness (mg/L as $CaCO_3$)	2,225	1,205	147	59	107
Chloride (mg/L)	870	125	3	3	11

Table 2-8: Newhall Ranch WRP Startup Wet Weather Water Quality Data for Selected General Constituents in the Santa Clara River, 2004 - 2006

Constituent	2-day Antecedent Rainfall (inches)	Sample Site	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
TSS	0.1 – < 1.0	NR1	5	5	32	107	58
		NR3	5	5	32	235	112
	≥ 1.0	NR3	1	1	-	-	43,360
TDS	0.1 – < 1.0	NR1	5	5	622	1,136	855
		NR3	5	5	698	2,020	1,076
	≥ 1.0	NR3	1	1	-	-	2,100
Hardness (mg/L as $CaCO_3$)	0.1 – < 1.0	NR1	5	5	304	464	387
		NR3	5	5	352	670	475
	≥ 1.0	NR3	1	1	-	-	832
Chloride	0.1 – < 1.0	NR1	2	2	84	117	100
		NR3	2	2	89	121	105
	≥ 1.0	NR3	1	1	46	46	46

- = no or insufficient data

Table 2-9: LACDPW Stormwater Monitoring for Selected General Constituents at the SCR Mass Emission Station (S29), 2002 -2007

Constituent	2-day Antecedent Rainfall (in)	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
TSS	0.1 – < 1.0	11	11	135	2,202	845
	≥ 1.0	8	8	53	6,591	1,635
TDS	0.1 – < 1.0	11	11	174	732	458
	≥ 1.0	8	8	28	364	216
Hardness	0.1 – < 1.0	11	11	90	428	249
	≥ 1.0	8	8	15	170	108
Chloride	0.1 – < 1.0	11	11	17	118	68
	≥ 1.0	8	8	3	52	24

Table 2-10: USGS Water Quality Data for Selected General Constituents in the Santa Clara River at the County Line, 1951 – 1995

Constituent	2-day Antecedent Rainfall (inches)	No. of Samples	No. of Detects	Minimum	Maximum	Average
TSS (mg/L)	0.1 – < 1.0	10	10	248	4,730	2,291
	≥ 1.0	41	41	107	51,200	10,711
Specific Conductance (uS/cm)	0.1 – < 1.0	33	33	831	4,220	2,246
	≥ 1.0	42	42	637	3,240	1,309
Hardness (mg/L)	0.1 – < 1.0	27	27	270	1,500	773
	≥ 1.0	37	37	250	1,200	546
Chloride (mg/L)	0.1 – < 1.0	34	34	21	290	122
	≥ 1.0	39	39	14	192	61

TSS. It is generally expected that TSS concentrations in alluvial streams can be greatly elevated during storm runoff because of the combination of high sediment supply and a high capacity for instream transport and erosion. TSS concentrations in Table 2-7 to 2-10 are sometimes very high, due to the highly erodible, easily transportable, sandy alluvial soils and sediments. High TSS concentrations were measured at some of the tributary canyons (Table 2-7), and were also observed in the SCR (Table 2-9 and Table 2-10). These later results show the capacity of high flows in the Santa Clara River for sediment transport and are consistent with other data showing that large rainfall events result in a "reset" of the main channel. As concluded by Balance Hydrologics (2005), concepts of "normal" or "average" sediment-supply and flow conditions have limited value in this "flashy" environment, where episodic storm and wildfire events have enormous influence on sediment and storm flow conditions. In the Santa Clara River, a large portion of sediment movement events can occur in a matter of hours or days.

Average and maximum concentrations are much higher for the larger storms than the smaller storms. The average TSS concentrations for the larger storms were greater at the lower SCR sites (NR-1, NR-3, USGS) than at the upstream LACDPW Mass Emission Station. This may reflect the difference in sampling techniques (grab sample versus composite sample), and/or occasionally large inputs of TSS from tributaries, such as some of those draining through the NRSP area (Table 2-7). It may also reflect a lower river bed gradient (and hence better settling characteristics) of the SCR near the LACDPW station.

TDS. Stormwater monitoring data collected in the NRSP tributaries (Table 2-7) show greatly differing TDS levels among the five monitoring stations. Measured TDS concentrations were very high at Sites A and B, while TDS concentrations at the other three sites were low. Elevated TDS levels in runoff at Site A and B are likely a result of the natural soil properties of the marine layers of the Pico formation, and the high groundwater table conditions in these two canyons, suggesting that groundwater discharges to the channels contributed to the elevated TDS levels. These greatly differing dissolved solid (TDS) concentrations are also reflected in some of the components that make up the TDS (chloride and hardness) as described below.

Average concentration of TDS in the Santa Clara River were moderate to high, ranging from 216 mg/L to 2,100 mg/L. The Basin Plan objective for TDS in Santa Clara River Reach 5 is 1,000 mg/L. Using an estimate of 0.64 times the specific conductance for the USGS data, the TDS concentrations at this station averaged around 1,400 mg/L for storm flows. Much higher average concentrations were observed at the three downstream SCR stations (NR-1, NR-3, USGS) compared with the upstream LACDPW station, and this could be due to their location downstream of Potrero Canyon and San Martinez Grande Canyon (Sites A and B), with their much higher TDS content.

Hardness. Hardness is a measure of the multivalent metallic cations in water, principally calcium, magnesium, strontium, iron, and manganese (Sawyer et al, 1994). These cations are capable of reacting with soap to form precipitates and with certain anions to form scale. The hardness in water is derived largely from contact with soil and rock formations, and affects the CTR values for certain metals as discussed above. Waters with a hardness concentration from 150 mg/L to 300 mg/L as $CaCO_3$ are considered hard; waters with a hardness concentration above 300 mg/L as $CaCO_3$ are considered very hard.

The stormwater monitoring data for hardness were analogous to the data for TDS. Hardness concentrations were very high at the tributary Sites A and B, and low to moderate at the other three tributary sites. High hardness at Sites A and B are likely due to natural high levels of calcium and magnesium in the local soils (such as lime and gypsum deposits), and the high groundwater table conditions in these two canyons, suggesting again that groundwater discharges contributed to the elevated hardness levels.

In the SCR, average hardness values were greater downstream (NR3, NR1, USGS sites – Table 2-8 and 2-10) than at the LACDPW station (Tables 2-9). This is most likely due to the influence of tributary inflows of high hardness waters (such as measured at Sites A and B – Table 2-6), other groundwater inputs, and agricultural return flows that enter the Santa Clara River between these stations. However, the magnitude of hardness concentrations was somewhat inconsistent, with the USGS station (Table 2-10) showing higher average hardness concentrations than those measured at NR-1 and NR-3 (Table 2-8) in the smaller storms, but the opposite in the larger storms.

Except for at NR1 and NR3, the average hardness concentration decreased with larger antecedent rainfall depth, as was found for TDS concentrations.

Chloride. Similar to TDS and hardness, monitoring data collected in the NRSP tributaries (Table 2-7) found very high chloride concentrations at Site A, high levels at Site B, and low concentrations at the remaining three sites.

As with the other dissolved ionic parameters (TDS and hardness), the average chloride concentrations at the LACDPW station (Table 2-9) were lower than those measured at downstream sites (NR1, NR3, USGS – Table 2-8 and 2-10). As described previously, this is likely due to differences in salt content of local soils.

Overall, the average chloride concentrations during recent stormwater monitoring were highly variable and ranged between 3 mg/L and 125 mg/L, with the exception of the very high chloride concentrations detected at the mouth of Potrero Canyon (Site A). Average chloride concentration at the USGS station was about 61 mg/L for storm flows. The average chloride concentration observed in the larger storms at all of the SCR stations were lower than the Basin Plan objective for chloride of 100 mg/L, while the average chloride concentrations in the smaller storms were above the Basin Plan objective at the downstream monitoring stations.

2.3.1.3. Nutrients

The major nutrients nitrogen and phosphorus are described here. Phosphorus was measured as total phosphorus (TP) and sometimes as dissolved phosphorus. Dissolved phosphorus is the more bioavailable form of phosphorus compared to TP, which is often made up of a high proportion of particulate phosphorus. Nitrogen is measured variously as nitrate, nitrite, ammonia, and total Kjeldahl nitrogen (TKN). TKN is the measure of ammonia plus the organic forms of nitrogen. Nitrate, nitrite, and ammonia are the more bioavailable forms of nitrogen, and of these, nitrate (or nitrate + nitrite) has the higher concentration in natural waters and is more important than ammonia as a nutrient. Tables 2-11 through 2-14 summarize available data for these nutrients. Only nitrate was measured in the Newhall Ranch Tributary Stormwater Monitoring.

Table 2-11: Average Concentrations of Nitrate from Newhall Ranch Tributary Stormwater Monitoring, March 2001

Constituent	Site A Mouth of Potrero	Site B Mouth of San Martinez Grande	Site C Long Canyon Upstream of Onion Field	Site D Mouth of Middle Canyon	Site E Middle of Chiquito
Nitrate + Nitrite-N (mg/L)	17.5	3.0	1.6	15.3	2.8

Table 2-12: Newhall Ranch WRP Pre-Startup Wet Weather Water Quality Data for Selected Nutrients in the Santa Clara River, 2004 - 2006

Constituent	2-day Antecedent Rainfall (inches)	Sample Site	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
Total Phosphorus	0.1 – < 1.0	NR1	5	5	0.4	0.5	0.4
		NR3	5	5	0.3	0.7	0.4
	≥ 1.0	NR3	1	1	13.4	13.4	13.4
Nitrate as N	0.1 – < 1.0	NR1	5	5	1.9	4.8	3.2
		NR3	5	5	2.3	3.7	3.0
	≥ 1.0	NR3	1	1	1.4	1.4	1.4
Nitrite as N	0.1 – < 1.0	NR1	5	0	<0.005	<0.005	-
		NR3	5	0	<0.005	<0.005	-
	≥ 1.0	NR3	1	0	<0.005	<0.005	-
Ammonia as N	0.1 – < 1.0	NR1	5	4	<0.005	0.3	0.2
		NR3	5	5	0.02	0.1	0.1
	≥ 1.0	NR3	1	1	0.5	0.5	0.5
TKN as N	0.1 – < 1.0	NR1	5	4	<0.04	0.7	0.3
		NR3	5	4	<0.04	0.6	0.4
	≥ 1.0	NR3	1	1	46.0	46.0	46.0

- = no or insufficient data

Table 2-13: LACDPW Stormwater Monitoring of Selected Nutrients at the SCR Mass Emission Station (S29), 2002-2007

Constituent	2-day Antecedent Rainfall (in)	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
Dissolved Phosphorus	0.1 – < 1.0	11	11	0.17	0.43	0.24
	≥ 1.0	8	8	0.10	0.45	0.26
Total Phosphorus	0.1 – < 1.0	11	11	0.37	1.17	0.60
	≥ 1.0	8	8	0.18	0.84	0.42
Nitrate-N	0.1 – < 1.0	11	9	0.50	1.85	1.15
	≥ 1.0	8	6	0.50	1.36	0.80
Nitrite-N	0.1 – < 1.0	11	4	<0.03	1.00	0.17
	≥ 1.0	8	3	<0.03	0.87	0.18
Ammonia-N	0.1 – < 1.0	11	5	<0.08	0.26	0.14
	≥ 1.0	8	6	<0.08	1.09	0.29
TKN as N	0.1 – < 1.0	11	11	0.80	8.70	2.54
	≥ 1.0	8	8	0.66	31.70	5.58

Table 2-14: USGS Water Quality Data for Selected Nutrients in the Santa Clara River at the County Line, 1951 to 1995

Constituent	2-day Antecedent Rainfall (inches)	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
Dissolved Phosphorus	0.1 – < 1.0	3	3	0.35	0.66	0.46
	≥ 1.0	1	1	0.01	0.01	0.01
Total Phosphorus	0.1 – < 1.0	5	5	0.81	1.8	1.28
	≥ 1.0	2	2	0.63	1.4	1.02
Ammonia as N	0.1 – < 1.0	3	3	0.03	0.39	0.16
	≥ 1.0	0	0	-	-	-
Nitrate + Nitrite as N	0.1 – < 1.0	7	7	0.87	4	2.1
	≥ 1.0	4	4	1.2	2	1.7
TKN as N	0.1 – < 1.0	1	1	0.64	0.64	0.64
	≥ 1.0	1	1	0.69	0.69	0.69
Total Nitrogen	0.1 – < 1.0	2	2	0.6	2.2	1.4
	≥ 1.0	2	2	3.5	4.4	4.0

- = no or insufficient data

Phosphorus. Recent wet weather monitoring (LACDPW Mass Emission Station and Newhall Ranch WRP Startup Monitoring) showed somewhat consistent total phosphorus levels, of a magnitude of about 0.4 to 0.6 mg/L. An exception was the large storm sample (>1.0 inch) collected at station NR-3, which measured 13.4 mg/L. This was likely due to the high concentration of total suspended solids measured during the same storm event, because total phosphorus is predominately found in the particulate-phase in stormwater runoff. Historical average total phosphorus concentrations at the USGS station were somewhat higher than recent results at 1.0 to 1.3 mg/L and appeared to be somewhat independent of storm event size.

Nitrogen. Nitrate-nitrogen was the only nutrient measured in the NRSP tributary stormwater monitoring. Measured nitrate-nitrogen concentrations in the tributary stormwater monitoring were generally low (less than 3 mg/L as N) at three of the sites, and were elevated at Sites A and D (17.5 mg/L and 15.3 mg/L, respectively). The numeric target for nitrate plus nitrite-nitrogen in the Santa Clara River Nitrogen Compounds TMDL is 4.5 mg/L (30-day average) based on achieving the Basin Plan water quality objective of 5 mg/L (note that nitrate-nitrogen is typically an order of magnitude greater than nitrite-nitrogen in natural waters, as nitrite is converted to nitrate in aerobic conditions). The Santa Clara River average nitrate-nitrogen concentrations were below this objective (0.8 mg/L to 3.2 mg/L). The average historical nitrate-N + nitrite-N concentrations at the USGS station were roughly similar, varying from 2.1 mg/L for lower storm flows to 1.7 mg/L for higher storm flows.

Average ammonia concentrations were low and ranged from 0.1 to 0.5 mg/L. The ammonia water quality objectives in the Santa Clara River Nitrogen Compounds TMDL range from 3.4 mg/L to 5.5 mg/L (one hour average) and 1.2 mg/L to 2.0 mg/L (30-day average).

Average total Kjeldahl nitrogen (TKN) concentrations, which is the measure of ammonia plus the organic forms of nitrogen, generally ranged from 0.3 mg/L to 5.6 mg/L. One exception was the concentration found in the large storm at NR-3, which measured 46 mg/L. As with total phosphorus, the organic forms of nitrogen in stormwater runoff are generally in the particulate-phase, and this result correlated with the high levels of total phosphorus and suspended solids measured during this same event.

2.3.1.4. Selected Metals, Pesticides, and Cyanide

The heavy metals cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn) can be toxic at high concentrations. Trace metals occur naturally in soils and sediments, and are present in urban runoff. Aluminum is one of the more abundant elements in the earth's crust. The organophosphorus pesticides chlorpyrifos and diazinon are two pesticides of concern due to their potential toxicity in receiving waters and, in the past, have been frequently detected downstream from urban and agricultural land uses. These pesticides are currently banned for residential use. Cyanide is a highly toxic substance and has a number of man-made and natural sources.

Tables 2-15 through 2-18 summarize the data for these metals and pesticides in the tributaries and the Santa Clara River. Cyanide was only measured at the LACDPW Mass Emission station. Available data for metals at the USGS station were very limited. For copper and lead, there were a considerable number of non-detects with very high detection limits. Therefore, comparison of the USGS data for copper, lead, and zinc with the recent monitoring information is considered inappropriate. Metals data were not collected in the one large storm event sampled for the Newhall Ranch WRP pre-startup monitoring; thus summarized data for this station represent storms less than one inch in depth.

Table 2-15: Average Concentration of Heavy Metals from Newhall Ranch Tributary Stormwater Monitoring, March 2001

Constituent	Site A Mouth of Potrero	Site B Mouth of San Martinez Grande	Site C Long Canyon Upstream of Onion Field	Site D Mouth of Middle Canyon	Site E Middle of Chiquito
Total Copper (µg/L)	15	175	170	10	70
Total Lead (µg/L)	6.1	53.5	95.2	7.6	36.8
Total Zinc (µg/L)	40	330	330	30	225
Total Cadmium (µg/L)	0.3	11.2	2	0.4	1.9

Table 2-16: Newhall Ranch WRP Pre-Startup Wet Weather Water Quality Data for Selected Metals and Pesticides in the Santa Clara River, 2004 - 2006

Constituent	2-day Antecedent Rainfall (inches)	Sample Site	No. of Samples	No. of Detects	Minimum (µg/L)	Maximum (µg/L)	Average (µg/L)
Dissolved Aluminum	0.1 – < 1.0	NR1	1	1	27	27	27
		NR3	1	1	19	19	19
Total Aluminum	0.1 – < 1.0	NR1	1	1	740	740	740
		NR3	1	1	770	770	770
Dissolved Copper	0.1 – < 1.0	NR1	1	1	4.6	4.6	4.6
		NR3	1	1	3.6	3.6	3.6
Total Copper	0.1 – < 1.0	NR1	2	2	4.6	5.2	4.9
		NR3	2	2	4.8	7.0	5.9
Dissolved Lead	0.1 – < 1.0	NR1	1	0	<0.07	<0.07	-
		NR3	1	0	<0.07	<0.07	-
Total Lead	0.1 – < 1.0	NR1	2	2	0.6	1.3	1.0
		NR3	2	2	0.6	0.9	0.8

Constituent	2-day Antecedent Rainfall (inches)	Sample Site	No. of Samples	No. of Detects	Minimum (µg/L)	Maximum (µg/L)	Average (µg/L)
Dissolved Zinc	0.1 – < 1.0	NR1	1	1	12	12	12
		NR3	1	1	8.7	8.7	8.7
Total Zinc	0.1 – < 1.0	NR1	2	2	13	22	18
		NR3	2	2	12	18	15
Diazinon	0.1 – < 1.0	NR1	1	0	<0.01	<0.01	-
		NR3	1	0	<0.01	<0.01	-
Chlorpyrifos	0.1 – < 1.0	NR1	1	0	<0.6	<0.6	-
		NR3	1	0	<0.6	<0.6	-

- = no or insufficient data

Table 2-17: LACDPW Stormwater Monitoring for Metals, Pesticides, and Cyanide at the SCR Mass Emission Station (S29), 2002-2007

Constituent	2-day Antecedent Rainfall (inches)	No. of Samples	No. of Detects	Minimum (µg/L)	Maximum (µg/L)	Average (µg/L)
Dissolved Aluminum	0.1 – < 1.0	11	3	<100	1390	894
	≥ 1.0	8	4	<100	3680	1086
Total Aluminum	0.1 – < 1.0	11	11	450	18000	5040
	≥ 1.0	8	8	131	19650	5672
Dissolved Copper	0.1 – < 1.0	11	11	3.32	10.60	5.80
	≥ 1.0	8	8	3.75	22.60	9.92
Total Copper	0.1 – < 1.0	11	11	7.33	50.50	25.78
	≥ 1.0	8	8	9.43	53.30	25.28
Dissolved Lead	0.1 – < 1.0	11	2	0.52	5.00	4.44
	≥ 1.0	8	5	0.44	12.50	3.32
Total Lead	0.1 – < 1.0	11	11	1.41	17.40	5.91
	≥ 1.0	8	8	1.14	39.80	17.12
Dissolved Zinc	0.1 – < 1.0	11	9	3	27	12
	≥ 1.0	8	8	12	37	26
Total Zinc	0.1 – < 1.0	11	11	11	118	54
	≥ 1.0	8	8	42	353	110
Dissolved Cadmium	0.1 – < 1.0	11	0	1.00	1.00	1.00
	≥ 1.0	8	1	0.74	1.00	0.94

Constituent	2-day Antecedent Rainfall (inches)	No. of Samples	No. of Detects	Minimum (µg/L)	Maximum (µg/L)	Average (µg/L)
Total Cadmium	0.1 – < 1.0	11	6	0.27	1.00	0.77
	≥ 1.0	8	6	0.25	1.27	0.78
Chlorpyrifos	0.1 – < 1.0	11	0	<0.05	<0.05	-
	≥ 1.0	8	0	<0.05	<0.05	-
Diazinon	0.1 – < 1.0	11	3	<0.01	0.41	0.05
	≥ 1.0	8	5	<0.01	0.43	0.10
Cyanide	0.1 – < 1.0	11	3	<10	10	10
	≥ 1.0	8	3	<10	590	200

- = no or insufficient data

Table 2-18: USGS Water Quality Data for Selected Metals and Pesticides in the Santa Clara River at the County Line, 1951 to 1995

Constituent	2-day Antecedent Rainfall (inches)	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
Dissolved Copper	0.1 – < 1.0	4	0	-	-	-
	≥ 1.0	0	0	-	-	-
Total Copper	0.1 – < 1.0	1	1	30	30	30
	≥ 1.0	0	0	-	-	-
Dissolved Lead	0.1 – < 1.0	39	4	1	23	7.8
	≥ 1.0	4	0	-	-	-
Total Lead	0.1 – < 1.0	3	0	-	-	-
	≥ 1.0	1	0	-	-	-
Dissolved Zinc	0.1 – < 1.0	4	1	10	10	10
	≥ 1.0	0	0	-	-	-
Total Zinc	0.1 – < 1.0	1	1	150	150	150
	≥ 1.0	0	0	-	-	-
Diazinon	0.1 – < 1.0	1	1	0.02	0.02	0.02
	≥ 1.0	0	0	-	-	-

- = no or insufficient data

Metals. Table 2-15 presents average total copper, lead, zinc, and cadmium concentrations measured in the NRSP tributary stormwater monitoring. Total copper, lead, and zinc measured at tributary Sites B and C were much higher than the concentrations measured at Sites A and D. Concentrations at Site E fell in the middle of the measured range. Elevated total metal concentrations are often associated with elevated TSS levels, although this trend is not evident in the tributary monitoring data. The average total copper concentrations at Sites B, C, and E were greater than the CTR acute copper criterion. The average total copper concentrations ranged from 10 µg/L to 175 µg/L; the CTR acute total copper criterion for a hardness concentration of greater than 400 mg/L is 52 µg/L. The average total lead and total zinc concentrations in all the tributaries were below the CTR acute criteria. The average total lead concentrations ranged from 6.1 µg/L to 95 µg/L; the CTR acute total lead criterion for a hardness concentration of greater than 400 mg/L is 480 µg/L. The average total zinc concentrations ranged from 30 µg/L to 330 µg/L; the CTR acute total zinc criterion for a hardness concentration of greater than 400 mg/L is 390 µg/L.

Average concentrations of dissolved and total copper measured in the Santa Clara River (3.6 µg/L to 9.9 µg/L, dissolved copper; 4.9 to 26 µg/L, total copper) were below the respective CTR acute criteria for the average hardness of 250 mg/L (32 µg/L, dissolved copper; 33 µg/L, total copper). Average concentrations of dissolved and total lead measured in the Santa Clara River (<0.07 µg/L to 4.4 µg/L, dissolved lead; 0.8 to 17 µg/L, total lead) were well below the respective CTR acute criteria for the average hardness of 250 mg/L (170 µg/L, dissolved lead; 260 µg/L, total lead). Average concentrations of dissolved and total zinc measured in the Santa Clara River (8.7 µg/L to 26 µg/L, dissolved zinc; 15 to 110 µg/L, total zinc) were all well below the respective CTR acute criteria for the average hardness of 250 mg/L (250 µg/L, dissolved zinc; 260 µg/L, total zinc).

Average dissolved aluminum concentrations showed a very wide range in the Santa Clara River, ranging from a low of 19 µg/L dissolved aluminum measured in small storms at station NR3 to 1,086 µg/L measured in large storms at the Los Angeles County mass emission station. Similarly, total aluminum ranged from a low of 740 µg/L dissolved aluminum measured in small storms at station NR1 to 5,672 µg/L measured in large storms at the Los Angeles County mass emission station. The National Ambient Water Quality Criteria (NAWQC) acute criterion for aluminum is 750 µg/L for a pH range of 6.5 to 9.0; the CTR does not include an aluminum criterion.

Pesticides. Chlorpyrifos was not detected in 19 samples taken at the County's mass emission station, while diazinon was detected in 8 of 19 samples with an average concentration of 0.05 µg/L in small storms and 0.10 µg/L in the larger storms. Diazinon and chlorpyrifos were not detected further downstream in the SCR during Newhall Ranch WRP wet weather sampling, but were detected in the one wet weather sample in the historical USGS data. The CTR acute criterion for diazinon is 0.17 µg/L. The diazinon criterion derived by the California Department of Fish and Game is 0.08 µg/L (Marshack, 2003).

Cyanide. Cyanide was detected in six of 19 wet weather samples at the County's mass emission station. Concentrations of cyanide ranged from below 10 µg/L to 590 µg/L. The CTR criterion for freshwater acute aquatic life protection for cyanide is 22 µg/L.

2.3.1.5. Fecal Indicator Bacteria

Pathogens such as viruses, bacteria, and protozoa that cause illness in humans are difficult to measure. Fecal indicator bacteria (FIB) such as total coliform, fecal coliform, and enterococci are commonly measured instead, and their presence indicates the presence of fecal contamination and the potential presence of associated pathogenic organisms. However, it does not indicate the source of the contamination and there are numerous natural and anthropogenic sources of pathogen indicators. Tables 2-19 through 2-22 summarize FIB data for the four datasets.

Table 2-19: Average Concentrations for Fecal Indicator Bacteria from Newhall Ranch Tributary Stormwater Monitoring, 2001

Constituent	Site A Mouth of Potrero	Site B Mouth of San Martinez Grande	Site C Long Canyon Upstream of Onion Field	Site D Mouth of Middle Canyon	Site E Middle of Chiquito
Total coliform (MPN/100ml)	40,000	>160,000	125,000	>50,000	>81,200
Fecal coliform (MPN/100ml)	4,300	953	6,300	>81,200	81,200

Table 2-20: Newhall Ranch WRP Startup Wet Weather Water Quality Data for Fecal Indicator Bacteria in the Santa Clara River, 2004 - 2006

Constituent	2-day Antecedent Rainfall (inches)	Sample Site	No. of Samples	No. of Detects	Minimum	Maximum	Average
Fecal coliform (MPN/100mL)	0.1 – < 1.0	NR1	5	4	<1	900	87
		NR3	5	4	<1	5,000	258
	≥ 1.0	NR3	1	1	≥1,600	≥1,600	≥1,600
Total coliform (MPN/100mL)	0.1 – < 1.0	NR1	5	4	<1	1,600	284
		NR3	5	4	<1	13,000	549
	≥ 1.0	NR3	1	1	≥1,600	≥1,600	≥1,600

Table 2-21: LACDPW Stormwater Monitoring for Fecal Indicator Bacteria at the SCR Mass Emission Station, 2002-2007

Constituent	2-day Antecedent Rainfall (inches)	No. of Samples	No. of Detects	Minimum	Maximum	Average
Total coliform (MPN/100mL)	0.1 – < 1.0	11	11	17,000	1,600,000	115,590
	≥ 1.0	8	8	50,000	500,000	246,812
Fecal coliform (MPN/100mL)	0.1 – < 1.0	11	11	230	300,000	7,332
	≥ 1.0	8	8	9,000	300,000	65,275
Fecal Enterococci (MPN/100mL)	0.1 – < 1.0	11	11	800	300,000	17,907
	≥ 1.0	8	8	17,000	500,000	90,150

Table 2-22: USGS Water Quality Data for Fecal Indicator Bacteria in the Santa Clara River at the County Line, 1951 - 1995

Constituent	2-day Antecedent Rainfall (inches)	No. of Samples	No. of Detects	Minimum	Maximum	Average
Fecal coliform (CFU/100mL)	0.1 – < 1.0	3	3	80	720	427
	≥ 1.0	1	1	-	-	2,700

- = no or insufficient data

Concentrations of total and fecal coliform bacteria in wet weather flows at all tributary monitoring stations, the Newhall Ranch WRP stations, and the County's mass emission station were highly variable and sometimes very high, consistent with other stormwater data throughout the region. Fecal coliform concentrations ranged from <1 Most Probable Number per 100 milliliters (MPN/100 mL) to 300,000 MPN/100 mL. Average bacteria concentrations at the lower stations were significantly lower, but still elevated, more so during larger storms. In waters designated for water contact recreation (REC-1), the Basin Plan objective for fecal coliform is a log mean of 200/100 mL (based on a minimum of not less than 10 percent of total samples during any 30-day period), nor shall more 10 percent of the total number of samples during any 30-day period exceed 400/100 mL.

2.3.1.6. Summary

Tables 2-23 and 2-24 summarize the average values from wet weather monitoring data for all monitoring locations.

Table 2-23: Average Wet Weather Monitoring Data (2-Day Antecedent Rainfall of 0.1 - 1.0 in)

Constituent	LACDPW Mass Emission Station	NRSP Area Tributary Monitoring					Newhall Ranch WRP Startup Monitoring		USGS Wet Weather Monitoring
	S29	*Site A*	*Site B*	*Site C*	*Site D*	*Site E*	*NR1*	*NR3*	*USGS*
General and Conventional Parameters									
TSS (mg/L)	845	835	41,100	36,000	5,650	6,645	58	112	2,291
TDS (mg/L)	458	7,380	2,825	190	160	205	855	1,076	1,437 [1]
Hardness (mg/L)	249	2,225	1,205	147	59	107	387	475	773
Chloride (mg/L)	68	870	125	3	3	11	100	105	122
Nutrients									
Total P (mg/L)	0.60	-	-	-	-	-	0.4	0.4	1.28
Nitrate-N (mg/L)	1.15	18[2]	3.0[2]	1.6[2]	15.3[2]	2.8[2]	3.2	3.0	2.1 [2]
Nitrite-N (mg/L)	0.17	-	-	-	-	-	<0.005	<0.005	-
Ammonia-N (mg/L)	0.14	-	-	-	-	-	0.2	0.1	0.16
TKN (mg/L)	2.5	-	-	-	-	-	0.3	0.4	0.64
Metals and Pesticides									
Dissolved copper (µg/L)	5.8	-	-	-	-	-	4.6	3.6	-
Total Copper (µg/L)	26	15	175	170	10	70	4.9	5.9	30
Dissolved Lead (µg/L)	4.4	-	-	-	-	-	<0.07	<0.07	7.8
Total Lead (µg/L)	5.9	6.1	54	95	7.6	37	1	0.8	-
Dissolved Zinc (µg/L)	12	-	-	-	-	-	12	8.7	10
Total Zinc (µg/L)	54	40	330	330	30	225	18	15	150
Dissolved Aluminum (µg/L)	894	-	-	-	-	-	27	19	-
Total Aluminum (µg/L)	5,040	-	-	-	-	-	740	770	-
Diazinon (µg/L)	0.05	-	-	-	-	-	<0.01	<0.01	0.02
Chlorpyrifos (µg/L)	<0.05	-	-	-	-	-	<0.6	<0.6	-
Cyanide (mg/L)	<0.01	-	-	-	-	-	-	-	-
Indicator Bacteria									
Fecal coliform (MPN/100mL)	7,332	4,300	953	6,300	>81,200	81,200	87	258	427 [3]
Total coliform (MPN/100mL)	115,590	40,000	>1.6E5	125,000	>50,000	>81,200	284	549	-

[1] Derived from Specific Conductance, [2] Nitrate + Nitrite-N, [3]CFU/100ml, - = no or insufficient data

Table 2-24: Average Wet Weather Monitoring Data (2-Day Antecedent Rainfall >1 inch)

Constituent	LACDPW SCR Mass Emission Station *S29*	Newhall Ranch WRP Startup Monitoring *NR3*	USGS Wet Weather Monitoring *11108500*
General and Conventional Parameters			
TSS (mg/L)	1,635	43,360	10,711
TDS (mg/L)	216	2,100	838 [1]
Hardness (mg/L)	108	832	546
Chloride (mg/L)	24	46	61
Nutrients			
Total P (mg/L)	0.42	13	1.0
Nitrate-N (mg/L)	0.80	1.4	1.7 [2]
Nitrite-N (mg/L)	0.18	ND	
Ammonia-N (mg/L)	0.29	0.5	-
TKN (mg/L)	5.6	46	0.69
Metals and Pesticides			
Dissolved Copper (µg/L)	9.9	-	-
Total Copper (µg/L)	26	-	-
Dissolved Lead (µg/L)	3.3	-	-
Total Lead (µg/L)	17	-	-
Dissolved Zinc (µg/L)	26	-	-
Total Zinc (µg/L)	110	-	-
Dissolved Aluminum (µg/L)	1,086	-	-
Total Aluminum (µg/L)	5,672	-	-
Diazinon (µg/L)	0.10	<0.01	-
Chlorpyrifos (µg/L)	<0.05	<0.6	-
Cyanide (µg/L)	200	-	-
Indicator Bacteria			
Fecal coliform (MPN/100 mL)	65,275	>1,600	2,700 [3]
Total coliform (MPN/100 mL)	246,812	>1,600	-

[1] Derived from Specific Conductance, [2] Nitrate + Nitrite-N, [3]CFU/100ml, - = no or insufficient data

2.3.2. Dry Weather Water Quality Monitoring

Dry season base flows in the SCR through the NRSP area are perennial. Dry season base flows may include contributions from natural groundwater flows; however, discharges from the upstream Saugus and Valencia WRPs contribute the majority of base flow. Discharges from the WRPs during dry weather conditions are a source of impairing pollutants in downstream reaches, including chloride, TDS, and nitrogen compounds.

Dry weather water quality monitoring data in the SCR are available from three sources:

- LACDPW sampling at the SCR mass emission station
- USGS Water Quality Monitoring
- Newhall Ranch WRP pre-startup monitoring

These sites were described above under Wet Weather Monitoring (Section 2.3.1). The LACDPW station is in the SCR at The Old Road, above the NRSP area, while the Newhall Ranch WRP pre-startup monitoring stations are at the western boundary and downstream of the NRSP area. The USGS station is also below the NRSP area, and provides a historical perspective from samples collected between 1951 and 1995.

2.3.2.1. General Constituents

Tables 2-25 through 2-27 summarize the available dry weather monitoring data for TSS, hardness, TDS, and chloride.

Table 2-25: LACDPW Dry Weather Monitoring for Selected General Constituents at the SCR Mass Emission Station (S29), 2002-2007

Constituent	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
TSS	10	10	2	1,320	200
Hardness	10	10	330	510	420
TDS	10	10	696	942	812
Chloride	10	10	47	140	115

Table 2-26: Newhall Ranch WRP Pre-Startup Dry Weather Monitoring for Selected General Constituents in the SCR, 2004-2006

Constituent	Sample Site	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
TSS	NR1	49	48	<1	342	66
	NR3	49	48	<1	676	128
Hardness	NR1	49	49	258	568	388
	NR3	49	49	324	684	458
TDS	NR1	49	49	504	1160	845
	NR3	49	49	576	1396	936
Chloride	NR1	24	24	66	145	120
	NR3	24	24	50	157	124

Table 2-27: USGS Dry Weather Water Quality Monitoring Data for Selected General Constituents in the SCR at the County Line, 1951-1995

Constituent	No. of Samples	No. of Detects	Minimum	Maximum	Average
TSS (mg/L)	73	73	7	5,980	349
Hardness (mg/L)	220	220	42	2,400	881
Specific Conductance (uS/cm)	383	383	925	7,620	2,408
TDS (mg/L)	-	-	592[1]	4,876[1]	1,541[1]
Chloride (mg/L)	355	355	30	585	140

[1]Derived from Specific Conductance

TSS. Relatively high average TSS concentrations were observed, especially the historical data from USGS station, which may have included samples taken during times of higher erosion or larger dry weather flows. Average dry weather flow TSS concentrations observed by the Newhall Ranch WRP pre-startup monitoring were similar to those observed for small storms in wet weather monitoring. Average concentrations of TSS appeared higher at the upstream DPW mass emission station than at the downstream Newhall Ranch WRP pre-startup sites. Differences may be due to physical factors such as channel substrate material, local flow regime, and tributary influences.

Hardness, TDS and Chloride. The average concentrations of hardness, TDS, and chloride were more similar between the County's mass emission station and Newhall Ranch WRP monitoring locations. However, the USGS County Line station historically recorded higher averages (approximately double) than the baseline data observed at the County's mass emission station and Newhall Ranch WRP monitoring locations. The baseline data suggests that the water flowing in the Santa Clara River in the proposed Project area during dry weather is very hard with high levels of other dissolved salts, including chloride. The average concentrations of TDS in the baseline data ranged from 812 mg/L to 936 mg/L, below the Basin Plan objective for TDS in Santa Clara River Reach 5 (1,000 mg/L). Average chloride concentrations in dry weather flows ranged from 115 mg/L to 124 mg/L, above the Basin Plan objective of 100 mg/L.

2.3.2.2. Nutrients

Tables 2-28 through 2-30 summarize the available dry weather monitoring data for selected nutrients.

Table 2-28: LACDPW Dry Weather Monitoring of Selected Nutrients at the SCR Mass Emission Station (S29), 2002-2007

Constituent	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
Dissolved phosphorus	10	10	0.05	0.30	0.18
Total phosphorus	10	10	0.10	0.67	0.26
Nitrate-N	10	9	<0.50	1.7	1.2
Nitrite-N	10	2	<0.03	0.6	0.1
Ammonia-N	10	2	<0.10	0.8	0.1
TKN	10	10	0.3	1.3	0.6

Table 2-29: Newhall Ranch WRP Pre-Startup Dry Weather Monitoring for Selected Nutrients in the SCR, 2004-2006

Constituent	Sample Site	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
Total phosphorus	NR1	49	49	0.1	1.1	0.5
	NR3	49	48	<0.008	0.8	0.5
Nitrate-N	NR1	49	49	1.0	4.9	2.8
	NR3	49	49	1.1	5.1	2.9
Nitrite-N	NR1	49	6	<0.005	0.2	0.02
	NR3	49	5	<0.005	0.2	0.02
Ammonia-N	NR1	49	34	<0.005	0.4	0.1
	NR3	49	39	<0.005	0.4	0.1
TKN	NR1	49	47	<0.04	1.0	0.4
	NR3	49	48	<0.04	1.3	0.5

Table 2-30: USGS Dry Weather Water Quality Monitoring Data for Selected Nutrients in the Santa Clara River at the County Line, 1951 - 1995

Constituent	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
Dissolved phosphorus	48	48	0.12	2.4	1
Total phosphorus	64	64	0.23	5.9	1.13
Ammonia as N	41	41	0.01	0.62	0.18
Nitrate + Nitrite as N	47	47	1.8	7.5	4
TKN as N	20	20	0.08	1.3	0.83
Total Nitrogen	33	33	0.5	15	3.7

Phosphorus and Nitrogen. The average concentrations for total phosphorus and nitrate in dry weather flows increased downstream, while ammonia and TKN concentrations were relatively consistent from upstream to downstream. All average nutrient concentrations were higher in the historical dataset. Nutrient concentrations measured in dry weathers flows reflect the influence of the Saugus and Valencia WRPs. Lower average concentrations in the Newhall WRP startup monitoring compared with the data at the USGS gauge could be due to historically greater WRP nutrient discharge concentrations and/or less responsible use of fertilizers. Higher historic TKN concentrations could also be attributed to higher TSS concentrations, and hence particulate nutrients, observed at this site.

2.3.2.3. Metals and Pesticides

Tables 2-31 through 2-33 summarize the available dry weather monitoring data for selected metals and pesticides.

Table 2-31: LACDPW Dry Weather Monitoring for Metals, Pesticides, and Cyanide at the SCR Mass Emission Station (S29), 2002-2007

Constituent	No. of Samples	No. of Detects	Minimum (µg/L)	Maximum (µg/L)	Average (µg/L)
Dissolved copper	10	10	1.9	3.8	2.9
Total copper	10	10	6.0	33.5	15.2
Dissolved lead	10	0	<5.00	<5.00	-
Total lead	10	10	0.6	8.2	1.8
Dissolved zinc	10	7	<1.00	26.0	6.4
Total zinc	10	8	<5.00	52.2	20.7
Dissolved cadmium	10	2	<1.00	41.0	5.3
Total cadmium	10	3	0.29	72.0	8.3

Constituent	No. of Samples	No. of Detects	Minimum (µg/L)	Maximum (µg/L)	Average (µg/L)
Dissolved aluminum	10	0	<100	<100	-
Total aluminum	10	3	<100	7,500	845
Chlorpyrifos	10	0	<0.05	<0.05	-
Diazinon	10	1	<0.05	0.02	0.01
Cyanide	10	0	<10	<10	-

- = no or insufficient data

Table 2-32: Newhall Ranch WRP Pre-Startup Dry Weather Monitoring for Metals and Pesticides in the SCR, 2004-2006

Constituent	Sample Site	No. of Samples	No. of Detects	Minimum (µg/L)	Maximum (µg/L)	Average (µg/L)
Dissolved copper	NR1	10	10	3.2	4.8	4
	NR3	10	10	3	5.2	4.2
Total copper	NR1	21	21	2.3	11	5
	NR3	21	21	2.6	15	6.5
Dissolved lead	NR1	10	5	<0.07	0.7	0.2
	NR3	10	6	<0.07	0.6	0.2
Total lead	NR1	21	18	<0.07	4.6	0.9
	NR3	21	18	<0.07	5.8	1.4
Dissolved zinc	NR1	10	10	7.8	14	11
	NR3	10	10	6.2	16	10.7
Total zinc	NR1	21	21	8.5	30	15.4
	NR3	21	21	7.8	51	19.5
Dissolved aluminum	NR1	4	4	21	290	170
	NR3	4	4	14	750	289
Total aluminum	NR1	4	4	240	2,100	1,018
	NR3	4	4	330	3,300	1,685
Diazinon	NR1	21	0	<0.01	<0.01	-
	NR3	21	0	<0.01	<0.01	-

- = no or insufficient data

Table 2-33: USGS Dry Weather Water Quality Monitoring Data for Metals and Pesticides in the Santa Clara River at the County Line, 1951-1995

Constituent	No. of Samples	No. of Detects	Minimum (µg/L)	Maximum (µg/L)	Average (µg/L)
Dissolved copper (ug/L)	40	13	1	5	1.8
Total copper (ug/L)	12	6	10	40	20
Dissolved lead (ug/L)	39	4	1	23	7.8
Total lead (ug/L)	30	0	-	-	-
Dissolved Zinc (ug/L)	39	29	5	50	15.8
Total zinc (ug/L)	12	12	20	110	45
Diazinon (ug/L)	6	4	0.01	0.05	0.03

- = no or insufficient data

Metals. Concentrations of heavy metals in dry weather flows were generally low and, for the most part, reasonably similar. Total metal concentrations are related to TSS concentrations, and this is reflected in the difference between the historical data collected at the USGS site with higher TSS and the more recent data with lower TSS. Average dissolved copper concentrations were fairly similar and ranged from 1.8 to 4.2 µg/L. Average dissolved zinc concentrations were also fairly similar and ranged from 6.4 to 15.8 µg/L. Dissolved lead concentrations were slightly higher for the historical than the more recent datasets, and this is likely due to the widespread use of leaded gasoline prior to 1995.

Average concentrations of dissolved and total copper measured in dry weather flows in the baseline data (2.9 µg/L to 4.2 µg/L, dissolved copper; 5 to 15.2 µg/L, total copper) were below the respective CTR chronic criteria for a hardness greater than 400 mg/L (29 µg/L, dissolved copper; 30 µg/L, total copper). Average concentrations of dissolved and total lead measured in dry weather flows (0.2 µg/L to 7.8 µg/L, dissolved lead; 0.9 to 1.8 µg/L, total lead) were well below the respective CTR chronic criteria for a hardness greater than 400 mg/L (11 µg/L, dissolved lead; 19 µg/L, total lead). Average concentrations of dissolved and total zinc measured in dry weather flows (6.4 µg/L to 11 µg/L, dissolved zinc; 15.4 to 20.7 µg/L, total zinc) were all well below the respective CTR chronic criteria for a hardness greater than 400 mg/L (380 µg/L, dissolved zinc; 390 µg/L, total zinc).

Aluminum concentrations were only measured at the Newhall Ranch WRP Startup Monitoring stations. Average dissolved aluminum concentrations in the dry weather flows ranged from 170 µg/L to 289 µg/L. Total aluminum ranged from 845 µg/L to 1,685 µg/L. The National Ambient Water Quality Criteria (NAWQC) acute criterion for acid soluble aluminum is 750 µg/L for a pH range of 6.5 to 9.0; the CTR does not include an aluminum criterion.

Pesticides. Diazinon was detected at the upstream LACDPW site and historically at the USGS site in dry weather flows. The more extensive data set collected at NR-1 and NR-3 did not detect diazinon and this may be due to its recent phase-out by EPA for residential uses.

Cyanide. Cyanide was measured but not detected in dry weather flows at the LACDPW mass emission station.

2.3.2.4. Fecal Indicator Bacteria

Tables 2-34 through 2-36 summarize the available dry weather monitoring data for fecal indicator bacteria (FIB).

Table 2-34: LACDPW Dry Weather Monitoring at the SCR Mass Emission Station (S29), 2002-2007

Constituent	No. of Samples	No. of Detects	Minimum	Maximum	Average
Total coliform (MPN/100mL)	10	10	130	50,000	3,626
Fecal coliform (MPN/100mL)	10	10	20	5,000	165
Enterococci (MPN/100mL)	10	9	<20	1,300	218

Table 2-35: Newhall Ranch WRP Pre-Startup Dry Weather Monitoring for Indicator Bacteria in the SCR, 2004 - 2006

Constituent	Sample Site	No. of Samples	No. of Detects	Minimum	Maximum	Average
Total coliform (MPN/100mL)	NR1	49	49	23	24,000	961
	NR3	49	49	23	24,000	1,207
Fecal coliform (CFU/100mL)	NR1	49	49	23	2,300	209
	NR3	49	49	23	3,000	213

Table 2-36: USGS Dry Weather Water Quality Monitoring Data for Indicator Bacteria in the Santa Clara River at the County Line, 1951-1995

Constituent	No. of Samples	No. of Detects	Minimum	Maximum	Average
Fecal coliform (CFU/100mL)	46	46	25	980	250

The concentrations of indicator bacteria indicated highly variable but generally elevated fecal indicator bacteria concentrations in dry weather flows. The observed data were above the REC-1 Basin Plan objective for fecal coliform (log mean of 200/100 mL (based on a minimum of not less than 10 percent of total samples during any 30-day period), nor shall more than 10 percent of the total number of samples during any 30-day period exceed 400/100 mL).

2.3.2.5. Summary

Table 2-37 summarizes the dry weather monitoring data available for the Santa Clara River in the NRSP area.

Table 2-37: Summary of Average Dry Weather Monitoring Data in the Santa Clara River

Constituent	SCR Mass Emission Station	USGS Dry Weather Monitoring	Newhall Ranch WRP Startup Monitoring	
	S29	*11108500*	*NR1*	*NR3*
General and Conventional Parameters				
TSS (mg/L)	200	349	66	128
Hardness (mg/L)	420	881	388	458
TDS (mg/L)	812	1541[1]	845	936
Chloride (mg/L)	115	140	120	124
Nutrients				
Total P (mg/L)	0.26	1.13	0.5	0.5
Nitrate-N (mg/L)	1.2	4[2]	2.8	2.9
Nitrite-N (mg/L)	0.1	-	0.02	0.02
Ammonia-N (mg/L)	0.1	0.18	0.1	0.1
TKN (mg/L)	0.6	0.83	0.4	0.5
Metals and Pesticides				
Dissolved copper (µg/L)	2.9	1.8	4	4.2
Total copper (µg/L)	15.2	20	5	6.5
Dissolved lead(µg/L)	<5.0	7.8	0.2	0.2
Total lead (µg/L)	1.8	ND	0.9	1.4
Dissolved zinc (µg/L)	6.4	15.8	11	10.7
Total zinc (µg/L)	20.7	45	15.4	19.5
Dissolved aluminum (µg/L)	-	-	170	289
Total aluminum (µg/L)	845	-	1018	1685
Diazinon (µg/L)	0.01	0.03	<0.01	<0.01
Chlorpyrifos (µg/L)	<0.05	-	-	-
Cyanide (mg/L)	<0.01	-	-	-

Constituent	SCR Mass Emission Station	USGS Dry Weather Monitoring	Newhall Ranch WRP Startup Monitoring	
	S29	*11108500*	*NR1*	*NR3*
Indicator Bacteria				
Fecal coliform (MPN/100 mL)	165	250 (CFU/100mL)	209	213
Total coliform (MPN/100 mL)	3,626	-	961	1207

- = no or insufficient data

2.4. Groundwater

2.4.1. Groundwater Beneficial Uses

The NRSP area is within the Basin Plan's Castaic Valley and Saugus Aquifer subbasin of the Santa Clarita Valley Groundwater Basin, East Subbasin. Beneficial uses for groundwaters for this subbasin are shown in Table 2-38.

Table 2-38: Beneficial Uses of Groundwaters

Groundwater Basin	MUN
DWR 4.07 - Eastern Santa Clara Sub-basin: Castaic Valley and Saugus Aquifer	E

E-Existing Beneficial Use
MUN: Community, military, or individual water supply systems including, but not limited to, drinking water supply
Source: Water Quality Control Plan for the Los Angeles Region (Basin Plan) (LARWQCB, 1994 as amended)

2.4.2. Existing Groundwater Quality

The NRSP subregion lies at the western end of the upper Santa Clara River hydrologic area, as defined by the California Department of Water Resources (DWR). The Santa Clara River Valley East Groundwater Subbasin lies within this hydrologic area and is the source of essentially all local groundwater used for water supply in the Santa Clarita Valley. The local groundwater supplies are obtained from relatively young surficial alluvial deposits and from an older geologic unit (the Saugus Formation) that underlies the alluvium and adjoining areas. The alluvium and the Saugus Formation are underlain by bedrock units consisting of the Pico Formation in the NRSP area and other geologic units in the eastern and northern portions of the Santa Clarita Valley. These deep bedrock units yield little water and are not considered viable for groundwater development.

The alluvial sediments lie within the portion of the Valley occupied by the Santa Clara River and also are present in side canyons that contain tributaries to the River. The alluvium consists of extensively interlayered and interfingered mixtures of gravel and sand, with variable amounts of cobbles and boulders and minor amounts of silt and clay. Due to the unconsolidated to poorly consolidated condition of the alluvium, and its lack of cementation, the alluvium has relatively high permeability and porosity. The groundwater flow direction in the Alluvial aquifer follows the topography of the Valley and its tributaries. Groundwater recharge occurs in the eastern, northern, and southern portions of the Valley. Natural mechanisms for groundwater discharge occur at the west end of the Valley and consist of discharge to the Santa Clara River, subsurface outflow beneath the River, and evapotranspiration by deep-rooted vegetation.

The Saugus Formation is present beneath the eastern portion of the NRSP subregion and most of the Santa Clarita Valley area east of the NRSP area. The upper subunits of the Saugus Formation consist of terrestrial sediments deposited in stream channels, floodplains, and alluvial fans by ancestral drainage systems. The upper subunits are a source of groundwater supply in the Santa Clarita Valley because of their productive nature and their good water quality. Deeper subunits of the Saugus Formation were deposited in a marine environment and are subsequently not used for water supplies because of their brackish water quality and fine-grained, low-permeability nature.

Faulting and folding of the Saugus Formation and the underlying bedrock units have created a bowl-shaped structure beneath the Santa Clarita Valley. The Saugus Formation and underlying bedrock generally dip downwards from the periphery of the Valley towards the deepest portion of the "bowl" beneath the central portion of the Valley. The thickness of the Saugus Formation also is controlled by the San Gabriel fault, which is present in the eastern and northern portions of the Valley. Because of its structure and its connection with the overlying Alluvial aquifer, groundwater flow in the Saugus Formation is generally towards the center of the bowl and also towards the western portion of the Santa Clara River. Like the Alluvial aquifer, the Saugus Formation is recharged in the eastern and other peripheral portions of the Santa Clarita Valley. Groundwater discharge from the Saugus Formation occurs at the west end of the Valley in the form of groundwater discharge into the overlying Alluvial aquifer, which in turn discharges to the River in the western end of the Valley.

Alluvium. In terms of the aquifer system, there is no convenient long-term record of water quality (*i.e.*, water quality data in one or more single wells that spans several decades and continues to the present). Thus, in order to examine a long-term record of water quality in the alluvium, individual records have been integrated from several wells completed in the same aquifer materials and in close proximity to each other to examine historical trends in general mineral groundwater quality throughout the basin (Luhdorff & Scalmanini, 2005). Based on these records of groundwater quality, wells within the alluvium have experienced historical fluctuations in general mineral content, as indicated by electrical conductivity (EC), which correlates with fluctuations of individual constituents that contribute to EC. However, the historic water quality data indicates that, on a long-term basis, there has not been a notable trend and, specifically, there has not been a decline in water quality within the alluvium.

Specific conductance within the alluvium exhibits a westward gradient, corresponding with the direction of groundwater flow in the alluvium. EC is lowest in the easternmost portion of the basin, and highest in the west, and generally exhibits an inverse correlation with precipitation and streamflow, with a stronger correlation in the easternmost portion of the basin where groundwater levels fluctuate the most. Wet periods have produced substantial recharge of higher quality (low EC) water, and dry periods have resulted in declines in groundwater levels, with a corresponding increase in EC (and individual contributing constituents) in the deeper parts of the alluvium.

The most notable groundwater quality issue in the alluvium is perchlorate contamination in a localized area situated about three miles east of the NRSP subregion. In 2002, one well (the Santa Clarita Water Division's Stadium Well), located near the former Whittaker-Bermite facility, was inactivated for municipal water supply due to detection of perchlorate slightly below the Notification Level. In early 2005, perchlorate was detected in a second well, the Valencia Water Company's Well Q2. In October 2005, Well Q2 was returned to service with wellhead perchlorate treatment under a permit from the California DHS. On-going monitoring in the alluvium north of the Whittaker-Bermite site (an ammunition manufacturing site) has shown no detections of perchlorate in any other Alluvial municipal water supply wells in this area.

Table 2-39 summarizes average metals, general chemistry, and organic compounds data for three Alluvial aquifer wells located in and near the NRSP subregion (see Figure 2-1). One well is a municipal water supply well that belongs to the Valencia Water Company (E-15) and is located in the Valencia Commerce Center area, north of the NRSP boundary. Two Newhall Ranch agricultural Alluvial aquifer wells (C and B6) were monitored twice (once each in 2000 and 2001).

Laboratory testing indicates that all constituents tested were at acceptable levels for drinking water, for all tested wells, with the exception of sulfate and iron in the agricultural supply well B6. Specifically, the average sulfate concentration (360 mg/L) exceeded the Basin Plan objective of 350 mg/L and the average iron concentration (0.4 mg/L) exceeded the secondary drinking water standard of 0.3 mg/L in Alluvial Well B6.

Tests conducted for perchlorate at the Alluvial aquifer wells listed in Table 2-39 indicated "non-detect," meaning no perchlorate was detected. Furthermore, no organic contaminants have been detected in any Alluvial aquifer wells.

Saugus Formation. Similar to the Alluvial aquifer, groundwater quality in the Saugus Formation is a key factor in assessing that aquifer as a municipal and agricultural water supply. As with the Alluvial aquifer, long-term Saugus groundwater quality data is not sufficiently extensive (few wells) to permit any basin-wide analysis or assessment of pumping-related impacts on quality. Accordingly, EC has been chosen as an indicator of overall water quality, and records have been combined to produce a long-term depiction of water quality. Water quality in the Saugus Formation historically has not exhibited the precipitation-related fluctuations seen in the Alluvial aquifer, and based on the historical record over the last 50 years, groundwater quality in the Saugus Formation has exhibited a slight overall increase in EC.

Table 2-39 summarizes average metals, general chemistry, and organic compounds data for one Saugus aquifer wells located near the NRSP subregion (see Figure 2-1). Saugus Well 206 is a municipal water supply well that belongs to the Valencia Water Company and is located in the RMDP project area. Laboratory testing indicates that all constituents tested were at acceptable levels for drinking water in Saugus Well 206.

As with the Alluvial aquifer, the most notable groundwater quality issue in the Saugus Formation is perchlorate contamination. Since 1997, four Saugus wells located near the former Whittaker-Bermite facility (about two miles east of the Specific Plan area) have been inactivated for water supply service due to the presence of perchlorate. A fifth well in that same location showed a detection of perchlorate below the DHS reporting level of 4 µg/L. To date, in the Saugus Formation, there have been no perchlorate detections in other active municipal-supply wells located down gradient (west) of the impacted wells. The development and implementation of a cleanup plan for the former Whittaker-Bermite facility and the impacted groundwater resources is being coordinated among the Castaic Lake Water Agency (CLWA), impacted purveyors, the California Department of Toxic Substances Control (DTSC), and the Corps. For the impacted groundwater, a Final Interim Remedial Action Plan for containment and extraction of perchlorate was completed and approved by DTSC in January 2006. Design of the treatment facilities and related pipelines also was completed in 2006. Construction of these facilities to implement the pump-and-treat program and to also restore inactivated well capacity is anticipated to conclude in mid-2008, with the facilities on line by fall 2008 (Luhdorff and Scalmanini, 2006).

Table 2-39: Groundwater Monitoring Data

Parameter	Units	Basin Plan Objective / Maximum Contaminant Level	Average Concentration			
			Alluvial Well E-15	Alluvial Well C	Alluvial Well B6	Saugus Well 206
Aluminum	µg/L	1,000(2)	ND	ND	ND	ND
Arsenic	µg/L	50(2)	n/a	ND	ND	n/a
Barium	mg/L	1(2)	ND	0.02	0.03	ND
Beryllium	µg/L	4(2)	ND	n/a	n/a	ND
Cadmium	µg/L	5(2)	ND	ND	ND	ND
Chromium	µg/L	50(2)	ND	ND	ND	ND
Copper	µg/L	1,000(3)	ND	ND	ND	ND
Iron	mg/L	0.3(3)	ND	0.1	**0.4**	ND
Manganese	µg/L	50(3)	ND	ND	ND	ND
Mercury, Total	µg/L	2(2)	n/a	ND	ND	n/a
Nickel	µg/L	100(2)	ND	ND	ND	ND
Selenium	µg/L	50(2)	n/a	ND	ND	n/a
Silver	µg/L	100(3)	NA	ND	ND	n/a
Thallium	µg/L	2(2)	NA	ND	ND	n/a
Zinc	µg/L	5,000(3)	ND	ND	ND	ND

Parameter	Units	Basin Plan Objective / Maximum Contaminant Level	Average Concentration			
			Alluvial Well E-15	Alluvial Well C	Alluvial Well B6	Saugus Well 206
Alkalinity as CaCO3	mg/L	--	226	255	295	221
Boron	mg/L	1.0(1)	0.48	0.39	0.48	n/a
Chloride	mg/L	150(1)	90	57	82	45
Color	Color unit	15(3)	ND	ND	5	ND
Cyanide, total	mg/L	0.15(2)	n/a	ND	ND	n/a
Fluoride	mg/L	2.0(2)	0.8	0.7	0.8	0.2
Hardness as CaCO3	mg/L	--	499	410	510	464
MBAS	mg/L	0.5(3)	n/a	ND	ND	n/a
Nitrate as NO3	mg/L	45(1)	18.5	9.5	10.6	20.9
Nitrite as N	mg/L	1(1)	ND	ND	ND	ND
Nitrate+Nitrite as N	mg/L	10(1)	3.6	2.1	2.4	4.7
Odor	TON	3(3)	1.1	ND	ND	1
Specific Conductance	umhos/cm	900-1600(3)	1317	1150	1400	1158
Sulfate	mg/L	350(1)	314	285	**360**	293
TDS	mg/L	1,000(1)	969	760	950	861
Turbidity	NTU	5(3)	0.4	0.35	1.4	0.2
Volatile Organic Chemicals (VOCs)	µg/L	variable	ND	ND	ND	ND
Synthetic Organic Chemicals (SVOCs)	µg/L	variable	ND	ND	ND	ND
Key: **Bold** **Exceeds Standard**						

-- = no applicable basin plan objective or MCL
n/a = not analyzed
ND = none detected
[1]Los Angeles Basin Plan Regional Objectives for Groundwater (Table 3-10).
[2]California Department of Public Health Primary Drinking Water MCL (Title 22 CCR Table 64431-A and Table 64444-A).
[3]California Department of Public Health Secondary Drinking Water MCL (Title 22 CCR Table 64449-A and Table 64449-B).

3. REGULATORY SETTING

3.1. Clean Water Act

In 1972, the Federal Water Pollution Control Act [later referred to as the Clean Water Act (CWA)] was amended to require National Pollutant Discharge Elimination System (NPDES) permits for the discharge of pollutants to waters of the United States from any point source. In 1987, the CWA was amended to require that the United States Environmental Protection Agency (USEPA) establish regulations for permitting of municipal and industrial stormwater discharges under the NPDES permit program. The USEPA published final regulations regarding stormwater discharges on November 16, 1990. The regulations require that municipal separate storm sewer system (MS4) discharges to surface waters be regulated by a NPDES permit.

In addition, the CWA requires the States to adopt water quality standards for receiving water bodies and to have those standards approved by the USEPA. Water quality standards consist of designated beneficial uses for a particular receiving water body (e.g. wildlife habitat, agricultural supply, fishing etc.), along with water quality criteria necessary to support those uses. Water quality criteria are prescribed concentrations or levels of constituents – such as lead, suspended sediment, and fecal coliform bacteria – or narrative statements which represent the quality of water that support a particular use. Because California had not established a complete list of acceptable water quality criteria, USEPA established numeric water quality criteria for certain toxic constituents in receiving waters with human health or aquatic life designated uses in the form of the California Toxics Rule (“CTR”) (40 CFR 131.38).

3.2. CWA Section 303(d) - TMDLs

When designated beneficial uses of a particular receiving water body are being compromised by water quality, Section 303(d) of the CWA requires identifying and listing that water body as “impaired”. Once a water body has been deemed impaired, a Total Maximum Daily Load (TMDL) must be developed for the impairing pollutant(s). A TMDL is an estimate of the total load of pollutants from point, non-point, and natural sources that a water body may receive without exceeding applicable water quality standards (with a “factor of safety” included). Once established, the TMDL allocates the loads among current and future pollutant sources to the water body.

The NRSP sub-regional projects will discharge runoff to Santa Clara River Reach 5. Table 3-1 lists the water quality impairments for the Santa Clara River, at and downstream of the NRSP location, as reported in the most recent (2006) CWA Section 303(d) List of Water Quality Limited Segments. Table 3-2 lists the 2006 Section 303(d) List of Water Quality Limited Segments Being Addressed by EPA Approved TMDLs. States are required to submit the Section 303(d) list and TMDL priorities to the EPA for approval. The 2006 Section 303(d) list was adopted by the SWRCB and approved for transmittal to EPA on October 25, 2006. The

2006 Section 303(d) list was approved by USEPA on June 28, 2007. Reach 5 of the Santa Clara River is listed for coliform bacteria and for chloride as “being addressed” in the reach. Downstream segments of the river, below the dry gap in Reach 4, are listed for total dissolved solids (TDS), toxicity, coliform bacteria, chlorinated legacy pesticides, and Toxaphene. Reach 3 is listed for ammonia and chloride as “being addressed.”

The Regional Board has adopted TMDLs for nitrogen compounds (nitrate plus nitrite-nitrogen and ammonia) and chloride into the Water Quality Control Plan for Los Angeles Region (Basin Plan). The wasteload allocations for stormwater discharges into Reach 5 of the Santa Clara River are summarized in Table 3-3. Pollutant reductions are regulated through effluent limits prescribed in POTW and minor point source NPDES Permits, Best Management Practices (BMPs) required in NPDES MS4 Permits, and State Water Resource Control Board (SWRCB) Management Measures for nonpoint source discharges. The Regional Board has not yet adopted a TMDL for coliform in Reach 5 .

3.3. California Toxics Rule

The California Toxics Rule (40 C.F.R. §131.38) is a federal regulation issued by the USEPA that provides water quality criteria for toxic pollutants in waters with human health or aquatic life designated uses in California. Not all waters receiving flows from the NRSP area, such as the tributaries to the Santa Clara River, are specifically designated with human health or aquatic life uses. However, the Santa Clara River does have such designated uses. Although CTR criteria do not apply directly to discharges of stormwater runoff, they can provide a useful benchmark to assess the potential impacts to the water quality of receiving waters from NRSP project stormwater runoff discharges. Here, the freshwater aquatic life criteria are used as benchmarks to evaluate the potential impacts of stormwater runoff to the NRSP projects' receiving waters. The CTR also contains human health criteria which are derived for drinking water sources and for fish consumption only. Since the human health criteria are less stringent than the aquatic life criteria for the pollutants of concern for the NRSP projects, the aquatic life criteria are used.

Table 3-1: 2006 CWA Section 303(d) Listings for the Santa Clara River Mainstem

SCR Reach or Tributary[1]	Geographic Description & Distance from Project to Upstream End of Reach	Pollutants	303(d) List Proposed TMDL Completion	Potential Sources
5	Blue Cut Gaging Station to West Pier Hwy 99 (Project location)	1) High Coliform Count	1) 2019	1) Nonpoint and Point Sources
3	Freeman diversion dam to "A" street [2] (25 miles)	1) Total Dissolved Solids	1) 2019	1) Nonpoint and Point Sources
1	Estuary to Highway 101 Bridge (30 miles)	1) Toxicity	1) 2019	1) Source Unknown
--	Estuary (40 miles)	1) ChemA[3] 2) Coliform 3) Toxaphene	1) 2019 2) 2019 3) 2019	1) Source Unknown 2) Nonpoint Source 3) Nonpoint Source

[1]SCR reaches upstream of the NRSP subregion have not been included.
[2]Reach 3 is downstream of the Dry Gap in Reach 4.
[3]ChemA suite of chlorinated legacy pesticides include: Aldrin, chlordane, Dieldrin, Endosulfan I/II, Endrin, gamma-BHC, heptachlor, heptachlor epoxide, and Toxaphene.

Table 3-2: 2006 CWA Section 303(d) List of Water Quality Limited Segments Being Addressed By EPA Approved TMDLs

Waterbody Name	Pollutants	Potential Sources	EPA Approved TMDL
Santa Clara River Reach 5	1. Chloride	1) Nonpoint/Point Source	1) 2005
Santa Clara River Reach 3	1. Ammonia 2. Chloride	1) Nonpoint/Point Source 2) Nonpoint/Point Source	1) 2004 2) 2002

Table 3-3: TMDL Wasteload Allocations for MS4 and Stormwater Sources to Santa Clara River Reach 5

Impairing Pollutant	Numeric Water Quality Objective	Wasteload Allocation
Chloride (Resolution No. 04-004)	100 mg/L.	Wasteload allocations have been adopted for the Saugus WRP and the Valencia WRP. Other NPDES discharges contribute a minor chloride load. The wasteload allocation for these point sources is **100 mg/L**. The source analysis indicates that nonpoint sources are not a major source of chloride. The load allocations for nonpoint sources is **100 mg/L**.
Nitrogen Compounds (Resolution No. 03-011)	The numeric target for NO_3-N + NO_2-N in the Nitrogen Compounds TMDL was based on achieving the existing water quality objective of 5 mg/L NO_3-N + NO_2-N. The numeric target that was used to calculate the wasteload allocations included a 10% margin of safety; thus the numeric target is 4.5 mg/L NO_3-N + NO_2-N (30-day average). The water quality objectives for ammonia in Reach 5 used in the Nitrogen Compounds TMDL are: TMDL Ammonia Water Quality Objective (mg/L as N) 1-hr average / 30-day average Reach 5 at County Line: 3.4 / 1.2 Reach 5 below Valencia: 5.5 / 2.0 Reach 5 above Valencia: 4.8 / 2.0	Concentration-based wasteloads are allocated to municipal, industrial, and construction stormwater sources regulated under NPDES permits. For stormwater Permittees discharging into Reach 5, the following wasteload allocations apply: **30-day average nitrate plus nitrite = 6.8 mg/L (NO_3-N + NO_2-N)** **1-hour average ammonia = 5.2 mg/L (NH_3 as N)** **30-day average ammonia = 1.75 mg/l (NH_3 as N)**

Freshwater aquatic life criteria for certain metals in the CTR are expressed as a function of hardness because hardness, and/or water quality characteristics that are usually correlated with hardness, can reduce the toxicities of some metals [4]. The minimum wet weather hardness value of 250 mg/L as $CaCO_3$ from USGS station 11108500 was used to approximate CTR criteria for metals. This value is likely to be more representative of conditions in the Santa Clara River within the NRSP subregion than Los Angeles County's Station 29 based on the water quality data summarized in Section 2.7 above. As per requirements of their discharge permit, the Valencia Water Reclamation Plant has a monitoring station just upstream of the NRSP subregion area. Monthly hardness values for the Santa Clara River at this station ranged from 326 to 360 mg/L as $CaCO_3$ in 2004. Other water quality comparisons to this station were not made due to lack of wet weather monitoring. The hardness value of 250 mg/L is a conservative estimate of wet weather hardness values that should occur in the NRSP subregion area, although higher values are likely to occur.

The CTR also establishes two types of aquatic life criteria: acute and chronic. Acute criteria represent the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time without deleterious effects; chronic criteria equal the highest concentration to which aquatic life can be exposed for an extended period of time (four days) without deleterious effects. Due to the intermittent nature of stormwater runoff (especially in southern California), the acute criteria are considered to be more applicable to stormwater conditions than chronic criteria. For example, the average storm duration in the 38-year Newhall gage rainfall record is 11.3 hours. In this document, the acute CTR criteria are used as one type of benchmark to evaluate the potential ecological impacts of Project runoff on the receiving waters.

3.4. California Porter-Cologne Act

The federal CWA places the primary responsibility for the control of surface water pollution and for planning the development and use of water resources with the states, although it does establish certain guidelines for the states to follow in developing their programs and allows USEPA to withdraw control from states with inadequate implementation mechanisms.

California's primary statute governing water quality and water pollution issues with respect to both surface waters and groundwater is the Porter-Cologne Water Quality Control Act of 1970

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[4] The toxicity of a chemical to an aquatic organism may vary according to attributes of the organism, chemical composition, and exposure environment, so that the chemical is more or less "bioavailable." Many chemicals exist in a variety of forms (chemical species), and such chemical speciation affects bioavailability because relative uptake rates can differ among chemical species and the relative concentrations of chemical species can differ among exposure conditions. Usually, metal toxicity is reduced by increased water hardness, which is composed of cations (primarily calcium and magnesium). In some cases, the apparent effect of hardness on toxicity might be partly due to complexation of the metal by higher concentrations of hydroxide and/or carbonate (increased pH and alkalinity) commonly associated with higher hardness. (USEPA, 2007)

(Porter-Cologne Act). The Porter-Cologne Act grants the State Water Resource Control Board (SWRCB) and the Regional Water Quality Control Boards (RWQCBs) power to protect water quality and is the primary vehicle for implementation of California's responsibilities under the federal Clean Water Act. The Porter-Cologne Act grants the SWRCB and the RWQCBs authority and responsibility to adopt plans and policies, to regulate discharges of waste to surface and groundwater, to regulate waste disposal sites and to require cleanup of discharges of hazardous materials and other pollutants. The Porter-Cologne Act also establishes reporting requirements for unintended discharges of any hazardous substance, sewage, or oil or petroleum product.

Each RWQCB must formulate and adopt a water quality control plan (Basin Plan) for its region. The Basin Plan must conform to the policies set forth in the Porter-Cologne Act and established by the SWRCB in its state water policy. To implement State and Federal law, the Basin Plan establishes beneficial uses for surface and groundwaters in the region, and sets forth narrative and numeric water quality standards to protect those beneficial uses. The Porter-Cologne Act also provides that a RWQCB may include within its regional plan water discharge prohibitions applicable to particular conditions, areas, or types of waste.

3.5. <u>Basin Plan</u>

The applicable Basin Plan (LARWQCB, 1994, as amended) provides quantitative and narrative criteria for a range of water quality constituents applicable to certain receiving water bodies and groundwater basins within the Los Angeles Region. Specific criteria are provided for the larger, designated water bodies within the region, as well as general criteria or guidelines for ocean waters, bays and estuaries, inland surface waters, and groundwaters. In general, the narrative criteria require that degradation of water quality does not occur due to increases in pollutant loads that will adversely impact the designated beneficial uses of a water body. For example, the Los Angeles Basin Plan requires that "Inland surface waters shall not contain suspended or settleable solids in amounts which cause a nuisance or adversely affect beneficial uses as a result of controllable water quality factors." Water quality criteria apply within receiving waters as opposed to applying directly to runoff; therefore, water quality criteria from the Basin Plan are utilized as benchmarks as one method to evaluate the potential ecological impacts of NRSP subregion project runoff on the receiving waters of the proposed project. Table 2-2 above lists the beneficial uses of applicable receiving surface waters.

The Basin Plan also contains water quality criteria for groundwater basins. For example, the Basin Plan requires that "Groundwaters shall not contain taste or odor producing substances in concentrations that cause nuisance or adversely affect beneficial uses." Table 2-38 above lists the beneficial uses of the applicable groundwater basin.

3.6. MS4 Permit

In 2001, the Los Angeles Regional Water Quality Control Board (LARWQCB, 2001) issued an NPDES Permit and Waste Discharge Requirements (Order No. 01-182) under the CWA and the Porter-Cologne Act for discharges of urban runoff in public storm drains in Los Angeles County. The Permittees are the Los Angeles County cities and the County (collectively "the Co-Permittees"). This permit regulates stormwater discharges from MS4s in the NRSP subregion. The NPDES permit details requirements for new development and significant redevelopment, including specific sizing criteria for treatment BMPs and flow control requirements.

To implement the requirements of the NPDES permit, the Co-permittees have developed development planning guidance and control measures that control and mitigate stormwater quality and quantity impacts to receiving waters as a result of new development and redevelopment. They are also required to implement other municipal source detection and elimination programs, as well as maintenance measures.

3.6.1. Stormwater Quality Management Program

The MS4 Permit contains the following provisions for implementation of the Stormwater Quality Management Program (SQMP) by the Co-permittees:

- General Requirements – Each Permittee is required to implement the SQMP to comply with applicable storm water program requirements and implement additional controls where necessary to reduce the discharge of pollutants in stormwater to the "maximum extent practicable" (MEP).

- BMP Implementation – Permittees are required to implement the most effective combination of BMPs for stormwater/urban runoff pollution control.

- SQMP Revision – Permittees are required to revise the SQMP to comply with regional, watershed specific requirements, and/or waste load allocations for implementation of TMDLs for impaired waterbodies.

- Responsibilities of the Principal Permittee – The responsibilities of the Los Angeles County Department of Public Works (as the Principal Permittee) include, but are not limited to, coordinating activities necessary to comply with the NPDES permit, providing personnel and fiscal resources for SQMP updates and annual reports and summaries of reports required under the SQMP, and implementing a County-wide Monitoring Program and evaluating results of the monitoring program.

- Responsibilities of Permittees – Each Permittee is required to comply with the requirements of the SQMP applicable to the discharges within its boundaries.

- Watershed Management Committees (WMCs) – WMCs are comprised of a voting representative from each Permittee within the Watershed Management Areas (WMAs).

WMCs are required to facilitate efforts and exchange of information between Permittees, establish additional goals for WMAs, prioritize pollution control efforts, monitor implementation of tasks designated for the WMA, and assess the effectiveness of and recommend revisions to the SQMP.

- Legal Authority – Permittees are granted the necessary legal authority to prohibit non-storm water discharges to the storm drain system.

The objective of the SQMP is to reduce pollutants in urban stormwater discharges to the "maximum extent practicable" in order to attain water quality objectives and to protect the beneficial uses of receiving waters in Los Angeles County. Special provisions are provided in the MS4 permit to facilitate implementation of the SQMP. These provisions include:

- BMP substitution – Substitution of site-specific BMPs is allowed provided the alternative BMP will meet or exceed pollutant reduction of the original BMP, the fiscal burden of the original BMP is substantially greater than the proposed alternative, and the alternative BMP will be implemented within a similar time period.

- Public Information and Participation Program (PIPP) – This requires the Permittee to identify how public education needs were determined, who is responsible for developing and implementing the program, and the method used to determine its effectiveness.

- Industrial/Commercial Facilities Control Program – This requires the Permittee to develop a plan for managing stormwater runoff from industrial and commercial facilities. This program will track, inspect, and ensure compliance at industrial and commercial facilities that are sources of pollutants in storm water.

- Development Planning Program – This requires the Permittee to implement a development-planning program that requires new development and redevelopment projects to minimize impacts from stormwater and urban runoff.

- Development Construction Program – This requires the Permittee to implement a program to control runoff from construction activity to minimize erosion and transportation of sediment and prevent non-stormwater discharges from equipment and vehicle washing.

- Public Agency Activities Program – This requires municipalities to evaluate existing public agency activities that have an impact on stormwater quality (such as vehicle maintenance, landscape maintenance and weed control, and construction and maintenance of streets, roads, and flood control systems) and to develop a program to reduce stormwater impacts with a schedule for implementation.

- Illicit Connections and Illicit Discharges Elimination Program – This requires each Permittee to have a plan for finding and preventing illegal connections and discharges and a mechanism for enforcing against illegal connections and discharges.

3.6.2. Standard Urban Stormwater Mitigation Plan

On March 8, 2000, the development planning program requirements, including the Standard Urban Stormwater Mitigation Plan requirements (collectively, development planning program requirements, including Standard Urban Stormwater Mitigation Pan requirements, are referred to in this report as SUSMP requirements) were approved by the RWQCB as part of the MS4 program to address stormwater pollution from new construction and redevelopment. The SUSMP contains a list of minimum BMPs that must be employed to infiltrate or treat stormwater runoff, control peak flow discharge, and reduce the post-project discharge of pollutants from stormwater conveyance systems. The SUSMP defines, based upon land use type, the types of practices that must be included and issues that must be addressed as appropriate to the development type and size. Compliance with SUSMP requirements is used as one method to evaluate significance of project development impacts on surface water runoff.

Finalized in May 2000, the County of Los Angeles' "Manual for the Standard Urban Stormwater Mitigation Plan" details the requirements for new development and significant redevelopment BMPs (Los Angeles County, 2000) (the "SUSMP Manual"). The SUSMP Manual is a model guidance document for use by Permittees and individual project owners to select post-construction BMPs and otherwise comply with the SUSMP requirements. It addresses water quality and drainage issues by specifying design standards for structural or treatment control BMPs that infiltrate or treat stormwater runoff and control peak flow discharge. BMPs are defined in the SUSMP Manual and SUSMP requirements as any program, technology, process, sizing criteria, operational methods or measures, or engineered systems, which, when implemented, prevent, control, remove, or reduce pollution. Treatment BMP sizing criteria and design guidance are also contained in the MS4 Permit and in the Manual.

One of the most important requirements within the SUSMP is the specific sizing criteria for stormwater treatment BMPs for new development and significant redevelopment projects. The SUSMP includes sizing criteria for both volume-based and flow-based BMPs. The sizing criteria options for volume-based BMPs, such as extended detention basins, are as follows:

1. The 85th percentile 24-hour runoff event storm event determined as the maximized capture stormwater volume for the area, from the formula recommended in Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87 (WEF, 1998); or,

2. The volume of annual runoff based on unit basin storage volume, to achieve 80% or more volume treatment by the method recommended in California Stormwater Best Management Practices Handbook – Industrial/Commercial (1993); or,

3. The volume of runoff produced from a 0.75 inch storm event, prior to its discharge to a stormwater conveyance system; or,

4. The volume of runoff produced from a historical-record based reference 24-hour rainfall criterion for "treatment" (0.75 inch average for the Los Angeles County Area) that achieves approximately the same reduction in pollutant loads and flows as achieved by mitigation of the 85th percentile, 24-hour runoff event.

Stormwater treatment facilities will be designed to meet or exceed the sizing standards contained in the SUSMP Manual. Volume-based treatment control BMPs for the NRSP projects will be sized to capture and treat 80 percent of the annual runoff volume, with a drawdown time of 48 hours. This methodology utilizes historical rainfall data with continuous simulation modeling to calculate the treatment volume for each treatment control BMP and is consistent with criteria 2 above.

Flow-based BMPs, such as vegetated swales, must be designed to infiltrate or treat the maximum flow rate generated from one of the following scenarios:

1. The flow of runoff produced from a rain event equal to at least 0.2 inches per hour intensity, or

2. The flow of runoff produced from a rain event equal to at least two times the 85th percentile hourly rainfall intensity for Los Angeles County, or

3. The flow of runoff produced from a rain event that will result in treatment of the same portion of runoff as treated using volumetric standards above.

Flow-based BMPs for the NRSP projects will be sized using a rainfall intensity of 0.3 inches per hour, which will result in treatment of the same portion of runoff as treated using volumetric standards above (criteria 3).

BMP sizing for each project within the NRSP will be finalized during the design stage by the project engineer with the final project-level hydrology study, which will be prepared and approved to ensure consistency with this analysis prior to issuance of a grading permit.

Also, the SUSMP includes general design specifications for individual priority project categories. These include:

- Single-Family Hillside Home
- 100,000 square foot commercial developments
- Restaurants
- Retail gasoline outlets

- Automotive repair shops
- Parking lots

For example, commercial developments must have properly designed loading and unloading dock areas, repair and maintenance bays, and vehicle equipment wash areas. Restaurants need to have properly designed equipment and accessory wash areas. Parking lots have to be properly designed to limit oil contamination and have regular maintenance of parking lot stormwater treatment systems (e.g., storm drain filters and biofilters).

The NRSP projects are required to incorporate appropriate SUSMP requirements into project plans as part of the development plan approval process. These project plans will identify the general design specifications related to parking lots and other project features associated with the NRSP projects. BMP designs will be evaluated in the Project Water Quality Technical Report (Project WQTR) to ensure consistency with this NRSP Sub-Regional SWMP as part of the project-level CEQA analysis. All BMPs to be included in the Project per the requirements and standards of this analysis and the Project WQTR will be incorporated into the Project SUSMP prepared for each NRSP development prior to the first to occur of issuance of grading permit or recordation of final tract map. (See Section 1.0)

3.6.3. Hydromodification and Peak Flow Control

Part 4. Section D.1. of the MS4 Permit notes that increased volume, velocity, and discharge duration of stormwater runoff from developed areas may potentially accelerate downstream erosion and impair habitat-related beneficial uses in Natural Drainage Systems. As a result, Section D.1. of the Permit stipulates that Permittees shall control post-development peak storm water runoff discharge rates, velocities and durations in Natural Drainage Systems to prevent accelerated stream erosion and to protect stream habitat. Natural Drainage Systems are defined by the Permit to include the Santa Clara River.

Further, under Part 4, § D.1 of the MS4 Permit, the County and its Co-permittees were required to develop and implement by February 1, 2005, numeric criteria for peak flow control in accordance with the findings of the Peak Discharge Impact Study analyzing the potential impacts on natural streams due to impervious development. The County of Los Angeles Department of Public Works and the Southern California Storm Water Monitoring Coalition had been conducting the study, but the study was not completed in time to meet the February 1st deadline. Therefore, on January 31, 2005, the County adopted and submitted to the LARWQCB an Interim Peak Flow Standard to be in effect until such time as a final standard can be adopted based on a completed study.

The adopted Los Angeles County Interim Peak Flow Standard was derived from a similar Interim Peak Flow Standard for Ventura County approved by the LARWQCB under the SUSMP requirements provisions of the MS4 Permit. The intent of the Interim Standard, as described by the County in the cover letter dated January 31, 2005, signed by Donald L. Wolfe transmitting the Interim Standard to Jonathan Bishop of the LARWQB, is to provide protection for natural streams to the extent supported by findings from the ongoing study, and consistent with practical construction practices.

The Interim Peak Flow Standard adopted by the County is:

> *The Peak Flow Standard shall require that all postdevelopment runoff from a 2-year, 24-hour storm shall not exceed the predevelopment peak flow rate, burned, from a 2-year, 24-hour storm when the predevelopment peak flow rate equals or exceeds five cubic feet per second. Discharge flow rates shall be calculated using the County of Los Angeles Modified Rational Method. The Peak Flow Standard shall also require that postdevelopment runoff from the 50-year capital storm shall not exceed the predevelopment peak flow rate, burned and bulked, from the 50-year capital storm.*

In its cover letter dated January 31, 2005, signed by Donald L. Wolfe, transmitting the Peak Flow Interim Standard to Jonathan Bishop of the LARWQB, the County notes that upon completion of the Peak Discharge Impact Study, new peak flow standards may be determined to be appropriate.

Per §4.D(9) of the MS4 Permit, this NRSP Sub-Regional Stormwater Mitigation Plan provides an alternative performance standard for the NRSP projects to the Interim Peak Flow Standard. The NRSP projects will be conditioned to require, as a project design feature, sizing and design of hydraulic features as necessary to control hydromodification impacts in accordance with this NSRP Sub-Regional SWMP. See further Section 5.3 below.

3.7. <u>Construction Permits</u>

Pursuant to the CWA Section 402(p), requiring regulations for permitting of certain stormwater discharges, the State Water Resources Control Board (SWRCB) has issued a statewide general NPDES Permit and Waste Discharge Requirements for stormwater discharges from construction sites ((NPDES No. CAS000002) California Water Resources Control Board Resolution No. 2001-046; Modification of Water Quality Order 99-08-DWQ State Water Resources Control Board (SWRCB) National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges Associated with Construction Activity (adopted by the SWRCB on April 26, 2001)).

Under this Construction General Permit, discharges of stormwater from construction sites with a disturbed area of one or more acres (effective March 2003) are required to either obtain individual NPDES permits for stormwater discharges or be covered by the Construction General Permit. Coverage under the Construction General Permit is accomplished by completing and filing a Notice of Intent with the SWRCB. Each applicant under the Construction General Permit must ensure that a Stormwater Pollution Prevention Plan (SWPPP) is prepared prior to grading and implemented during construction. The primary objective of the SWPPP is to identify, construct, implement, and maintain BMPs to reduce or eliminate pollutants in stormwater discharges and authorized non-stormwater discharges from the construction site during construction. Compliance with the requirements of the Construction General Permit is used as one method to evaluate project construction-related impacts on surface water quality.

3.8. General Waste Discharge Requirements for Dischargers of Groundwater From Construction and Project Dewatering

The Los Angeles Regional Water Quality Control Board has issued a General NPDES Permit and General Waste Discharge Requirements (WDRs) (Order No. R4-2003-0111, NPDES No. CAG994004) governing construction-related dewatering discharges within the project development areas (the "General Dewatering Permit.") This permit addresses discharges from temporary dewatering operations associated with construction and permanent dewatering operations associated with development. The discharge requirements include provisions mandating notification, sampling and analysis, and reporting of dewatering and testing-related discharges. The General Dewatering Permit authorizes such construction-related activities so long as all conditions of the permit are fulfilled. Compliance with the requirements of the General Dewatering Permit is used as one method to evaluate project construction-related impacts on surface water quality.

3.9. NPDES Permit for the Newhall Ranch WRP

On September 6, 2007, the Regional Water Quality Control Board, Los Angeles Region, approved Order No. R4-2007-0046, NPDES Permit No. CA0064556, effective October 27, 2007. This Order serves as the NPDES Permit for point source discharges from the Newhall Ranch WRP, pursuant to section 402 of the federal Clean Water Act and chapter 5.5, division 7 of the California Water Code. The Order also serves as the Waste Discharge Requirements for the new County Sanitation District with respect to discharges to the Santa Clara River, pursuant to article 4, chapter 4, of the California Water Code. Specifically, the Order specifies limitations and discharge requirements for the Newhall Ranch WRP, including discharge prohibitions, technology-based and water quality-based effluent limitations, receiving water limitations, and other provisions such as monitoring and reporting requirements.

3.10. Discharge of Fill or Dredge Materials

Hydrologic conditions of concern addressed in this report include instream changes in sediment transport, erosion, and sedimentation, and ultimately channel stability. There is a nexus between these concerns and the stream, habitat, and species protection programs administered by the United States Army Corps of Engineers (ACOE), California Department of Fish and Game (CDFG) and the U.S. Fish and Wildlife Service.

Section 404 of the Clean Water Act is a program that regulates the discharge of dredged and fill material into waters of the United States, including wetlands. Activities in waters of the United States that are regulated under this program include fills for development (including physical alterations to drainages to accommodate storm drainage, stabilization, and flood control improvements), water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and conversion of wetlands to uplands for farming and forestry. USEPA and the ACOE have issued Section 404(b)(1) Guidelines (40 CFR 230) that regulate dredge and fill activities, including water quality aspects of such activities. Subpart C at Sections 230.20 thru 230.25 contains water quality regulations applicable to dredge and fill activities. Among other topics, these guidelines address discharges which alter substrate elevation or contours, suspended particulates, water clarity, nutrients and chemical content, current patterns and water circulation, water fluctuations (including those that alter erosion or sediment rates), and salinity gradients.

Section 401 of the Clean Water Act requires that any person applying for a federal permit or license which may result in a discharge of pollutants into waters of the United States must obtain a state water quality certification that the activity complies with all applicable water quality standards, limitations, and restrictions. Subject to certain limitations, no license or permit may be issued by a federal agency until certification required by Section 401 has been granted. Further, no license or permit may be issued if certification has been denied. CWA Section 404 permits and authorizations are subject to section 401 certification by the Regional Water Quality Control Boards (RWQCBs).

This report does not analyze the habitat and wildlife impacts associated with physical alterations to waters of the United States proposed in conjunction with NRSP projects, such as dredge, fill, or bed, bank or channel improvements or stabilization measures affecting waters of the U.S. The impacts associated with these physical alterations are analyzed in detail in the biota and floodplain modification sections of the NRSP RMDP and the related EIR/EIS. As discussed in Section 4.4.2 below, this report analyzes the adverse impacts to natural drainage systems that may be caused by the Project's alteration of hydrologic conditions. The report further analyzes water quality impacts associated with the NRSP projects, to support issuance of Section 401 Water Quality Certification and to allow preparation of Section 404(b)(1) analysis for NRSP Section 404 permits.

3.11. <u>Lake or Streambed Alteration Agreement (LSAA)</u>

The CDFG is responsible for conserving, protecting, and managing California's fish, wildlife, and native plant resources. To meet this responsibility, the law requires the proponent of a project that may impact a river, stream, or lake to notify the CDFG before beginning the project. This includes rivers or streams that flow at least periodically or permanently through a bed or channel with banks that support fish or other aquatic life and watercourses having a surface or subsurface flow that support or have supported riparian vegetation.

Section 1602 of the Fish and Game Code requires any person who proposes a project that will substantially divert or obstruct the natural flow or substantially change the bed, channel, or bank of any river, stream, or lake or use materials from a streambed to notify the CDFG before beginning the project. Similarly, under section 1602 of the Fish and Game Code, before any State or local governmental agency or public utility begins a construction project that will: 1) divert, obstruct, or change the natural flow or the bed, channel, or bank of any river, stream, or lake; 2) use materials from a streambed; or 3) result in the disposal or deposition of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into any river, stream, or lake, it must first notify the CDFG of the proposed project. If the CDFG determines that the project may adversely affect existing fish and wildlife resources, a Lake or Streambed Alteration Agreement is required.

As discussed above, this report does not analyze the habitat and wildlife impacts associated with physical alterations to waters of the United States proposed in conjunction with NRSP projects, such as dredge, fill, or bed, bank or channel improvements or stabilization measures affecting waters of the U.S. The impacts associated with these physical alterations are analyzed in detail in the biota and floodplain modification sections of the RMDP and the related EIR/EIS. As discussed in Section 4.4.2 below, this report analyzes the adverse impacts to natural drainage systems that may be caused by the project's alteration of hydrologic conditions.

4. POLLUTANTS OF CONCERN AND SIGNIFICANCE CRITERIA

4.1. Surface Water Pollutants of Concern

4.1.1. Pollutants of Concern

Pollutants of concern, as defined in the Los Angeles County SUSMP Manual, consist of any pollutants that exhibit one or more of the following characteristics: current loadings or historic deposits of the pollutant are impacting the beneficial uses of a receiving water, elevated levels of the pollutant are found in sediments of a receiving water and/or have the potential to bioaccumulate in organisms therein, or the detectable inputs of the pollutant are at concentrations or loads considered potentially toxic to humans and/or flora and fauna. The pollutants of concern for the water quality analysis are those that are anticipated or potentially could be generated by the project at concentrations, based on water quality data collected in Los Angeles County from land uses that are the same as those included in the NRSP, that exhibit these characteristics. Identification of the pollutants of concern also considered Basin Plan beneficial uses and water quality objectives, CTR criteria, and current 303(d) listings and TMDLs in the Santa Clara River, as well as pollutants that have the potential to cause toxicity or bioaccumulate in the receiving waters. Appendix A lists the pollutants of concern, the basis for their selection, and the significance criteria that will be applied for each.

The following pollutants were chosen as pollutants of concern for purposes of evaluating water based upon the above considerations:

***Sediments (TSS and Turbidity)*:** Excessive erosion, transport, and deposition of sediment in surface waters are a significant form of pollution resulting in major water quality problems. Sediment imbalances impair waters' designated uses. Excessive sediment can impair aquatic life by filling interstitial spaces of spawning gravels, impairing fish food sources, filling rearing pools, and reducing beneficial habitat structure in stream channels. In addition, excessive sediment can cause taste and odor problems in drinking water supplies and block water intake structures.

***Nutrients (Phosphorus and Nitrogen (Nitrate+Nitrite-N and Ammonia-N))*:** Nutrients of concern include inorganic forms of nitrogen (nitrate, nitrite and ammonia) and phosphorus. Organic forms of nitrogen are associated with vegetative matter such as particulates from sticks and leaves. Inorganic forms of nitrogen include nitrate, nitrite and ammonia. Total Nitrogen (TN) is a measure of all nitrogen present, including inorganic and particulate forms. Phosphorus can be measured as total phosphorus (TP) or as dissolved phosphorus. Dissolved phosphorus is the more bioavailable form of phosphorus. TP is often composed mostly of soil-related particulate phosphorus. There are several sources of nutrients in urban areas, mainly fertilizers in runoff from lawns, pet wastes, failing septic systems, atmospheric deposition from industry and automobile emissions, and soil erosion. Nutrient over-enrichment is especially prevalent in agricultural areas where manure and fertilizer inputs to crops significantly contribute to nitrogen and phosphorus levels in streams and other receiving waters. Eutrophication due to excessive nutrient input can lead to changes in algae, benthic, and fish communities; extreme eutrophication can cause hypoxia or anoxia, resulting in fish kills. Surface algal scum, water discoloration, and the release of toxins from sediment can also occur.

Various downstream reaches of the Santa Clara River are identified as impaired by ammonia and nitrate- plus nitrite-nitrogen. Evidence of impairment includes low diversity of benthic macroinvertebrates and observations of excessive algae growth. A source analysis found that the majority of ammonia and nitrate/nitrite loads are from point sources; primarily water reclamation plants (WRPs) (LARWQCB, 2003). Sources from municipal storm sewers are considered a minor source, but have a potential to cause significant local effects on water quality (LARWQCB, 2003). TMDLs have been developed and adopted into the Basin Plan for nitrogen compounds, including nitrate/nitrite and ammonia.

***Trace Metals (Aluminum, Copper, Lead, and Zinc)*:** The primary sources of trace metals in stormwater are typically commercially available metals used in transportation (e.g. automobiles), buildings, and infrastructure. Metals are also found in fuels, adhesives, paints, and other coatings. Copper, lead, and zinc are the most prevalent metals typically found in urban runoff. Other trace metals, such as cadmium, chromium, and mercury, are typically either not detected in urban runoff or are detected at very low levels (LACDPW, 2000). Metals are of concern because of the potential for toxic effects on aquatic life and the potential for groundwater contamination. High metal concentrations can lead to bioaccumulation in fish and shellfish and affect the beneficial uses of receiving waters.

Aluminum has been identified by the Los Angeles County Department of Public Works as a constituent of concern for the Santa Clara River based on monitoring conducted at mass emission Station S29 (see Section 2.3 above). In stormwater, the majority of aluminum is in the particulate phase. Its presence in stormwater is mainly due to aluminosilicate minerals found in soils, because stormwater particles are largely composed of eroded soils. Aluminum is a large component of soils and is the third most common element in the earth’s crust. The average aluminum soil content is about eight percent (or 80,000 mg/kg) and suspended sediments in rivers have total aluminum contents of a similar order of magnitude. Aluminosilicates include a wide range of minerals with varying properties; some are formed during the laying down of the earth’s crust and some by weathering processes. They are highly insoluble and unreactive, although aluminum can be extracted and solubilized to some degree under acidic conditions. The amount of aluminum extracted will mainly depend on the type and particle size of aluminosilicates present in the soil matrix. A study by Kobayashi and Kizu (2001) showed that only eight percent of aluminum remained in waters after passing through a 0.22 micron filter, supporting the assertion that the majority of aluminum is found in the insoluble, suspended fraction. According to the USEPA, aluminum is not considered a contaminant of potential concern to fish or aquatic organisms when surrounding soil pH is greater than 5.5 or when in solution of a pH above 5.5 (USEPA 2003) because aluminum solubility and resultant toxicity has been linked to pH values below this standard. In general, NRSP area soils are not expected to have a pH of less than 5.5. DeClerk and Singer (2003) compared historic (1945) pH levels of agricultural soils in Southern California to 2001 conditions and found that pH levels have actually risen, from approximately 7.2 in 1945 to nearly 8.0 in 2001. As the majority of the pre-development land use consists of agriculture or open space, it is safe to assume that soil pH levels within the NRSP area will be, for the most part, above 5.5. In addition, pH in stormwater runoff is not expected to be below 5.5, as mean runoff concentrations in the Los Angeles County stormwater monitoring data ranged from 6.5 for mixed and single-family residential land uses to 7.0 for commercial land uses. In urban areas, aluminum building materials are a minor source of aluminum, as the metal is coated in unreactive aluminum oxide.

***Pathogens (Bacteria, Viruses, and Protozoa)* –** Elevated pathogens are typically caused by the transport of domestic animal, wildlife, or human fecal wastes from the watershed. Runoff that flows over land such as urban runoff can mobilize pathogens, including bacteria and viruses. Even runoff from natural areas can contain pathogens (e.g., from wildlife). Other sources of pathogens in urban areas include pets, septic systems and leaky sanitary sewer pipes. The presence of pathogens in runoff can impair receiving waters and contaminate drinking water sources. Elevated pathogens are typically caused by the transport of animal or human fecal wastes from the watershed. Historically an indicator organism such as fecal coliform has been used for pathogens due to the difficulty of monitoring for pathogens directly. More recently, the scientific community has questioned the use of indicator organisms, as scientific studies have shown no correlation between indictor and pathogen levels and therefore total and fecal coliform may not indicate a significant potential for causing human illness (Paulsen and List, 2005). Santa Clara River Reach 5 is identified as impaired by high fecal coliform counts from point and nonpoint sources. Coliform TMDLs have not yet been developed for this river reach.

***Petroleum Hydrocarbons (Oil and Grease and PAHs)*:** The sources of oil, grease, and other petroleum hydrocarbons in urban areas include spillage fuels and lubricants, discharge of domestic and industrial wastes, atmospheric deposition, and runoff. Runoff can be contaminated by leachate from asphalt roads, wearing of tires, and deposition from automobile exhaust. Also, do-it-yourself auto mechanics may dump used oil and other automobile-related fluids directly into storm drains. Petroleum hydrocarbons, such as polycyclic aromatic hydrocarbons (PAHs), can bioaccumulate in aquatic organisms from contaminated water, sediments, and food and are toxic to aquatic life at low concentrations. Hydrocarbons can persist in sediments for long periods of time and result in adverse impacts on the diversity and abundance of benthic communities. Hydrocarbons can be measured as total petroleum hydrocarbons (TPH), oil and grease, or as individual groups of hydrocarbons, such as PAHs.

***Pesticides*:** Pesticides (including herbicides, insecticides and fungicides) are chemical compounds commonly used to control insects, rodents, plant diseases, and weeds. Excessive application of a pesticide in connection with agriculture cultivation or landscaping may result in runoff containing toxic levels of its active component. Pesticides may be classified as organochlorine pesticides or organophosphorus pesticides, the former being associated with persistent bioaccumulative pesticides (e.g., DDT and other legacy pesticides) which have been banned. The Santa Clara River estuary is listed as impaired for legacy pesticides. Organophosphorus pesticides include diazinon and chlorpyrifos whose uses also are being restricted by USEPA.

***Trash & Debris*:** Trash (such as paper, plastic, polystyrene packing foam, and aluminum materials) and biodegradable organic debris (such as leaves, grass cuttings, and food waste) are general waste products on the landscape that can be entrained in urban runoff. The presence of trash & debris may have a significant impact on the recreational value of a water body and aquatic habitat. Excess organic matter can create a high biochemical oxygen demand in a water body and thereby lower its water quality. Also, in areas where stagnant water exists, the presence of excess organic matter can promote septic conditions resulting in the growth of undesirable organisms and the release of odorous and hazardous compounds such as hydrogen sulfide.

***Bioaccumulation*:** Certain pollutants, such as pesticides, selenium and mercury, have a tendency to bioaccumulate. The Basin Plan and the CTR criteria set forth toxicity objectives for receiving water levels of substances that bioaccumulate in aquatic resources to prohibit concentrations of toxic substances that are harmful to human health and adversely affect beneficial uses.

***Chloride*:** High levels of chloride in Santa Clara River Reaches 3, 5 and 6 are causing impairment of listed beneficial uses for agricultural irrigation. Irrigation of salt sensitive crops, such as avocados and strawberries, with water containing elevated levels of chloride can result in reduced crop yields. Chloride levels in some areas exceed water quality standards associated with groundwater recharge. Chloride TMDLs have been developed and adopted into the Basin Plan. The major sources of elevated chloride are dry weather discharges from WRPs, contributing about 70% of the chloride load. Minor point sources are dewatering operations, and swimming pool and water ride discharges.

Methylene Blue Activated Substances (MBAS). MBAS are related to the presence of detergents in water. Positive results may indicate the presence of wastewater or be associated with urban runoff due to commercial and/or residential vehicle washing or other outdoor washing activities. Surfactants disturb the surface tension which negatively affects insects and can also harm the gills in aquatic life.

Cyanide. Cyanide has been identified by the Los Angeles County Department of Public Works as a constituent of concern for the Santa Clara River based on monitoring conducted at mass emission Station S29 (LACDPW, 2005). Cyanide is used in electroplating, metallurgy, and mining. It is also used to make synthetic fibers, plastics, dyes, pharmaceuticals, and pesticides, including fumigants. In addition, cyanide serves as a chemical intermediate in various production processes. Natural cyanides are produced by certain bacteria, fungi, and algae, and they are present in a number of plants and foods as cyanogenic glycosides. Man-made cyanides typically enter the environment from metal finishing and organic chemical industries. Other sources include iron and steel works, municipal waste burning, cyanide-containing pesticides, road deicers, and vehicle exhaust.

4.1.2. Other Constituents

This section discusses other constituents that are listed in the Basin Plan, but for reasons explained below, are not pollutants of concern for the NRSP subregion.

BOD (Biochemical Oxygen Demand) and Dissolved Oxygen. Adequate levels of dissolved oxygen are necessary to support aquatic life. High levels of oxygen demanding substances discharged to receiving waters can depress oxygen levels to levels of concern. Oxygen demanding substances are compounds that can be biologically degraded through aerobic processes. The presence of oxygen demanding substances can deplete oxygen supplies in waters and can contribute to algal growth. Nutrients in fertilizers and food wastes in trash are examples of likely oxygen demanding compounds to be present on the NRSP subregion site. Other biodegradable organic materials include human and animal waste and vegetative matter. Biodegradable pollutants are largely subsumed by the nutrients and trash and debris categories above, and therefore will not be discussed as a separate category.

Chemical Constituents. Chemical constituents in excessive amounts in drinking water are harmful to human health. The Basin Plan objective for chemical constituents states: "Surface waters shall not contain concentrations of chemical constituents in amounts that adversely affect any designated beneficial use." As Santa Clara River Reach 5 is not designated with a municipal water supply designated use (see Section 2.2.4 above), chemical constituents are not a pollutant of concern for the NRSP subregion.

Temperature. Increase in temperature can result in lower dissolved oxygen levels, impairing habitat and other beneficial uses of receiving waters. Discharges of wastewater can also cause unnatural and/or rapid changes in temperature of receiving waters, which can adversely affect aquatic life. Elevated temperatures are typically associated with discharges of process wastewaters or non-contact cooling waters. As the beneficial uses in the receiving waters for the NRSP subregion include warm freshwater habitat to support warm water ecosystems, temperatures of stormwater runoff in the NRSP subregion are not of concern.

Total Residual Chlorine. Total residual chlorine can be present in wastewater treatment plant discharges, or may be present in dry weather urban runoff from the emptying of swimming pools that have not been de-chlorinated. Chlorine is a strong oxidant and is therefore very toxic to aquatic life. Municipal pools and private pools in areas served by a municipal sanitary system are required to be discharged into the sanitary system, and therefore, total residual chlorine will not be present in runoff from the NRSP projects.

Color, Taste, and Odor. The Basin Plan contains narrative objectives for color, taste, or odor that causes a nuisance or adversely affects beneficial uses. Undesirable tastes and odors in water may be a nuisance and may indicate the presence of a pollutant(s). Odor associated with water can result from decomposition of organic matter or the reduction of inorganic compounds, such as sulfate. Other potential sources of odor causing substances, such as heavy industrial processes, will not occur as part of the NRSP projects. Color in water may arise naturally, such as from minerals, plant matter, or algae, or may be caused by industrial pollutants. Project land uses will include business park uses such as light manufacturing, warehousing and distribution, not heavy industrial land uses. Therefore, color-, taste-, or odor-producing substances are not pollutants of concern for the NRSP projects.

Exotic Vegetation. Non-native (exotic) vegetation typically provides little habitat value and can out compete native vegetation that is more suitable habitat for aquatic and terrestrial organisms. The Basin Plan objective for exotic vegetation states: "Exotic vegetation shall not be introduced around stream courses to the extent that such growth causes nuisance or adversely affects designated beneficial uses." The removal of non-native plant species from natural drainages is addressed in the RMDP.

Mineral Quality: TDS, Sulfate, Boron, and SAR. Mineral quality in natural waters is largely determined by the mineral assemblage of soils and rocks near the land surface. Elevated mineral concentrations could impact beneficial uses; however, the minerals listed in the Basin Plan, except chloride and nitrogen, are not believed to be constituents of concern due to the absence of river impairments and/or, as with TDS, anticipated post-development runoff concentrations well below the Basin Plan objectives (Table 4-1). Therefore, these constituents are not considered pollutants of concern for the NRSP projects.

Table 4-1: Comparison of Mineral Basin Plan Objectives with Mean Measured Values in LA County

Mineral	Los Angeles Basin Plan Water Quality Objective for SCR Reach 5 (mg/L)	Range of Mean Concentration in Urban Runoff[1] (mg/L)
Total Dissolved Solids	1000	53 - 226
Sulfate	400	7 - 35
Boron	1.5	0.16 – 0.25
Sodium Absorption Ratio[2]	10	0.4 – 1.9

[1]Source: LACDPW, 2000. Land uses include SFR, MFR, commercial, education, transportation, light industrial, and mixed residential.
[2]Sodium adsorption ratio (SAR) predicts the degree to which irrigation water tends to enter into cation-exchange reactions in soil.

pH. The hydrogen ion activity of water (pH) is measured on a logarithmic scale, ranging from 0 to 14. While the pH of "pure" water at 25 ºC is 7.0, the pH of natural waters is usually slightly basic due to the solubility of carbon dioxide from the atmosphere. Aquatic organisms can be highly sensitive to pH. The Basin Plan objective for pH is:

> "the pH of inland surface waters shall not be depressed below 6.5 or raised above 8.5 as a result of waste discharges. Ambient pH levels shall not be changed more than 0.5 units from natural conditions as a result of waste discharge."

Mean runoff concentrations in the Los Angeles County stormwater monitoring data ranged from 6.5 for mixed- and single-family residential land uses to 7.0 for commercial land use. Therefore, pH in the Santa Clara River is not expected to be affected by runoff discharges from the NRSP projects.

PCBs. PCBs are highly toxic persistent chemicals that have been historically released into the environment from industrial uses, such as transformers, but are no longer produced in the United States. Due to their persistence, PCBs can still be detected in urban runoff due to historic industrial sources of these chemicals. The NRSP subregion area did not historically include PCB-producing land uses. Therefore, PCBs are not a pollutant of concern for the NRSP projects.

Radioactive Substances. Radioactive substances typically occur at very low concentrations in natural waters. Some activities such as mining or certain industrial activities (e.g., energy production, fuel reprocessing) can increase the amount of radioactive substances impairing beneficial uses. The NRSP projects will not have industrial or other activities that would be a source of any radioactive substances, and development will stabilize any naturally radioactive soils, though unlikely to be present in the NRSP subregion. Therefore, radioactive substances are not a pollutant of concern for the NRSP projects.

Toxicity. Certain pollutants in stormwater runoff have the potential to be highly toxic to aquatic organisms resulting in effects such as impaired reproduction or mortality. The Basin Plan water quality objective for toxicity is:

> "All surface waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life."

Toxicity in urban runoff could be caused by ammonia, trace metals, PAHs, or pesticides. These constituents are subsumed by the pollutant of concern categories above.

4.2. <u>Groundwater Pollutants of Concern</u>

The NRSP projects will allow for incidental infiltration of urban runoff to groundwater after receiving treatment in the PDFs, as well as incidental infiltration of irrigation water. Research conducted on the effects on groundwater from stormwater infiltration by Pitt *et. al.* (1994) indicate that the potential for contamination is dependent on a number of factors including the local hydrogeology and the chemical characteristics of the pollutants of concern.

Chemical characteristics that influence the potential for groundwater impacts include high mobility (low absorption potential), high solubility fractions, and abundance in runoff, including dry weather flows. As a class of constituents, trace metals tend to adsorb onto soil particles and are filtered out by the soils. This has been confirmed by extensive data collected beneath stormwater detention/retention ponds in Fresno (conducted as part of the Nationwide Urban Runoff Program (Brown & Caldwell, 1984)) that showed that trace metals tended to be adsorbed in the upper few feet in the bottom sediments. Bacteria are also filtered out by soils. More mobile constituents such as chloride and nitrate would have a greater potential for infiltration.

4.2.1. Pollutants of Concern

The pollutants of concern for the groundwater quality analysis are those that are anticipated or potentially could be generated by the NRSP projects at concentrations, based on water quality data collected in Los Angeles County from land uses that are the same as those included in the NRSP that exhibit these characteristics. Identification of the pollutants of concern for the NRSP projects considered proposed land uses as well as pollutants that have the potential to impair beneficial uses of the groundwaters below the NRSP subregion. The Los Angeles Basin Plan contains numerical objectives for bacteria, mineral quality, nitrogen, and various toxic chemical compounds, and contains qualitative objectives for taste and odor.

Nitrate+nitrite-N was chosen as the pollutant of concern for purposes of evaluating groundwater quality impacts based upon the above considerations. High nitrate levels in drinking water can cause health problems in humans. Infants can develop methemoglobinemia (blue-baby syndrome). Human activities and land use practices can influence nitrogen concentrations in groundwaters. For example, irrigation water containing fertilizers can increase levels of nitrogen in groundwater.

4.2.2. Other Constituents

Bacteria: The Basin Plan contains numeric criteria for bacteria in drinking water sources. As bacteria are removed through straining in soils (for example, as with septic tank discharges), incidental infiltration of runoff in the treatment PDFs is not expected to affect bacteria levels in groundwater. The WRP will include a disinfection process to reduce bacteria below levels of concern, and therefore bacteria in irrigation water are not expected to impact groundwater.

Chemical Constituents and Radioactivity: Drinking water limits for inorganic and organic chemicals that can be toxic to human health in excessive amounts and radionuclides are contained in Title 22 of the California Code of Regulations. These chemicals and radionuclides are not expected to occur in the NRSP project's runoff. Title 22 specifies California's Wastewater Reclamation Criteria (WRC) and the NRSP WRP's reclaimed water must meet or exceed these criteria. These criteria apply to the treatment processes; treatment performance standards, such as removal efficiencies and effluent water quality; process monitoring programs, including type and frequency of monitoring; facility operation plans; and necessary reliability features.

Taste and Odor. The Basin Plan contains a narrative objective for taste and odor that cause a nuisance or adversely affect beneficial uses. Undesirable tastes and odors in groundwater may be a nuisance and may indicate the presence of a pollutant(s). Odor associated with water can result from natural processes, such as the decomposition of organic matter or the reduction of inorganic compounds, such as sulfate. Other potential sources of odor causing substances, such as industrial processes, will not occur as part of the Project. Therefore, taste and odor-producing substances are not pollutants of concern for the NRSP projects.

Mineral Quality: TDS, Sulfate, Chloride, and Boron. Mineral quality in groundwaters is largely influenced by the mineral assemblage of soils and rocks that it comes into contact with. Elevated mineral concentrations could impact beneficial uses; however, the minerals listed in the Basin Plan are not believed to be pollutants of concern due to the anticipated runoff concentrations and the expected mineral concentrations in Newhall Ranch WRP irrigation water, which are below the Basin Plan groundwater objectives (Table 4-2).

As required by the CWA, the Newhall Ranch WRP discharge permit includes effluent limitations that are protective of receiving water quality and designated beneficial uses (LARWQCB, 2007). Effluent limits in the WDR were developed based on the most stringent of applicable technology-based and water quality-based standards, including Basin Plan surface and groundwater objectives, CTR criteria, and applicable TMDL waste load allocations. Therefore, these constituents are not considered pollutants of concern for the Project.

Table 4-2: Comparison of Basin Plan Mineral Groundwater Objectives with Mean Measured Values in LA County Urban Runoff and Anticipated Irrigation Water Quality

Mineral	Los Angeles Basin Plan Groundwater Quality Objective[1] (mg/L)	Range of Mean Concentrations in Urban Runoff[2] (mg/L)	Anticipated Average Concentration in Effluent from the NRSP WRP[3](mg/L)
Total Dissolved Solids	1,000	53 – 237	790
Sulfate	350	7 – 35	165
Chloride	150	4 – 50	<100
Boron	1.0	0.2 – 0.3	0.69

[1]Eastern Santa Clara-Castaic Valley
[2]Source: LACDPW, 2000. Includes all monitored land uses.
[3]Source: CH2M Hill, 2007.

4.3. <u>Hydrologic Conditions of Concern (Hydromodification)</u>

Urbanization modifies natural watershed and stream hydrologic and geomorphic processes by introducing increased volumes and duration of flow via increased runoff from impervious surfaces and drainage infrastructure. Several studies have evaluated affects of increased runoff associated with the introduction of impervious surfaces and drainage facilities on geomorphic processes (SCCWRP, 2005a; Geosyntec, 2002; Bledsoe & Watson, 2001; Booth, 1990; Hollis, 1975; Hammer, 1972). Potential changes to the hydrologic regime may include increases in runoff volumes, frequency of runoff events, long-term cumulative duration, as well as increased peak flows. Urbanization may also introduce dry weather flows where only wet weather flows existed prior to development. These changes are referred to as "hydromodification."

Hydromodification intensifies sediment transport and often leads to stream channel enlargement and loss of habitat and associated riparian species (SCCWRP, 2005a; Geosyntec, 2002; Bledsoe & Watson, 2001; MacRae, 1992; Booth, 1990). Under certain circumstances, development can also cause a reduction in the amount of sediment supplied to the stream system, which can lead to stream channel incision and widening. These changes also have the potential to impact downstream channels and habitat integrity. A project that increases runoff due to impervious surfaces and traps sediment from upland watershed sources creates compounding effects.

A change to the project site's hydrologic regime would be considered a condition of concern if the change could have a significant impact on downstream natural channels and habitat integrity, alone or in conjunction with impacts of other projects.

4.4. <u>Significance Criteria and Thresholds for Significance</u>

4.4.1. Surface Water Quality Significance Thresholds

Appendix A provides the criteria for evaluating the significance of a potential impact for each pollutant of concern. These criteria and the thresholds for significance can be summarized as follows. The application of the criteria to a decision regarding significance requires an integrated or "weight of evidence" approach, rather than a decision based on any one of the individual criterion.

Thresholds of significance for surface water quality impacts have been developed based on a review of the MS4 Permit and the CEQA Guidelines, Appendix G. Significant adverse water quality impacts are presumed to occur if the proposed project would:

- Create sizeable additional sources of polluted runoff to receiving waters that would result in exceedances of receiving water quality or substantially degrade water quality in receiving waters.

- Create sizeable additional sources of polluted runoff that would violate any water quality standards or waste discharge requirements for surface water runoff.

- Create sizeable additional sources of polluted construction site runoff (including polluted discharges associated with construction activities such as materials delivery, staging or storage, vehicle or equipment fueling, vehicle or equipment maintenance, waste handling, or hazardous materials handling or storage) that would violate any water quality standards or waste discharge requirements for surface water runoff or groundwater discharge.

This report analyzes whether sizeable additional sources of polluted runoff may result from the project based on the results of water quality modeling and qualitative assessments that take into account water quality controls or BMPs that are considered Project Design Features (PDFs). Any increases in pollutant concentrations or loads in runoff resulting from the development of the project site are considered an indication of a potentially significant adverse water quality impact. If loads and concentrations resulting from development are predicted to stay the same or to be reduced when compared with existing conditions, it is concluded that the project will not cause a significant adverse impact to the ambient water quality of the receiving waters for that pollutant.

If pollutant loads or concentrations are expected to increase, then for both the post-development and construction phases, potential impacts are assessed by evaluating compliance of the project, including PDFs, with applicable regulatory requirements of the MS4 Permit, including SQMP and SUSMP requirements, the Construction General Permit, and the General Dewatering Permit. Further, post-development increases in pollutant loads and concentrations are evaluated by comparing the magnitude of the increase to relevant benchmarks, including receiving water TMDLs and receiving water quality objectives and criteria from the Basin Plan and CTR, as described below.

Receiving Water Benchmarks. Comparison of post-development water quality concentrations in the runoff discharge with benchmark TMDL waste load or load allocations for MS4 discharges establishes the likelihood that runoff would result in TMDL exceedances in receiving waters or would otherwise degrade receiving water quality.

Comparison of post-development water quality concentrations in the runoff discharge with benchmark numeric and narrative receiving water quality criteria as provided in the Basin Plan and the CTR facilitates analysis of the potential for runoff to result in exceedances of receiving water quality standards, adversely affect beneficial uses, or otherwise degrade receiving waters.

Water quality criteria are considered benchmarks for comparison purposes only, as such criteria apply within receiving waters as opposed to applying directly to runoff discharges. Narrative and numeric water quality objectives contained in the Basin Plan apply to the project's receiving waters. Water quality criteria contained in the CTR provide concentrations that are not to be exceeded in receiving waters more than once in a three year period for those waters designated with aquatic life or human health related uses. Projections of runoff water quality are compared to the acute form of the CTR criteria (as discussed above), as stormwater runoff is associated with episodic events of limited duration, whereas chronic criteria apply to 4-day exposures which do not describe typical storm events in the NRSP subregion, which last 11 hours on average. If pollutant levels in runoff are not predicted to exceed receiving water benchmarks, it is one indication that no significant impacts will result from project development.

As there is no water quality objective or criteria for total aluminum in the Basin Plan or the CTR, the national water quality criteria recommended by the USEPA will be used for comparison (USEPA, 1988).

MS4 Permit Requirements for New Development (SUSMP). Satisfaction of MS4 Permit requirements for new development, including SUSMP requirements and SQMP requirements, and satisfaction of construction-related requirements of the Construction General Permit and General Dewatering Permit establish compliance with water quality regulatory requirements applicable to stormwater runoff.

The MS4 Permit requires that the SQMP specify BMPs that will be implemented to reduce the discharge of pollutants in stormwater to the Maximum Extent Practicable. MS4 requirements are met when new development complies with the SUSMP requirements set forth in the MS4 Permit. Under the SUSMP requirements, the effectiveness of stormwater treatment controls are primarily based on two factors - the amount of runoff that is captured by the controls and the selection of BMPs to address identified pollutants of concern. Selection and numerical sizing criteria for new development treatment controls are included in the MS4 Permit and the County SUSMP Manuals. If the project PDFs meet these criteria, and other source control and site design BMPs consistent with the SUSMP requirements are implemented, it indicates that no significant impacts will occur as the result of insufficient capacity for stormwater treatment.

Construction General Permit and General Dewatering Permit. The Construction General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP) that describes erosion and sediment control BMPs as well as material management/ non-stormwater BMPs that will be used during the construction phase of development. The General Dewatering Permit addresses discharges from permanent or temporary dewatering operations associated with construction and development and includes provisions mandating notification, sampling and analysis, and reporting of dewatering and testing-related discharges. To evaluate significance of construction phase project water quality impacts, we evaluate whether water quality control is achieved by implementation of BMPs consistent with Best Available Technology Economically Achievable and Best Conventional Pollutant Control Technology (BAT/BCT), as required by the Construction General Permit and the General Dewatering Permit.

4.4.2. Significance Thresholds for Hydrologic Conditions of Concern (Hydromodification Impacts)

Thresholds of significance for evaluating hydrologic impacts and conditions of concern have been developed based on a review of the MS4 Permit and the CEQA Guidelines, Appendix G. Significant adverse impacts to natural drainage systems created by altered hydrologic conditions of concern are presumed to occur if the proposed project would:

- Substantially alter the existing drainage pattern of a natural drainage, stream, or river causing substantial erosion, siltation, or channel instability in a manner that substantially adversely affects beneficial uses; or

- Substantially increase the rates, velocities, frequencies, duration and/or seasonality of flows causing channel instability and harming sensitive habitats or species in natural drainages in a manner that substantially adversely affects beneficial uses.

4.4.3. Cumulative Impacts

CEQA requires the analysis of cumulative impacts of a project when the project's incremental effects may be significant when assessed along with the effects of past projects and the effects of other current projects, and the reasonably foreseeable effects of probable future projects. The discussion of cumulative impacts must reflect the potential severity of the impacts and their likelihood of occurrence, but the discussion and analysis need not provide as great a detail as is provided for the direct effects attributable to the project alone. This report therefore analyzes the potential for cumulative water quality impacts, cumulative groundwater quality impacts, and cumulative hydrologic impacts generally in accordance with the thresholds for direct impacts discussed in Sections 4.4.1 and 4.4.2 above, and Section 4.4.4 below. See Sections 7.7, 7.8 and 7.9 below.

The cumulative analysis of all surface water quality and hydrologic impacts in this report is based primarily on "adopted plans and projections" found in the Los Angeles County Department of Public Works adopted and approved Hydrology Manual, which have been verified by reference to approved plans, including the City of Santa Clarita and County of Los Angeles adopted General Plans, as well as available empirical data for the Santa Clara River. As required by CEQA, the focus of the cumulative impacts analysis for this project will be on the project's incremental contribution to significant adverse water quality and hydrologic impacts to the SCR, taking into account the reasonably foreseeable water quality and hydrologic impacts of other projects that may develop impervious surfaces and urban land uses within the SCR watershed in accordance with adopted general plans and related projections. The cumulative impacts analysis will consider the project's incremental contribution to significant cumulative water quality and hydrologic impacts to the SCR in light of the water quality and hydrology impact mitigation achieved by certain of the PDFs. The analysis will also consider whether the project, including PDFs, and future projects, including the Newhall Ranch WRP, will comply with specific requirements in a previously approved ordinance, plan or mitigation program (such as the Basin Plan, the CTR, the MS4 Permit, the Construction General Permit, the General Dewatering Permit, and WRP regulations and permit conditions) that have been adopted for the purpose of avoiding or substantially lessening the cumulative water quality and hydrologic impact problems within the geographic area in which the project is located.

4.4.4. Groundwater Quality Impacts

Thresholds of significance for evaluating the hydrologic and water quality impacts of the NRSP projects on groundwater have been developed based on CEQA Appendix G thresholds. Significant adverse impacts to groundwater are presumed to occur if the proposed project would:

- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge so as to cause a net deficit in aquifer volume or a lowering of the local groundwater table.

- Through changes in surface water runoff quality and quantity (including project treatment PDFs), and changes in groundwater recharge, result in a violation of any groundwater quality standards or waste discharge requirements or otherwise substantially degrade water quality.

Groundwater quality is addressed in Sections 7.8.1 and 7.8.2. Groundwater quality benchmarks were compared with post-development runoff water quality to establish the likelihood that runoff would result in a degradation of groundwater quality. Groundwater recharge is addressed in Section 7.8.3. The hydrologic effects of the NRSP projects on groundwater were examined by comparison of historical and present levels of the underlying aquifer to determine the impact of development on aquifer volume.

5. POST DEVELOPMENT SURFACE WATER QUALITY AND HYDROMODIFICATION CONTROL PROJECT DESIGN FEATURES

Project Design Features (PDFs) for surface water quality and hydrologic impacts include site design, source control, treatment control, and hydromodification control BMPs that will be incorporated into the NRSP projects and are considered a part of the projects for impact analysis. Effective management of wet and dry weather runoff water quality begins with limiting increases in runoff pollutants and flows at the source. Site design and source control BMPs are practices designed to minimize surface runoff and the introduction of pollutants into runoff. Treatment control BMPs are designed to remove pollutants once they have been mobilized by rainfall and runoff. Hydromodification control BMPs are designed to control increases in post-development runoff flows and/or volumes. This section describes the post-development site design, source control, treatment control, and hydromodification control PDFs for the NRSP projects.

5.1. SUSMP Requirements and Project Design Features

Table 5-1 summarizes the SUSMP requirements and the corresponding proposed PDFs that will be incorporated into the NRSP projects.

Table 5-1: SUSMP Requirements and Corresponding Newhall Ranch Project Design Features

SUSMP Requirement	Criteria/ Description	Corresponding Newhall Ranch PDFs
1. Runoff Flow Control	• Control post-development peak stormwater runoff discharge rates, velocities, and duration in Natural Drainage Systems to prevent accelerated downstream erosion and to protect habitat related beneficial uses.[5] • All post-development runoff from a 2-year, 24-hour storm shall not exceed the predevelopment peak flow rate, burned, from a 2-year, 24-hour storm when the predevelopment peak flow rate equals or exceeds 5 cfs. Discharge flow rates shall be calculated using the County of Los Angeles Modified Rational Method. • Post-development runoff from the 50-year capital storm shall not exceed the predevelopment peak	• Hydromodification source controls include minimizing impervious surfaces through clustering development and using bioretention, extended detention, and other vegetated treatment control BMPs to disconnect impervious surfaces and reduce runoff volumes through evapotranspiration and infiltration. • Extended detention basins can provide hydromodification control as well as water quality treatment. • In-stream stabilization techniques will be employed in the tributaries that will receive post development NRSP project runoff to prevent accelerated erosion and to protect habitat related beneficial uses, per the Newhall Ranch RMDP. • The NRSP projects will be conditioned to require, as a design feature, sizing and design of hydraulic features as necessary to control hydromodification impacts in accordance with

[5] This requirement is from Part 4, § D.1 of the MS4 Permit.

SUSMP Requirement	Criteria/ Description	Corresponding Newhall Ranch PDFs
	flow rate, burned and bulked, from the 50-year capital storm. • Control peak flow discharge to provide stream channel and over bank flood protection, based on flow design criteria selected by the local agency.	this NSRP Sub-Regional SWMP. • 50-year capital storm peak flow rate analysis is contained in the floodplain modification sections of the Newhall Ranch RMDP EIR.
2. Conserve Natural Areas	• Concentrate or cluster development on portions of a site while leaving the remaining land in a natural undisturbed condition • Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection • Maximize trees and other vegetation at each site, planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants • Promote natural vegetation by using parking lot islands and other landscaped areas • Preserve riparian areas and wetlands	• The NRSP clusters development into villages. Approximately 70% (8,335 acres) of the NRSP subregion will remain undeveloped. • Site clearing and grading will be limited as necessary to allow development, allow access, and provide fire protection. • Native and/or non-native/non-invasive vegetation will be utilized within the development. • The final project stormwater system will include the use of the vegetated treatment BMPs, including bioretention placed in common area landscaping in commercial and multi-family residential areas, roadway median strips, and parking lot islands (where applicable), vegetated swales, and extended detention basins. • Riparian buffers will be preserved along the Santa Clara River corridor and tributary drainages by clustering development upland and away from the River and tributary drainages.
3. Minimize Stormwater Pollutants of Concern	• Minimize to the maximum extent practicable, the introduction of pollutants of concern that may result in significant impacts, generated from site runoff of directly connected impervious areas (DCIA), to the stormwater conveyance system as approved by the building official.	• Treatment control BMPs will be selected to address the pollutants of concern for the project (see Section 5.3 below). These BMPs are designed to minimize introduction of pollutants to the Maximum Extent Practicable (MEP). • The NRSP projects will include numerous source controls, including education programs, animal waste bag stations, street sweeping and catch basin cleaning, an Integrated Pest Management (IPM) Program for common area landscaping in multi-family residential areas and commercial areas, use of native and/or non-native/non-invasive vegetation, and installation of a car wash pad in multi-family residential areas. • An education program will be implemented that includes both the education of residents and commercial businesses regarding water quality issues. Topics will include services that could affect water quality, such as carpet cleaners and

SUSMP Requirement	Criteria/ Description	Corresponding Newhall Ranch PDFs
		others that may not properly dispose of cleaning wastes; community car washes; and residential car washing. The education program will emphasize animal waste management, such as the importance of cleaning up after pets and not feeding pigeons, seagulls, ducks, and geese. • Vegetated treatment control BMPs will allow for infiltration of treated stormwater. • Landscape watering in common areas, commercial areas, multiple family residential areas, and in parks will use efficient reclaimed water irrigation technologies with centralized irrigation controls.
4. Protect Slopes and Channels	Project plans must include BMPs consistent with local codes and ordinances and the SUSMP requirements to decrease the potential of slopes and/or channels from eroding and impacting stormwater runoff: • Convey runoff safely from the tops of slopes and stabilize disturbed slopes • Utilize natural drainage systems to the maximum extent practicable • Control or reduce or eliminate flow to natural drainage systems to the maximum extent practicable • Stabilize permanent channel crossings • Vegetate slopes with native or drought tolerant vegetation • Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion with the approval of all agencies with jurisdiction, e.g., the U.S. Army Corps of Engineers and the California Department of Fish and Game.	• The NRSP projects will provide slope stabilization to areas with significant slopes. • Natural slopes and native vegetation on slopes adjacent to the SCR will be preserved and/or, if impacted during construction, they will be restored and enhanced. Native plants will be used in all plant palettes placed on restored slopes. • Project PDFs, including swales, bioretention areas, and water quality basins (hydrologic source controls), will reduce flows to natural channels through infiltration and evapotranspiration. • The banks of the Santa Clara River at portions of this site will be stabilized primarily using buried bank stabilization per the Newhall Ranch RMDP. After the implementation of these measures and other flow control and volume reduction PDFs, the Santa Clara River will be capable of handling the expected flow regime with little or no erosion. • All outlet points to the Santa Clara River and tributaries will include energy dissipaters. • In-stream stabilization techniques will be employed in the tributaries that will receive post development NRSP project runoff to prevent accelerated erosion and to protect habitat related beneficial uses, per the Newhall Ranch RMDP. Geomorphic principles will be used to design stable, naturalistic drainages given the expected hydrologic and sediment regimes.

SUSMP Requirement	Criteria/ Description	Corresponding Newhall Ranch PDFs
5. Provide Storm Drain System Stenciling and Signage	• All storm drain inlets and catch basins within the project area must be stenciled with prohibitive language and/or graphical icons to discourage illegal dumping. • Signs and prohibitive language and/or graphical icons, which prohibit illegal dumping, must be posted at public access points along channels and creeks within the project area. • Legibility of stencils and signs must be maintained.	• All storm drain inlets and water quality inlets will be stenciled or labeled. • Signs will be posted in areas where dumping could occur. • The County, a Landscape or Local Maintenance District (LMD), Home Owners Association (HOA), or other maintenance entity would maintain stencils and signs.
6. Properly Design Outdoor Material Storage Areas	• Where proposed project plans include outdoor areas for storage of materials that may contribute pollutants to the storm water conveyance system measures to mitigate impacts must be included.	• Pesticides, fertilizers, paints, and other hazardous materials used for maintenance of common areas, parks, commercial areas, and multifamily residential common areas will be kept in enclosed storage areas.
7. Properly Design Trash Storage Areas	All trash containers must meet the following structural or treatment control BMP requirements: • Trash container areas must have drainage from adjoining roofs and pavement diverter around the areas. • Trash container areas must be screened or walled to prevent offsite transport of trash.	• All outdoor trash storage areas will be covered and isolated from stormwater runoff.
8. Provide Proof of Ongoing BMP Maintenance	• Applicant required to provide verification of maintenance provisions through such means as may be appropriate, including, but not limited to legal agreements, covenants, and/or Conditional Use Permits.	• Depending on the type and location of the BMP, either the County, a Landscape or Local Maintenance District (LMD), or Home Owners Association (HOA) will be responsible for maintenance. The County will have the right, but not the duty, to inspect and maintain the BMPs that are maintained by the HOA or LMD, at the expense of the HOA or LMD, if they are not being properly maintained. • The Home Owners Associations or commercial/business owners will be responsible for operation and maintenance of site-based BMPs (such as bioretention placed in common area landscaping in multi-family residential areas and commercial areas). • Los Angeles County Department of Public Works will be responsible for maintenance of village-level and sub-regional BMPs (dry extended detention basins).

SUSMP Requirement	Criteria/ Description	Corresponding Newhall Ranch PDFs
9. Design Standards for Structural or Treatment Control BMPs	• Post-construction Structural or Treatment Control BMPs shall be designed to mitigate (infiltrate or treat) stormwater runoff using either volumetric treatment control BMPs or flow-based treatment control BMPs sized per listed criteria (see section 3.6.2 above).	• Stormwater treatment facilities will be designed to meet or exceed the sizing standards in the LA County SUSMP requirements. • Volume-based treatment control BMPs for the NRSP projects will be designed to capture 80 percent or more of the annual runoff volume per criteria 2 of the MS4 Permit. • Flow-based BMPs will be sized using criteria 3, which will provide 80 percent capture of annual runoff volume per criteria of the MS4 Permit. • The size of the facilities will be finalized during the design stage by the Project Engineer with the final hydrology study, which will be prepared and approved to ensure consistency with this analysis prior to issuance of a final grading permit. • Types of treatment control BMPs that will be employed include extended detention basins, bioretention, vegetated swales, cartridge media filtration, and a combination thereof.
10.B.1 Properly Design Loading/ Unloading Dock Areas (100,000 ft^2 Commercial Developments)	• Cover loading dock areas or design drainage to minimize run-on and runoff of stormwater • Direct connections to storm drains from depressed loading docks (truck wells) are prohibited	• Loading dock areas will be covered or designed to preclude run-on and runoff. • Direct connections to storm drains from depressed loading docks (truck wells) will be prohibited. • Below grade loading docks for fresh food items will drain through a Treatment Control BMP applicable to the use, such as a catch basin insert. • Loading docks will be kept in a clean and orderly condition through weekly sweeping and litter control, at a minimum and immediate cleanup of spills and broken containers without the use of water.

SUSMP Requirement	Criteria/ Description	Corresponding Newhall Ranch PDFs
10B.2. Properly Design Repair/ Maintenance Bays (100,000 ft^2 Commercial Developments)	• Repair/ maintenance bays must be indoors or designed in such a way that does not allow stormwater run-on or contact with stormwater runoff. • Design a repair/maintenance bay drainage system to capture all wash water, leaks, and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/ maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.	• Commercial areas will not have repair/maintenance bays or the bays will comply with design requirements.
10B.3. Properly Design Vehicle/ Equipment Wash Areas (100,000 ft^2 Commercial Developments)	• Self-contained and /or covered, equipped with a clarifier, or other pretreatment facility, and properly connected to a sanitary sewer.	• Areas for washing/steam cleaning of vehicles will be self-contained or covered with a roof or overhang; will be equipped with a wash racks and with the prior approval of the sewering agency; will be equipped with a clarifier or other pretreatment facility: and will be properly connected to a sanitary sewer.
10.C. Properly Design Equipment/ Accessory Wash Areas (Restaurants)	• Self-contained, equipped with a grease trap, and properly connected to a sanitary sewer. • If the wash area is to be located outdoors, it must be covered, paved, have secondary containment, and be connected to the sanitary sewer.	• Food preparation areas shall have either contained areas or sinks, each with sanitary sewer connections for disposal of wash waters containing kitchen and food wastes. • If located outside, the containment areas or sinks shall also be structurally covered to prevent entry of storm water. Adequate signs shall be provided and appropriately placed stating the prohibition of discharging washwater to the storm drain system.

SUSMP Requirement	Criteria/ Description	Corresponding Newhall Ranch PDFs
10.D. Properly design fueling area (Retail Gasoline Outlets)	• The fuel dispensing area must be covered with an overhanging roof structure or canopy. The cover's minimum dimensions must be equal to or greater than the area within the grade break. The cover must not drain onto the fuel dispensing area and the downspouts must be routed to prevent drainage across the fueling area. • The fuel dispensing area must be paved with Portland cement concrete (or equivalent smooth impervious surface). The use of asphalt concrete shall be prohibited. • The fuel dispensing areas must have a 2% to 4% slope to prevent ponding, and must be separated from the rest of the site by a grade break that prevents run-on of urban runoff. • At a minimum, the concrete fuel dispensing area must extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meter), whichever is less.	• Retail gasoline outlets will comply with design requirements.
10.E.1. Properly design fueling area (Automotive Repair Shops)	• See requirement 10.D. above.	• Automotive repair shop fueling areas will comply with design requirements.
10.E.2. Properly design repair/maintenance bays (Automotive Repair Shops)	• See requirement 10.B.2 above.	• Automotive repair shop repair/maintenance bays will comply with design requirements.
10.E.3. Properly design vehicle/equipment wash areas (Automotive Repair Shops)	• Self-contained and/or covered, equipped with a clarifier, or other pretreatment facility, and properly connected to a sanitary sewer or to a permitted disposal facility.	• Automotive repair shop vehicle/equipment wash areas will comply with design requirements.
10.E.4. Properly design loading/unloading dock areas (Automotive Repair Shops)	• See requirement 10.B.1. above.	• Automotive repair shop loading/unloading dock areas will comply with design requirements.

SUSMP Requirement	Criteria/ Description	Corresponding Newhall Ranch PDFs
10.F.1. Properly Design Parking Area (Parking Lots)	• Reduce impervious land coverage of parking areas • Infiltrate runoff before it reaches the storm drain system • Treat runoff before it reaches storm drain system	• Commercial and multi-family parking lots will incorporate bioretention facilities located in islands to promote filtration and infiltration of runoff. • Stormwater runoff from parking lots will be directed to treatment control BMPs, including swales, water quality basins, bioretention areas, and/or catch basin media filters in compliance with SUSMP requirements.
10.F.2 Properly Design to Limit Oil Contamination and Perform Maintenance (Parking Lots)	• Treat to remove oil and petroleum hydrocarbons at parking lots that are heavily used. • Ensure adequate operation and maintenance of treatment systems particularly sludge and oil removal	• See above. • Treatment of runoff in detention basins, bioretention areas, or catch basin inserts will be used to address oil and petroleum hydrocarbons from high-use parking lots. • The Home Owners Associations or property owners will be responsible for operation and maintenance of treatment control BMPs that serve private parking lots.
13. Limitation of Use of Infiltration BMPs	• Infiltration is limited based on design of BMP, pollutant characteristics, land use, soil conditions, and traffic. • Appropriate conditions must exist to utilize infiltration to treat and reduce stormwater runoff for the project.	• Per the LARWQCB Clarification Letter (LARWQCB, 2006), generally, the common pollutants in stormwater are filtered or adsorbed by soil, and unlike hydrophobic solvents and salts, do not cause groundwater contamination. In any case, infiltration of 1-2 inches of rainfall in semi-arid areas like Southern California where there is a high rate of evapo-transpiration, presents minimal risks. • The proposed treatment control BMPs are not considered infiltration BMPs; they allow for infiltration of fully-treated runoff only.

5.2. Low Impact/Site Design BMPs

The purpose of low impact/site design BMPs is, to the extent feasible, to mimic the natural hydrologic regime. This low impact/site design philosophy is often referred to as Low Impact Development (LID). The primary goals of low impact/site design BMPs are to maintain a landscape functionally equivalent to predevelopment hydrologic conditions and to minimize the generation of pollutants of concern.

Low impact/site design principles include:

Minimize Impervious Area/Maximize Permeability – Principles include preserving natural open space, reducing impervious surfaces such as roads, using more permeable paving materials, reducing street widths, using minimal disturbance techniques during development to avoid soil compaction, reducing the land coverage of buildings by building taller and narrower footprints, minimizing the use of impervious materials such as decorative concrete in landscape design, and incorporating detention or infiltration into landscape design.

***Minimize Directly Connected Impervious Areas (DCIAs)* –** Minimizing DCIA can be achieved by directing runoff from impervious areas to vegetated areas (e.g., landscaped areas or vegetated treatment control BMPs) or to infiltration BMPs.

***Conserve Natural Areas* –** Conserving and protecting native soils, vegetation, and stream corridors helps to mimic the site's natural hydrologic regime. This may be accomplished by clustering development within portions of the site to conserve as much natural open space as possible, limiting the extent of clearing and grading of native vegetation, planting additional vegetation, using native and/or non-native/non-invasive vegetation in parking lot islands and other landscape areas, and preserving and/or restoring riparian areas and wetlands.

***Select Appropriate Building Materials* –** Use of appropriate building materials reduces the generation and discharge of pollutants of concern in runoff (and is therefore also a source control BMP).

***Protect Slopes and Channels* –** Protecting slopes and channels reduces the potential for erosion and preserves natural sediment supply.

5.2.1. Consideration of Spatial Scale

Low impact/site design implementation for each NRSP project will account for the different spatial scales of development. These spatial scales are listed below, from larger to smaller scale:

- Ranch scale – the Newhall Ranch Specific Plan sub-region;
- Village scale – Landmark Village, Mission Village, Homestead, Potrero Valley, Entrada, and Legacy projects;
- Land use scale – single family residential, multi-family residential, commercial, education, parks, and roadways within each project, and
- Lot or parcel scale – individual lots or parcels within each project.

5.2.2. Newhall Ranch Low Impact/Site Design BMPs

Table 5-2 below lists the low impact/site design BMPs that will be implemented by the NRSP projects at each spatial scale.

Table 5-2: Newhall Land Low Impact/Site Design BMPs

Spatial Scale	Corresponding Low Impact/Site Design BMP
1. Ranch	The NRSP clusters development into villages. Approximately 70% (8,335 acres) of the NRSP subregion will remain undeveloped Open Areas.
	A system of Open Areas will weave through the central portion of the NRSP subregion. The Open Areas include community parks, prominent ridges, bluffs, slopes, creek beds, and utility and trail system easements, and would often function as a transition between development areas. The Open Areas are designed to protect significant landforms and natural resources, and to provide an opportunity to integrate the proposed development within its natural context.
	The NRSP Land Use Plan designates a total of 5,159 acres for the River Corridor and High Country Special Management Areas (SMAs). These SMAs are designed to protect the existing natural resources within Los Angeles County's Significant Ecological Areas SEA 20 and SEA 23.
	The 976-acre River Corridor SMA is designed to protect the sensitive biological resources in SEA 23, which consists of the Santa Clara River corridor. The River Corridor SMA is to be dedicated to the Center for Natural Lands Management (CNLM), and the CNLM will assume responsibility for management of this area.
	The largest land use designation of the NRSP Land Use Plan is the 4,185-acre High Country SMA. The High Country is located in the southern portion of the sub-region and includes oak savannahs, high ridgelines, and various canyon drainages including Salt Creek, a regionally significant wildlife corridor that provides an important habitat link to the Santa Clara River. The High Country is to be dedicated in fee to a Joint Powers Authority (JPA) consisting of representatives from the County of Los Angeles, the City of Santa Clarita, and the Santa Monica Mountains Conservancy.
	To enhance the wildlife corridor movement through the High Country Special Management Area, the 1,517-acre portion of the Salt Creek watershed situated in Ventura County, which is under the ownership of Newhall Land, will be dedicated to the public. This dedication area is west of Newhall Ranch, and will be managed in the same manner as the Newhall Ranch High Country SMA.
	Two conservation easements of approximately 64 acres have been granted to CDFG for the purpose of conserving populations of spineflower that occur on the NRSP sub-region.

Spatial Scale	Corresponding Low Impact/Site Design BMP
2. Village	Impervious areas will be minimized by incorporating landscaped areas into each village. Significant portions of each village area will remain as open space or parks.
	The village-level stormwater treatment system will include the use of vegetated treatment BMPs, including bioretention, vegetated swales, and/or extended detention basins.
	In areas not subject to mass grading, the smallest site disturbance area possible will be delineated and flagged and temporary storage of construction equipment will be restricted in these areas to minimize soil compaction on site. Site clearing and grading will be limited as necessary to allow development, allow access, and provide fire protection.
	Riparian buffers will be provided along the Santa Clara River corridor and major tributaries by clustering development upland and away from the River and tributary drainages.
	Natural slopes and native vegetation on slopes adjacent to the SCR will be preserved and/or, if impacted during construction, they will be restored and enhanced.
3. Land Use	Streets, sidewalks, and parking lot aisles will be constructed to the minimum widths specified in the NRSP and in compliance with regulations for the Americans with Disabilities Act and safety requirements for fire and emergency vehicle access.
	Trails in reserve areas and some parks will be constructed with open-jointed paving materials, granular materials, or other pervious materials.
	Native and/or non-native/non-invasive vegetation that requires less watering and chemical application will be utilized within the common area landscaping in commercial areas and multi-family residential areas.
	Impervious surfaces will be minimized in common area landscape design.
	Landscape watering in common areas, commercial areas, multiple family residential areas, and parks will use efficient reclaimed water irrigation technologies with centralized irrigation controls. Efficient irrigation for common area irrigation systems will include a combination of the following techniques: • Low volume irrigation systems will be used, including low volume sprinkler heads, drip emitters, and bubbler emitters, to minimize water use. • “Smart” irrigation controllers will be installed to control the amount of time irrigation systems are operated each day. These may include satellite controlled sensors or other equally effective technology.

Spatial Scale	Corresponding Low Impact/Site Design BMP
4. Lot	Bioretention or vegetated swales will be placed within the road right-of-way in some locations.
	Runoff from most sidewalks, walkways, trails, and patios will be directed into adjacent landscaping or to vegetated swales.
	Bioretention areas or vegetated swales will collect and treat runoff from some of the industrial, commercial and multi-family residential areas. These bioretention areas will be located in parking lot islands and other on-site landscaped areas.
	Landscape areas will be determined by zoning requirements, village setback/parkway standards, and design objectives.
	Porous pavement will be used in some parking and low traffic areas.
	Building materials for roof gutters and downspouts will not include copper or zinc.
	Home builders will be encouraged to direct rooftop runoff through landscaped areas.

5.3. Treatment BMPs

The SUSMP requirements mandate that treatment controls address the pollutants of concern, which are defined in the SUSMP Manual as consisting of any pollutants that exhibit one or more of the following characteristics: current loadings or historic deposits of the pollutant are impacting the beneficial uses of a receiving water, elevated levels of the pollutant are found in sediments of a receiving water and/or have the potential to bioaccumulate in organisms therein, or the detectable inputs of the pollutant are at concentrations or loads considered potentially toxic to humans and/or flora and fauna. These parameters were considered in defining pollutants of concern for analysis. See Section 4.1 of this report. Pollutants of concern for the NRSP projects include:

- Sediments (TSS and Turbidity)
- Nutrients (Total Phosphorus, Nitrate-N + Nitrite-N, Ammonia-N, and Total Nitrogen)
- Trace Metals (Aluminum, Copper, Lead, and Zinc)
- Pathogens (Bacteria, Viruses, and Protozoa)
- Petroleum Hydrocarbons (Oil and Grease and PAHs)
- Pesticides
- Trash & Debris

- Chloride
- Methylene Blue Activated Substances (MBAS)
- Cyanide

The types of post development runoff treatment control BMPs that will be employed include, but are not limited to, extended detention basins, bioretention, vegetated swales, and cartridge media filtration devices. These treatment control BMPs are effective for treating most of the pollutants of concern based on the California Stormwater Association Stormwater BMP Handbook for New Development and Redevelopment (2003) (Table 5-2). The stormwater treatment system will be configured to achieve treatment in multiple BMP facilities for the majority of the developed areas. This "treatment train" approach, in combination with the site design and source control BMPs, will effectively address all of the pollutants of concern.

According to Table 5-3 below, treatment controls that best address the TMDL constituents nitrogen and bacteria incorporate either infiltration (e.g., infiltration basins) or biological processes that incorporate de-nitrification (e.g., wetlands). However, project conditions may limit the available surface area and the head required for wetlands and soil types for infiltration basins. Given these potential site constraints, the following treatment BMPs, which incorporate natural treatment processes that provide some infiltration but require less surface area and head were selected:

- Vegetated Swales
- Filter Strips
- Bioretention Areas
- Extended Detention Basins
- Cartridge Media Filtration (or equivalent)

Table 5-3: Treatment Control BMP Selection Matrix

Pollutant of Concern[1]	Treatment Control BMP Categories			
	Extended Detention Basins	Bioretention	Vegetated Swale/ Filter Strip	Media Filtration
Sediment	M	H	M	H
Nutrients	L	M	L	L
Trash	H	H	L	H
Trace Metals	M	H	M	H
Bacteria	M	H	L	M
Organics[2]	M	H	M	H

Source: California Stormwater Best Management Practices Handbook for New Development and Redevelopment (CASQA, 2003)
Note: H, M, L, indicates high, medium, and low removal efficiency.
[1]Chloride and MBAS are addressed with source control BMPs, as they are not treatable in typical stormwater treatment BMPs, aside through incidental infiltration.
[2]Includes pesticides and petroleum hydrocarbons.

Vegetated Swales: Vegetated swales are engineered vegetation-lined channels that provide water quality benefits in addition to conveying runoff. Swales provide pollutant removal through settling and filtration in the vegetation (often grasses) lining the channels and also provide the opportunity for volume reductions through infiltration and evapotranspiration. Swales are most effective where longitudinal slopes are small (2 percent to 6 percent), thereby increasing the residence time for treatment, and where water depths are less than the vegetation height. A conceptual illustration of a vegetated swale is shown in Figure 5-1 and photographs of existing swales are provided in Figure 5-2.

Filter Strips: Filter strips are vegetated areas designed to treat sheet flow runoff from adjacent impervious surfaces or intensive landscaped areas such as golf courses. Filter strips decrease runoff velocity, filter out sediment and associated pollutants, and provide some infiltration into underlying soils. While some assimilation of dissolved constituents may occur, filter strips are generally more effective in trapping sediment and particulate-bound metals, nutrients, and pesticides. Filter strips rely on dense turf vegetation with a thick thatch growing on a moderately permeable soil and are well suited to treat runoff from roads and highways, driveways, and small parking lots. They are also good for use as vegetated buffers between developed areas and natural drainages. A conceptual illustration of a filter strip is shown in Figure 5-3.

Bioretention: Bioretention areas are vegetated (i.e., landscaped) shallow depressions that provide storage, infiltration, and evapotranspiration, and also provide for pollutant removal (e.g. filtration, adsorption, nutrient uptake) by filtering runoff through the vegetation and soils. In bioretention areas, as well as in vegetated swales and filter strips, pore spaces and organic material in the soils help to retain water in the form of soil moisture and to promote the adsorption of pollutants (e.g., dissolved metals and petroleum hydrocarbons) into the soil matrix. Plants utilize soil moisture and promote the drying of the soil through transpiration. A conceptual illustration of a biofiltration area is shown in Figure 5-4, and photographs of existing bioretention areas are provided in Figure 5-5.

Extended Detention Basins: Extended detention basins (EDBs) store stormwater runoff for sufficient periods of time to promote the removal of pollutants primarily through sedimentation. Dry extended detention basins are designed with outlets that detain the runoff volume from the water quality design storm for some minimum time (in this case 48 hours) to allow particulates and associated pollutants (phosphorus, trace metals, some pesticides, and other pollutants) to settle out. These basins are not designed or anticipated to contain standing water for periods in excess of 48 hours. The EDBs will also incorporate a series of gravel-filled subsurface flow trenches that will provide water quality treatment and facilitate evapotranspiration (ET) and percolation of dry weather flows and small storm events within the basin footprint. As runoff flows through the trenches, pollutant removal is achieved through settling and biological uptake of nutrients and dissolved pollutants within the wetland plants that will grow within the trenches, filtration within the trench gravel, and percolation into underlying soils. In addition, a specially constructed dry well that will support deep subsurface percolation of dry weather flows that may exceed the capacity of the gravel trenches will be provided. It is anticipated that the dry well will receive water primarily during the winter months, when ET rates are lower. A conceptual illustration of an extended detention basin is shown in Figure 5-6 and photographs of existing basins are shown in Figure 5-7.

Media Filtration: For small drainage catchments where it is not possible to direct runoff to the vegetated treatment control BMPs listed above due to proposed project grading, media filtration (or equivalent) will be used. A proprietary media filter, such as the Stormwater Management StormFilter®, is an example of this type of treatment (Figure 5-8). The StormFilter is a passive, flow-through stormwater media filtration system. The StormFilter is typically comprised of a vault (or catch basin for small drainage catchments) that houses rechargeable, media-filled cartridges that trap particulates and remove pollutants such as dissolved metals, nutrients, and hydrocarbons. During the filtering process, the treatment system also removes floating pollutants (e.g., oil and grease). The StormFilter system (or equivalent) will be placed off-line to limit resuspension of debris and sediment that will settle in the vault. A high flow bypass structure utilizing a weir or orifice to control the flow to the stormwater treatment system is used to divert flows to the treatment unit.

The typical precast StormFilter unit is composed of three bays: the inlet bay, the filtration bay, and the outlet bay. Stormwater in the inlet bay is directed through a flow spreader, which traps some floatables, oils, and surface scum, and then enters an energy dissipater and the filtration bay where treatment takes place. Stormwater flows laterally (horizontally) through the filter cartridge to a centerwell, where the flow is then directed downward to an underdrain system.

Large particles settle out in the inlet bay and filtration bay, and finer particles and other pollutants are removed as stormwater flows through the filter media in the cartridges.

Stormwater treatment facilities for the NRSP projects will be designed to meet or exceed the sizing standards contained in the SUSMP Manual. Volume-based treatment control BMPs will be sized to capture and treat 80 percent of the annual runoff volume, with a drawdown time of 48 hours. Flow-based BMPs will be sized using a minimum rainfall intensity of 0.3 inches per hour.

5.4. Hydromodification Control PDFs

A series of progressive hydromodification control measures will be used in the NRSP projects to prevent and control hydromodification impacts to the Santa Clara River and the tributaries:

- Avoid, to the extent possible, the need to mitigate for hydromodification impacts by preserving natural hydrologic conditions and protecting sensitive hydrologic features, sediment sources, and sensitive habitats.

- Minimize the effects of development through site design practices (e.g., reducing connected impervious surfaces), implementation of stormwater volume-reducing BMPs (project-based hydrologic source control), and incorporation of flow duration control into water quality treatment basins, as needed.

- Mitigate hydromodification impacts in-stream using geomorphically-based channel design.

In some cases, hydromodification control measures that provide habitat, water quality treatment, hydromodification control, and flood control in one integrated solution may be feasible.

5.4.1. Hydrologic Source Control

Disconnecting impervious areas from the drainage network and adjacent impervious areas is a key approach to protecting channel stability. Several hydrologic source controls will be included in the NRSP projects that will limit impervious area and disconnect imperviousness to avoid and minimize hydromodification impacts:

- *Site Design.* Site design PDFs that help to reduce the increase in runoff volume include the clustering of development into village areas, leaving large amounts of undeveloped open space within the NRSP subregion; routing of impervious area runoff to vegetated areas; use of native and/or non-native/non-invasive vegetation in landscaped areas; and the use of efficient irrigation systems in common area landscaped areas.

- *Treatment Controls*. The project's treatment control BMPs will also serve as hydromodification source control BMPs. Vegetated swales, filter strips, and extended detention basins can provide volume reduction on the order of 20 to 30 percent through infiltration and evaporation. Projects will incorporate bioretention areas sized to capture and treat 80 percent of the average annual stormwater runoff from its tributary catchment and, in some cases, will not utilize underdrains. Thus, all water captured in the facilities without underdrains will be effectively removed from the project's stormwater discharges. Collectively these vegetated treatment facilities are expected to provide significant reduction in wet weather runoff. In addition these facilities will also receive and eliminate dry weather flows.

- *Storage of Excess Runoff Volume for Irrigation Reuse*. In the irrigation reuse alternative, excess flows could be directed to storage tanks or above ground water features located in parks or a golf course for irrigation reuse, or alternatively, to blend excess stormwater runoff with reclaimed water from the proposed Newhall Water Reclamation Plant for reuse.

5.4.2. Project-Based Flow Duration Control

Stream erosion/deposition and sediment transport processes are functions of the long-term cumulative effects of geomorphically significant flows. Maintaining the long-term cumulative duration of geomorphically significant flows maintains the existing capacity to transport sediment and promotes long-term stability. Flow duration control was first discussed in the literature by Derek Booth (1990), of the University of Washington. Flow duration control maintains the existing (pre-development) frequency distribution of hourly runoff as well as the total runoff volume within prescribed limits to minimize hydromodification impacts in natural receiving waters. Flow duration control is a detention basin design methodology that sets standards for on-site capture and runoff volume reduction to maintain the existing distribution of those in-stream flows which are above the critical flow for bed mobility, and as a result maintains the pre-project capacity to transport sediment and avoids creating channel instability. Flow duration control basins can also be designed to accommodate a reduction in sediment supply by reducing the frequency of sediment transporting flows. The treatment control extended detention basins can be modified to provide flow duration control in addition to water quality treatment.

5.4.3. Geomorphically-Referenced Channel Design

The hydromodification management approach for the Santa Clara River and tributaries will incorporate "geomorphically-referenced " channel design as described in SCCWRP Technical Report 450 (SCCWRP, 2005a). The goal of this approach is to preserve the natural stream channel function to the maximum extent practicable while limiting instability in stream channel morphology.

In the five tributaries that will be redesigned or enhanced within the NRSP area (Chiquito Canyon, San Martinez Grande Canyon, Lion Canyon, Long Canyon, and Potrero Canyon), geomorphic principles will be used to design stable stream channels given the expected post-development hydrologic and sediment regimes (see Appendix G for further detail). A minimum of hard, engineered structural elements will be used within the tributary drainages so that a natural appearance will be preserved, while the new drainage channel form will remain stable and habitat will be preserved or enhanced. Examples of modified/engineered natural channels are provided in Figure 5-9.

Within the Santa Clara River, the development footprint will allow for the greatest freedom possible for "natural stream channel" activity. This includes establishing buffer zones and maintaining setbacks to allow for channel movement and adjustment to changes in energy associated with runoff.

The engineered structural elements that will be implemented where needed for the Santa Clara River and the five tributaries listed above include energy dissipation, bank stabilization, and grade stabilization structures.

Energy Dissipation. Energy dissipation at storm drain outfalls provides erosion protection in areas where discharges have the potential to cause localized stream erosion. Erosion protection will be provided at all storm drain outlets to the Santa Clara River and tributaries.

Bank Stabilization. Consistent with the Specific Plan, the RMDP proposes bank stabilization where necessary to protect against flooding and erosion pursuant to Federal Emergency Management Administration (FEMA) and Los Angeles County Department of Public Works' requirements. The bank stabilization is designed and would be constructed to retain the Santa Clara River's significant riparian habitat, to allow the river to continue to function as a regional east-west wildlife corridor, and to provide flood protection pursuant to Los Angeles County standards. Bank protection will be also be installed along portions of the five designated tributaries as required by the Los Angeles County Department of Public Works. Four types of bank protection will be utilized for the Santa Clara River and the Tributaries: 1) buried soil cement, 2) ungrouted rock rip-rap, 3) concrete gunite slope lining, and 4) turf reinforcement mats. The location of the bank stabilization will be selected so that bank protection along the river and tributaries will generally be placed in non-jurisdictional upland areas adjacent to the river or drainage. Installing bank protection in non-jurisdictional areas reduces and/or avoids impacts to the channel and has the potential to create new channel bed areas, allows for channel movement and adjustment to changes in energy associated with runoff, and increases riparian habitat. For example, buried soil cement bank stabilization is proposed on the north side of the Santa Clara River near its confluence with Castaic Creek, and it would be installed on agricultural lands north of the existing river channel. The land located between the existing river channel and the newly created stabilized bank would be excavated, widening the existing river channel in that location. This condition is repeated along the northern bank of the Santa Clara River in several locations

Grade Stabilization Structures. Grade stabilization structures will be installed in Long Canyon, Potrero Canyon, Chiquito Canyon, and San Martinez Grande Canyon to prevent long term degradation, downcutting, and incision of the channel bed. The number of grade stabilization structures to be used within each drainage will be determined based on the expected post development hydrologic and sediment regime (see Appendix G for further discussion). The number of structures will be limited so that a natural appearance will be preserved, while enough grade stabilization structures will be provided to ensure channel stability and habitat preservation and/or enhancement.

Although Lion Canyon will not receive post-development storm flows from NRSP developed area, grade stabilization structures will also be installed in Lion Canyon. Existing conditions within Lion Canyon include deep channel incision as a result of stormwater runoff from historically disturbed portions of the NRSP area due to agriculture, grazing, and oil and gas operations. In order to stabilize and restore the Lion Canyon drainage, a geomorphic channel design will utilize grade and bank stabilization techniques and limited grading to enhance and restore the Lion Canyon drainage. The Lion Canyon restoration will also include plantings of upland and riparian vegetation to enhance the habitat-related beneficial uses.

The tributary channels will designed at the project level and the preliminary channel designs will be described in the Project Water Quality Technical Report for the project in which the tributary channel will be affected, as follows: the Homestead WQTR will include Chiquito Canyon, San Martinez Grande Canyon, and Long Canyon; the Potrero Village WQTR will include Potrero Canyon; and the Mission Village WQTR will include the lower portion of Lion Canyon. Lion Canyon would also be affected by the neighboring Legacy Village Project, and therefore Lion Canyon will also be addressed in the Legacy Village WQTR.

5.4.4. Hydromodification Control Performance Standard

For direct discharges to the Santa Clara River, NRSP projects will incorporate hydrologic source controls that will limit impervious area and disconnect imperviousness to avoid and minimize hydromodification impacts. The NRSP projects' development footprints will establish buffer zones and maintain setbacks to allow for channel movement and adjustment to changes in energy associated with runoff. The engineered structural elements that will be implemented include energy dissipation structures at all outfalls and buried soil cement bank stabilization in selected locations as required by the County of Los Angeles Department of Public Works.

The choice of a hydromodification control approach for each tributary drainage will be dictated by the strategies that are appropriate given the conditions of each drainage and its contributing watershed. Consequently, a suite of on-site and in-stream control approaches will be applied for each tributary drainage to provide a comprehensive solution that avoids, minimizes, and mitigates potential increases in runoff due to land use change. Further discussion is provided in Appendix G of this report.

The project-level tributary drainage designs will be based on modeled pre- and post-development hydrology, hydraulics, and sediment transport capacity of flows in each drainage using the project-level land plans and drainage concepts, including planned hydromodification source controls. The assessment of tributary drainage stability will address the long-term cumulative effect of all sediment-transporting and erosive flows using continuous hydrologic modeling and analysis. Continuous hydrologic modeling incorporates the full distribution of rainfall events in the record and uses in-stream flow duration as a basis for work and sediment transport computations. This state-of-the-art analytical technique assesses all of the "geomorphically significant flows" regardless of their magnitude, and does not assume one size storm adequately characterizes all the important hydrologic conditions. The approach considers frequent sediment transporting flows, wet years and droughts, back-to-back storms, and antecedent conditions.

The project-level hydrology, hydraulics, and sediment transport capacity analysis will identify the necessary longitudinal slope required to maintain the existing sediment transport capacity for drainages determined to be stable in the existing condition. For those channel segments that are determined to be currently unstable, the longitudinal slope necessary to restore channel stability will be determined. Channel design will incorporate stable slopes for the predicted post-development flows in each tributary drainage through a combination of installing grade control structures and/or by changes in channel cross section geometry such as widening the channel and/or adding sinuosity.

The MS4 Permit (§4.D.1) states that "…The Permittees shall control post-development peak storm water runoff discharge rates, velocities, and duration (peak flow control) in Natural Drainage Systems (i.e., mimic pre-development hydrology) to prevent accelerated stream erosion and to protect stream habitat…" The erosion potential analysis, discussed further in Appendix G, provides a metric, Ep, which measures the potential impact of modified flows on stream stability and excessive erosion, and has been developed as a means to define an in-stream performance standard and a "significance test" of the effectiveness of proposed hydromodification control strategies. An equivalently effective, similarly geomorphically-referenced approach may be developed and applied in the future in place of the erosion potential approach.

Using the Ep approach as a point of reference, the following performance standard has been defined for discharges from the NRSP projects to the drainages tributary to the Santa Clara River:

> *The erosion potential (Ep) of stormwater discharges from the Project shall be maintained within 20% of the target value in the tributary drainages that will receive post-development flows. The target erosion potential (Ep) will consider changes in sediment supply.*

The hydromodification performance standard will be met for all of the NRSP projects from the point of discharge to the tributary drainage channel downstream to the confluence of the tributary drainage with the Santa Clara River, and shall be achieved through on-site or in-stream controls, or a combination thereof.

5.5. Operation and Maintenance

Depending on the type and location of the BMP, either the County, a Landscape Maintenance District (LMD), Geologic Hazard Abatement District (GHAD), Home Owners Association (HOA), or other similar government or quasi-government agency will be responsible for maintenance. LMD(s), GHAD(s), or other similar government or quasi-government agency would be formed prior to turnover of stormwater facilities, prior to the first home sale. Maintenance and inspection agreements will be established as the treatment facilities are approved and built. HOA maintenance agreements will incorporate a list of HOA responsibilities. The LMD(s), GHAD(s), or other similar government or quasi-government agency will have a mechanism and staffing to monitor, maintain, and enforce BMP maintenance. The County will have the right to inspect and maintain the BMPs that are maintained by the HOA, LMD, GHAD, or other similar agency at the expense of the HOA, LMD, GHAD, or other similar agency, if they are not being properly maintained.

Table 5-4 lists the operation and maintenance (O&M) activities for the primary treatment control PDFs and the frequencies at which O&M activities will be conducted. BMP maintenance will be conducted in compliance with maintenance requirements established in the Los Angeles County Stormwater BMP Design and Maintenance Manual.

5.5.1. Monitoring

A Memorandum of Understanding (MOU) and Water Resource Monitoring Program have been entered into between Newhall Land, the United Water Conservation District, and the Upper Basin Water Purveyors. This monitoring program will result in a database addressing water usage in the Saugus Formation and Alluvial Aquifer over various representative water cycles. The parties to the MOU intend to utilize this database to further identify surface water and groundwater impacts on the Santa Clara River Valley. Newhall Land, in coordination with LARWQCB staff, will select a representative location upstream and downstream of the Newhall Ranch Specific Plan and sample surface and groundwater quality. Sampling from these two locations would begin upon approval of the first subdivision map and be provided annually to the LARWQCB and Los Angeles County for the purpose of monitoring water quality impacts of the Specific Plan over time. If the sampling data results in the identification of significant new or additional water quality impacts resulting from the Specific Plan which were not previously known or identified, additional mitigation shall be required at the subdivision map level. A to-be-formed district (GHAD, Drainage Benefit Assessment (DBA), or other special district), formed prior to the first home sale, will conduct monitoring within the Newhall Land subregion and will report to the Los Angeles County Department of Public Works.

Table 5-4: Water Quality BMP Operation and Maintenance Activities

Treatment Control BMP	Operation & Maintenance Category	Activities	Frequency	Maintenance Responsibility
Dry Extended Detention Basin	Routine Facility Maintenance	• Facility inspection • Trash and debris removal • Minor sediment removal • Vector Control	• Annually prior to wet season. • After major storm events (>0.75 in/24 hrs) if spot checks of some basins indicate widespread damage/ maintenance needs. • Remove minor sediment accumulation from inlet or outlet when affecting inlet/outlet conditions.	• LACDPW
	Vegetation/ Landscape Maintenance	• Integrated Pest/Plant Management • Minor Vegetation Removal/ Thinning • Irrigation System Adjustment	• Monthly (or as dictated by agreement between County/HOA/LMD and landscape contractor)	
	Major Maintenance	• Structural repairs • Major vegetation removal/ planting • Major sediment removal	• As needed (infrequently) • Major sediment removal as needed; approximately every 10 to 20 years.	
Vegetated Swales/ Filter Strips	Routine Facility Maintenance	• Facility inspection • Trash and debris removal • Minor sediment removal • Vector Control	• Annually prior to wet season. • After major storm events if spot checks of some basins indicate widespread damage/ maintenance needs. • Remove minor sediment accumulation from inlet or outlet when affecting inlet/outlet conditions.	• Home Owners Associations or commercial/ business owners will be responsible for maintenance of site-based BMPs • LACDPW will be responsible for maintenance of BMPs within public ROW
	Vegetation/ Landscape Maintenance	• Integrated Pest/Plant Management • Minor Vegetation Removal/ Thinning	• Monthly (or as dictated by agreement between County/HOA/LMD and landscape contractor)	
	Major Maintenance	• Major vegetation removal/ planting • Major sediment removal	• As required (annually or less frequently)	

Treatment Control BMP	Operation & Maintenance Category	Activities	Frequency	Maintenance Responsibility
Bioretention	Routine Facility Maintenance	• Facility inspection • Trash and debris removal • Minor sediment removal	• Annually prior to wet season. • After major storm events if spot checks of some basins indicate widespread damage/ maintenance needs. • Remove minor sediment accumulation from inlet or outlet when affecting inlet/outlet conditions.	• Home Owners Associations or commercial/ business owners will be responsible for maintenance of site-based BMPs • LACDPW will be responsible for maintenance of BMPs within public ROW
	Vegetation/ Landscape Maintenance	• Integrated Pest/Plant Management • Minor Vegetation Removal/ Thinning • Irrigation System Adjustment • Mulching	• Monthly (or as dictated by agreement between County/HOA/LMD and landscape contractor)	
	Major Maintenance	• Major vegetation removal/ planting	• As needed (infrequently)	
Media Filtration	Routine Facility Maintenance	• Facility Inspection • Trash and Debris Removal • Minor Sediment Removal	• Typically twice per year depending on the accumulation rate	• Home Owners Associations or commercial/ business owners will be responsible for maintenance of site-based BMPs • LACDPW will be responsible for maintenance of BMPs within public ROW
	Major Maintenance	• Major sediment removal • Cartridge/ Media Replacement	• Typically biannually depending on accumulation rate	

The Newhall Ranch WRP NPDES Permit (Order No. R4-2007-0046) requires that a watershed-wide monitoring program be developed for the Santa Clara River watershed under the leadership of the LARWQCB and the stakeholder groups developing salt and nutrient TMDLs. The goals of the watershed-wide monitoring program include evaluating or assessing compliance with receiving water objectives, trends in surface water quality, impacts to beneficial uses, the health of the biological community, data needs for modeling contaminants of concern, and attaining the goals of the TMDLs under implementation in the Santa Clara River watershed. Until the watershed-wide monitoring program is developed, Newhall Land will continue to monitor water quality in the Santa Clara River per the requirements of the Newhall Ranch WRP NPDES Permit. The Newhall Ranch WRP NPDES permit monitoring program, which includes three Santa Clara River sampling locations, requires semi-annual sampling until the Newhall Ranch WRP begins discharge; once discharge from the WRP commences, more frequent sampling is required. The Newhall Ranch WRP receiving water monitoring program includes chemical, toxicity, and bioassessment monitoring in the Santa Clara River.

6. WATER QUALITY ANALYSIS APPROACH

6.1. Water Quality Model Description

A water quality model was used to estimate pollutant loads and concentrations in project area stormwater runoff for certain pollutants of concern for pre-development conditions and post-development conditions with PDFs. Table B-6 in Appendix B lists the NRSP pre- and post-development land uses as well as the land use category used in the water quality model, percent impervious value, and runoff coefficient equation used for the land uses. High country areas and the Santa Clara River corridor will not be impacted by the proposed development and therefore were not included in the water quality modeling. The modeled project area, 7,003 acres, includes the developed portion of the NRSP subregion as well as adjoining natural slopes and open space areas. Therefore, the loads and concentrations presented in Section 7 are not representative of the pollutant loads and concentrations in runoff from the entire NRSP area, but only from the developed portion of the NRSP subregion and adjoining natural slopes and open space areas. The remaining area within the NRSP subregion will be preserved as open space, so runoff water quality from these areas will not be impacted by project development. Although the absolute value of the loads from the entire NRSP subregion are not provided, the predicted *change* in pollutant loads is representative of the entire NRSP subregion because the loads from the open space areas remain unchanged. In general, the pollutant concentrations are not representative of the runoff from the entire NRSP subregion, as the predicted pollutant concentrations are lower from open space than from the other land uses for all of the pollutants of concern except for TSS, which is higher from open space. The concentrations presented in Section 7 for nutrients and trace metals are therefore conservative (i.e., higher than would actually occur after mixing with runoff from open areas).

The water quality model is one of the few models that takes into account the observed variability in stormwater hydrology and water quality. This is accomplished by characterizing the probability distribution of observed rainfall event depths, the probability distribution of event mean concentrations, and the probability distribution of the number of storm events per year. These distributions are then sampled randomly using a Monte Carlo Approach to develop estimates of mean annual loads and concentrations.

A detailed description of the water quality model is presented in Appendix B. The following summarizes major features of the water quality model:

- *Rainfall Data*: The water quality model estimates the volume of runoff from storm events. The storm events were determined from 32 years (1969 - 2002) of hourly rainfall data measured at the National Climatic Data Center (NCDC) Newhall rain gage that incorporates a wide range of storm events. The rainfall analysis that is incorporated in the water quality model requires rainfall measurements at one hour intervals and a period of record that is at least 20 to 30 years in length.

- *Land Use Runoff Water Quality*: The water quality model estimates the concentration of pollutants in runoff from storm events based on existing and proposed land uses. The pollutant concentrations for various land uses, in the form of Event Mean Concentrations (EMCs), were estimated from data collected in Los Angeles County. The Los Angeles County database was chosen for use in the model because: (1) it is an extensive database that is quite comprehensive, (2) it contains monitoring data from land use specific drainage areas, and (3) the data is representative of the semi-arid conditions in southern California.

- *Pollutant Load*: The pollutant load associated with each storm is estimated as the product of the storm event runoff times the event mean concentration. For each year in the simulation, the individual storm event loads are summed to estimate the annual load. The mean annual load is then the average of all the annual loads.

- *PDFs Modeled*: The treatment PDFs included in the water quality modeling were swales for the majority of the Landmark Village project area and dry extended detention basins for the remaining developed areas within the NRSP subregion. Although vegetated swales, bioretention areas, and other low impact/site design BMPs will be incorporated into the NRSP projects, these PDFs were not modeled as it is unknown at this time where they may be located within the specific project areas. Detention basins have been modeled as the water quality treatment PDF for the majority of the NRSP subregion, as this PDF represents the minimum level of treatment that will be provided in all of the NRSP projects. The low impact/site design BMPs will provide for greater volume and pollutant load reduction than the modeled treatment control PDFs. The model also does not take into account the source control PDFs (e.g., street sweeping and catch basin inserts) that would also improve water quality. In this respect, the modeling results are conservative, i.e., tend to overestimate pollutant loads and concentrations.

- *Treatment Effectiveness*: The water quality model estimates mean pollutant concentrations and loads in stormwater following treatment. The amount of stormwater runoff that is captured by the treatment BMPs was calculated for each storm event, taking into consideration the intensity of rainfall, duration of the storm, and duration between storm events. The mean effluent water quality for treatment BMPs was based on the International Stormwater BMP Database (ASCE/EPA, 2003). The International Stormwater BMP Database was used because it is a robust, peer reviewed database that contains a wide range of BMP effectiveness studies that are reflective of diverse land uses. An analysis of the monitored inflow and outflow data contained in the International Stormwater BMP Database showed a volume reduction on the order of 38 percent for biofilters and 30 percent for extended detention basins (Strecker et al, 2004). Based on this analysis, a conservative estimate of 25 percent of the inflow to the vegetated swales and 20 percent of the inflow to extended detention basins was assumed to infiltrate and/or evapotranspire in the water quality model. These assumptions regarding volumetric losses were also used to assess the quantity of dry weather flows that would be captured in the treatment BMPs (see Section 7.8.2).

BMP effectiveness studies in the International Stormwater BMP database infrequently monitor aluminum; therefore, insufficient effluent data were available to model the removal effectiveness of treatment control BMPs for this water quality constituent. The total aluminum content of a water sample will be directly related to the concentrations of the suspended particulate matter. The aluminum content of the suspended solids is likely to directly reflect the composition of the source materials (e.g., the catchment soils). Therefore, it would be expected and is assumed that total aluminum concentrations and loads would be reduced proportionally to removal of suspended solids by project BMPs. In order to estimate the reduction in total aluminum load and concentration (dissolved aluminum was assumed to pass through BMPs without removal), TSS removal was used as a surrogate.

- *Bypass Flows*: The water quality model takes into account conditions when the treatment facility is full and flows are bypassed.

- *Representativeness to Local Conditions*: The water quality model utilizes runoff water quality data obtained from tributary areas that have a predominant land use, and as measured prior to discharge into a receiving water body. Currently such data are available from stormwater programs in LA County, San Diego County, and Ventura County, although the amount of data available from San Diego County and Ventura County is small in comparison with the LA County database. Such data is often referred to as "end-of-pipe" data to distinguish it from data obtained in urban streams, for example.

6.2. Pollutants Modeled

The appropriate form of data used to address water quality are flow composite storm event samples, which are a measure of the average water quality during the event. To obtain such data usually requires automatic samplers that collect data at a frequency that is proportionate to flow rate. The pollutants of concern for which there are sufficient flow composite sampling data in the Los Angeles County database are:

- Total Suspended Solids (sediment)
- Total Phosphorus
- Nitrate-Nitrogen, Nitrite-Nitrogen, Ammonia, and Total Nitrogen (TN)
- Dissolved Copper
- Total Lead
- Dissolved Zinc

- Total Aluminum
- Chloride

The other pollutants of concern, such as pathogens, hydrocarbons, pesticides, and trash and debris, are not amenable to this type of sampling either because of short holding times (e.g., pathogens), difficulties in obtaining a representative sample (e.g., hydrocarbons), or low detection levels (e.g., pesticides). These pollutants were addressed qualitatively using literature information and best professional judgment due to the lack of statistically reliable monitoring data for these pollutants (see Section 6.3 below).

6.3. Qualitative Impact Analysis

Post development stormwater runoff water quality impacts associated with the following pollutants of concern were addressed based on literature information and professional judgment because available data were not deemed sufficient for modeling:

- Turbidity
- Pathogens (Bacteria, Viruses, and Protozoa)
- Hydrocarbons (Oil and Grease, Polycyclic Aromatic Hydrocarbons)
- Pesticides
- Trash and Debris
- Methylene Blue Activated Substances (MBAS)
- Cyanide

Human pathogens are usually not directly measured in stormwater monitoring programs because of the difficulty and expense involved; rather, indicator bacteria such as fecal coliform or certain strains of *E. Coli* are measured. Unfortunately, these indicators are not very reliable measures of the presence of pathogens in stormwater, in part because stormwater tends to mobilize pollutants from many sources, some of which contain non-pathogenic bacteria. For this reason, and because holding times for bacterial samples are necessarily short, most stormwater programs do not collect flow-weighted composite samples that potentially could produce more reliable statistical estimates of concentrations. Fecal coliform or *E. Coli* are typically measured with grab samples, making it difficult to develop reliable EMCs. Total coliform and fecal bacteria (fecal coliform, fecal streptococcus, and fecal enterococci) were detected in stormwater samples tested in Los Angeles County at highly variable densities (or most probable number, MPN) ranging between several hundred to several million cells per 100 ml (LACDPW, 2000).

Hydrocarbons are difficult to measure because of laboratory interference effects and sample collection issues (hydrocarbons tend to coat sample bottles). Hydrocarbons are typically measured with single grab samples, making it difficult to develop reliable EMCs.

Pesticides in urban runoff are often at concentrations that are below detection limits for most commercial laboratories and therefore there are limited statistically reliable data available on pesticides in urban runoff. Pesticides were not detected in Los Angeles County monitoring data for land use-based samples, except for diazinon and glyphosate which were detected in less than 15 percent and 7 percent of samples, respectively (LADPW, 2000).

Turbidity, trash and debris, MBAS, and cyanide are not typically included in routine urban stormwater monitoring programs. Turbidity is not typically included in post-construction treatment control BMP effectiveness studies. Several studies conducted in the Los Angeles River basin have attempted to quantify trash generated from discrete areas, but the data represent relatively small areas or relatively short periods, or both. MBAS was included in the land use-based monitoring data, but not enough data is available for modeling purposes. Cyanide was not included in the Los Angeles County land use-based monitoring program.

Also addressed qualitatively are potential water quality impacts from runoff and dewatering discharges during construction (Section 7.4), potential water quality impacts due to pollutant bioaccumulation (Section 7.5), and dry weather runoff water quality impacts (Section 7.6).

7. IMPACT ASSESSMENT

The modeled pollutant impact assessment is presented in Section 7.1 and the qualitative analyses of the remaining pollutants of concern follow in Section 7.2. Analyses of dry weather impacts and compliance with NPDES Permit requirements and construction-related requirements of the Construction General Permit and Dewatering General Permit follow the pollutant-by-pollutant impact assessment. Also included is a discussion of other considerations, including operation and maintenance, vector control, bioaccumulation, and hydrologic impacts. The analysis of cumulative impacts to surface water, groundwater, and hydromodification is also provided. A weight of evidence approach is employed using the various thresholds and significance criteria discussed in Section 4.4

7.1. Post Development Stormwater Runoff Impact Assessment for Modeled Pollutants of Concern

In this section, model results for each pollutant are evaluated in relation to the following significance criteria: (1) comparison of post-development versus pre-development stormwater quality concentrations and loads; (2) comparison with MS4 Permit, Construction General Permit, and General Dewatering Permit requirements for new development; and (3) evaluation in light of receiving water benchmarks. Pursuant to the third criterion, predicted runoff pollutant concentrations in the post-development condition, with runoff treatment PDFs, are compared with benchmark receiving water quality criteria as provided in the Basin Plan and the CTR and TMDL waste load allocations. The water quality criteria and waste load allocations are considered benchmarks for comparison purposes only, since they do not apply directly to runoff from the NRSP projects, but the comparison provides useful information to evaluate potential impacts. A weight of evidence approach is employed in this analysis considering the various significance criteria.

Results from the water quality model for significance criterion 1 are reported in a series of tables, organized by constituent, showing predicted mean annual pollutant loads (lbs/yr) and mean annual concentrations. Projections are made for two conditions: (1) existing condition, and (2) developed condition with PDFs.

Note that the modeling results account for pollutant reductions in the extended detention basins and vegetated swales only and do not account for the pollutant reductions that will occur due to low impact/site design PDFs and source control PDFs. Because not all BMPs are modeled, the model results predict greater water quality impacts than are likely to occur from the NRSP projects.

Following the table comparing post-development and pre-development water quality loads and concentrations for each constituent is a table comparing the post-development (with PDFs) runoff quality to the benchmark water quality objectives and criteria and TMDL waste load allocations for downstream reaches of the Santa Clara River. Water quality observed in the Santa Clara River is also included on these tables as a benchmark.

7.1.1. Stormwater Runoff Volume

Table 7-1 shows the predicted changes in stormwater runoff mean annual volume. The mean annual runoff volume is expected to increase substantially with development. The increase can be explained by the change in percent imperviousness associated with urbanization, as runoff volume is directly proportional to percent imperviousness. In the pre-development condition, the majority of the land use is open space and agriculture with assumed imperviousness values of one percent and two percent, respectively. A small percentage of the pre-developed land area (three percent) is developed oil and gas pads with an imperviousness of 60 percent. In contrast, the post-development condition has urban land uses with much higher imperviousness including single family residential with an assumed imperviousness of 42 percent, multi-family residential with an assumed imperviousness of 68 percent, and commercial land use with an assumed imperviousness of 91 percent.

Project PDFs include site design, source control, and treatment control BMPs in compliance with the SUSMP requirements. Most of the site design PDFs, especially the minimization of impervious area and the conservation of approximately 8,335 acres of open space areas within the NRSP subregion, reduce the impacts of the proposed development on increases in stormwater runoff volume. The treatment control PDFs will allow for some runoff volume reduction as well. Based on BMP monitoring data in the International Stormwater BMP Database, a 20 percent reduction in stormwater runoff volume was assumed to occur in the dry extended detention basins and 25 percent volume reduction in vegetated swales. The modeling does not account for volume reductions that would occur in low impact/site design BMPs or in basins designed for hydromodification control, which would significantly lessen the increase in post-development runoff volume.

Table 7-1: Predicted Average Annual Stormwater Runoff Volumes

Site Conditions	Average Annual Stormwater Runoff Volume (acre-ft)
Existing	838
Developed with PDFs	2839
Change	2001

7.1.2. TSS

Comparison of Pre- and Post-Project Conditions: Table 7-2 shows the predicted average annual TSS concentration and loads. Conversion from the predominately pre-development open space and agricultural land uses to the post-development urban land use (with treatment) will reduce the average TSS concentration and loads in stormwater runoff.

Table 7-2: Predicted Average Annual TSS Concentration and Loads

Site Conditions	Average Annual TSS Concentration (mg/L)	Average Annual TSS Load (tons/yr)
Existing	402	458
Developed with PDFs	60	232
Change	-342	-226

Comparison with Water Quality Criteria: The predicted average annual TSS concentration in stormwater runoff from the total modeled area with PDFs is compared to water quality criteria and the range of observed concentrations in the Santa Clara River in Table 7-3. Predicted TSS load and concentration declines with development and is at the low end of the range of observed concentrations in Santa Clara River Reach 5. Based on the comprehensive site design, source control, and treatment control strategy, and the comparison with available in-stream data and basin plan benchmark objectives, the TSS in stormwater runoff will not cause a nuisance or adversely affect beneficial uses in the receiving waters.

Table 7-3: Comparison of Predicted TSS Concentrations with Water Quality Criteria and Observed Concentrations in Santa Clara River Reach 5

Predicted Average Annual TSS Concentration (mg/L)	LA Basin Plan Water Quality Objectives	California Toxics Rule Criteria	Range of Observed[1] Concentrations in Santa Clara River Reach 5 (mg/L)
60	Water shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect beneficial uses	NA	32 – 6,591

[1] Range of concentrations observed in the Santa Clara River during wet weather (Stations S29, NR1, and NR3, see Section 2.3.1).
NA – not applicable

7.1.3. Total Phosphorus

Comparison of Pre- and Post-Project Conditions: Table 7-4 shows the predicted average total phosphorus (TP) concentration and annual loads. Because much of the total phosphorus load is associated with sediments, and the sediment concentrations are predicted to decrease with development, the average annual TP concentration is also predicted to decrease. Because post-development flows are expected to increase significantly, the average annual TP load is expected to remain constant even though the TP concentration is expected to decrease.

Table 7-4: Predicted Average Annual Total Phosphorus Concentration and Annual Load

Site Conditions	Average Annual Total Phosphorus Concentration (mg/L)	Average Annual Total Phosphorus Load (tons/yr)
Existing	1.0	1.1
Developed with PDFs	0.3	1.1
Change	-0.7	0.0

Comparison with Water Quality Criteria: There are no numeric objectives for TP in the LA Basin Plan. A narrative objective for biostimulatory substances in the LA Basin Plan states: "waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses." The low predicted TP concentrations in project stormwater discharges will not promote (i.e., increase) algae growth and therefore comply with the narrative objective for biostimulatory substances in the LA County Basin Plan. As shown in Table 7-5, the predicted total phosphorus concentration is at the low end of the range of observed concentrations in Santa Clara River Reach 5.

Table 7-5: Comparison of Predicted Total Phosphorus Concentration with Water Quality Criteria and Observed Concentrations in Santa Clara River Reach 5

Predicted Average Annual Total Phosphorus Concentration (mg/L)	LA Basin Plan Water Quality Objectives	California Toxics Rule Criteria	Range of Observed[1] Concentrations in Santa Clara River Reach 5 (mg/L)
0.3	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses	NA	0.18 – 13.4

[1] Range of concentrations observed in the Santa Clara River during wet weather (Stations S29, NR1, and NR3, see Section 2.3.1).
NA – not applicable

Based on the comprehensive site design, source control, and treatment control strategy and the comparison with available in-stream monitoring data and Basin Plan benchmark objectives, potential impacts associated with total phosphorus are predicted to be less than significant.

7.1.4. Nitrogen Compounds

Comparison of Pre- and Post-Project Conditions: The predicted average nitrate-nitrogen plus nitrite-nitrogen, ammonia, and total nitrogen concentrations and annual loads are summarized in Table 7-6 through Table 7-8, respectively. Average loads and concentrations of all forms of nitrogen are predicted to decrease, except for average annual ammonia load, which is predicted to increase and the annual total nitrogen load, which is predicted to remain constant. The decrease in nitrate-nitrogen plus nitrite-nitrogen load and nitrate-nitrogen plus nitrite-nitrogen, ammonia, and total nitrogen concentrations can be attributed to higher nitrite-, nitrate-, and ammonia-nitrogen EMCs observed in monitoring data from agricultural land uses versus urbanized land uses, along with nitrogen reductions in the treatment control PDFs. Although ammonia concentrations are predicted to decrease, ammonia loads are predicted to increase due to the increase in runoff volume. Similarly, the average annual TP load is expected to remain constant even though the TP concentration is expected to decrease due to the increase in runoff volume.

Table 7-6: Predicted Average Annual Nitrate-N + Nitrite-N Concentration and Load

Site Conditions	Average Annual Nitrate+Nitrite-Nitrogen Concentration (mg/L)	Average Annual Nitrate+Nitrite-Nitrogen Load (tons/yr)
Existing	4.7	5.4
Developed with PDFs	0.6	2.5
Change	-4.1	-2.9

Table 7-7: Predicted Average Annual Ammonia-N Concentration and Load

Site Conditions	Average Annual Ammonia-N Concentration (mg/L)	Average Annual Ammonia-N Load (tons/yr)
Existing	0.7	0.7
Developed with PDFs	0.5	1.8
Change	-0.2	1.1

Table 7-8: Predicted Average Annual Total Nitrogen-N Concentration and Load

Site Conditions	Average Annual Total Nitrogen Concentration (mg/L)	Average Annual Total Nitrogen Load (tons/yr)
Existing	8.0	9.1
Developed with PDFs	2.4	9.1
Change	-5.6	0

Comparison with Water Quality Criteria: Predicted nitrogen compound concentrations are compared to Basin Plan objectives and observed concentrations in Table 7-9. Average annual stormwater concentration of ammonia is predicted to be considerably less than the waste load allocation for Santa Clara River Reach 5 and the Basin Plan objective, and within the range of observed concentrations. Likewise, the average annual stormwater concentration of nitrate-N plus nitrite-N is predicted to be considerably less than the TMDL waste load allocation or the Basin Plan water quality objective and within the range of observed concentrations for this reach of the Santa Clara River.

There are no numeric objectives for Total Nitrogen in the LA Basin Plan. A narrative objective for biostimulatory substances in the LA Basin Plan states: "waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses." The low predicted Total Nitrogen concentrations in project stormwater discharges will not promote (i.e., increase) aquatic growth and therefore comply with the narrative objective for biostimulatory substances in the LA Basin Plan. As shown in Table 7-9, the predicted total nitrogen concentration is in the range of observed concentrations in Santa Clara River Reach 5.

Based on the comprehensive site design, source control, and treatment control strategy, and the comparison with available in-stream monitoring data and benchmark Basin Plan objectives and waste load allocations, potential impacts associated with nitrogen compounds are predicted to be less than significant.

Table 7-9: Comparison of Predicted Nitrogen Compound Concentrations with Water Quality Objectives, TMDLs, and Observed Concentrations in Santa Clara River Reach 5

Nutrient	Predicted Average Annual Concentration (mg/L)	Basin Plan Water Quality Objectives[1] (mg/L)	Wasteload Allocations for MS4 Discharges into the Santa Clara River Reach 5 (mg/L)	Range of Observed[2] Concentrations in Santa Clara River Reach 5 (mg/L)
Nitrate-N + Nitrite-N	0.6	5	6.8[3]	0.5 – 4.8
Ammonia-N	0.5	2.2[4]	1.75[5]	<0.005 – 1.1
Total Nitrogen	2.4	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses	NA	<0.04 – 46[6]

[1] There are no CTR criteria for nitrogen compounds. The biostimulatory substances water quality objective is included because excessive nutrients can contribute to excessive aquatic growth.
[2] Range of concentrations observed in the Santa Clara River during wet weather (Stations S29, NR1, and NR3, see Section 2.3.1).
[3] 30-day average.
[4] 4-day average, ELS present, 90th percentile pH and temperature pairing observed at USGS Monitoring Station 11108500.
[5] 30-day average in Reach 5 below Valencia.
[6] Observed values for TKN (ammonia plus organic nitrogen).

7.1.5. Metals

Comparison of Pre- and Post-Project Conditions: Projected loads and concentrations for the trace metals copper, lead, zinc, and aluminum are presented in through Tables 7-10 through 7-13. Except for aluminum and lead, the projections are for the dissolved form of the metal, as it is the dissolved form to which the CTR criteria apply. Due to consistently low concentrations of dissolved lead in the available stormwater runoff data, it was not possible to develop reliable EMC parameters for most land uses for modeling the dissolved fraction of lead. This constituent was therefore modeled as the total recoverable metal. Copper, lead, and zinc are the most prevalent metals typically found in urban runoff. Other trace metals, such as cadmium, chromium, and mercury, are typically not detected in urban runoff or are detected at very low levels (LA County, 2000).

Post-development trace metal loads are predicted to increase compared to pre-development conditions; while post-development trace metal concentrations are predicted to decrease. These results can be explained by the difference in EMC values observed in representative monitoring data from agriculture and light industrial land uses (used in the model for portions of project area in the predeveloped condition) and the post-developed urban condition (see Appendix B, Table B-11, for the land use-based EMC values employed in the model). Runoff volumes will increase with development and the change in land use will decrease runoff metals concentrations for most proposed land uses.

Project PDFs include site design, source control, and treatment control BMPs in compliance with the SUSMP requirements. Specific site design PDFs that will be implemented to minimize increases in trace metals include directing drainage from impervious areas to bioretention areas and the selection of building material for roof gutters and downspouts that do not include copper or zinc. Source control PDFs that target metals include education for property owners, BMP maintenance, and street sweeping private streets and parking lots. The treatment control BMPs will also reduce trace metals in the runoff from the proposed development. Only the effects of the treatment control PDFs are reflected in the model results.

Table 7-10: Predicted Average Annual Dissolved Copper Concentration and Load

Site Conditions	Average Annual Dissolved Copper Concentration (µg/L)	Average Annual Dissolved Copper Load (lbs/yr)
Existing	11	25
Developed with PDFs	9	72
Change	-2	47

Table 7-11: Predicted Average Total Lead Concentration and Annual Load

Site Conditions	Average Annual Total Lead Concentration (µg/L)	Average Annual Total Lead Load (lbs/yr)
Existing	12	27
Developed with PDFs	7	55
Change	-5	28

Table 7-12: Predicted Average Annual Dissolved Zinc Concentration and Load

Site Conditions	Average Annual Dissolved Zinc Concentration (µg/L)	Average Annual Dissolved Zinc Load (lbs/yr)
Existing	104	236
Developed with PDFs	42	324
Change	-62	88

Table 7-13: Predicted Average Annual Total Aluminum Concentration and Load

Site Conditions	Average Annual Total Aluminum Concentration (µg/L)	Average Annual Total Aluminum Load (lbs/yr)
Existing	873	1,991
Developed with PDFs	555	4,288
Change	-318	2,297

Comparison with Water Quality Criteria: A narrative objective for toxic substances in the LA Basin Plan states: "all waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life."

The CTR criteria are the applicable water quality objectives for protection of aquatic life. The CTR criteria are expressed for acute and chronic (4-day average) conditions; however, only acute conditions were considered to be applicable for stormwater discharges because the duration of stormwater discharge is consistently less than 4 days. The CTR criteria are calculated on the basis of the hardness of the receiving waters. Lower hardness concentrations result in lower, more stringent CTR criteria. The minimum hardness value (250 mg/L as $CaCO_3$) observed in the Santa Clara River at the USGS Station 11108500 during wet weather was used as a conservative estimate; the mean observed hardness value was 660 mg/L as $CaCO_3$.

For aluminum, the National Ambient Water Quality Criteria (NAWQC) acute criterion (750 μg/L for a pH range of 6.5 to 9.0) was used as a benchmark, as the CTR does not include aluminum. Although the NAWQC criterion is in the form of acid soluble aluminum (USEPA, 1988), the available monitoring data are for either dissolved aluminum or total aluminum. Acid soluble aluminum (which is operationally defined as the aluminum that passes through a 0.45 μm membrane filter after the sample has been acidified to a pH between 1.5 and 2.0 with nitric acid) represents the forms of aluminum toxic to aquatic life or that can be readily converted to toxic forms under natural conditions. The acid soluble measurement does not measure forms of aluminum, such as aluminum that is occluded in minerals, clays, and or is strongly sorbed to particulate matter, that are not toxic and are not likely to become toxic under natural conditions. As acid soluble aluminum data is not available, total aluminum has been used in order to be conservative.

Comparison of the predicted runoff metal concentrations and the acute CTR criteria for dissolved copper, total lead, and dissolved zinc and the NAWQC criterion for aluminum are shown in Table 7-14, along with the range of observed concentrations in Santa Clara River Reach 5. Although the trace metal loadings are predicted to increase, the comparison of the post-developed with PDFs condition to the benchmark CTR and NAWQC values shows that all of the trace metal concentrations are below the benchmark water quality criteria. As shown in Table 7-14, the predicted trace metal concentrations are in the range of observed concentrations in Santa Clara River Reach 5 except for dissolved zinc which is slightly higher.

Table 7-14: Comparison of Predicted Trace Metal Concentrations with Water Quality Criteria and Observed Concentrations in Santa Clara River Reach 5

Metal	Predicted Average Annual Concentration (μg/L)	California Toxics Rule Criteria[1] (μg/L)	Range of Observed[2] Concentrations in Santa Clara River Reach 5 (μg/L)
Dissolved Copper	9.3	32	3.3 – 22.6
Total Lead	7.1	260	0.6 – 40
Dissolved Zinc	42	250	3 – 37
Total Aluminum	555	750	131 – 19,650

[1] Hardness = 250 mg/L, based on minimum observed value at USGS Station 11108500. Lead criteria is for total recoverable lead. NAWQC aluminum criteria for pH 6.5 – 9.0.
[2] Range of concentrations observed in the Santa Clara River during wet weather (Stations S29, NR1, and NR3, see Section 2.3.1).

Based on the comprehensive site design, source control, and treatment strategy and the comparison with the instream water quality monitoring data and benchmark water quality criteria, the NRSP projects will not have significant impacts resulting from trace metals.

7.1.6. Chloride

Comparison of Pre- and Post-Project Conditions: Table 7-15 shows the predicted average annual chloride concentration and load. Due to the conversion from agricultural to urban land-uses and the associated EMCs, annual chloride concentration is predicted to decrease when compared to the existing conditions, although the average annual chloride load is predicted to increase due to increased runoff volume.

Table 7-15: Predicted Average Annual Chloride Concentration and Load

Site Conditions	Average Annual Chloride Concentration (mg/L)	Average Annual Chloride Load (tons/yr)
Existing	20	23
Developed with PDFs	14	52
Change	-6	29

Comparison with Water Quality Criteria: The predicted chloride concentration in post-development project runoff is compared to the LA Basin Plan water quality objective and the range of observed concentrations in Santa Clara River Reach 5 in Table 7-16. The predicted average annual chloride concentration in stormwater runoff is at the low end of the range of observed concentrations for this pollutant and is well below the Santa Clara River Reach 5 Basin Plan water quality objective and the TMDL waste load allocation for Santa Clara River Reach 5 (100 mg/L for both). Based on the comprehensive site design, source control, and treatment control strategy, and comparison with benchmark receiving water criteria and instream monitoring data, the NRSP projects are not expected to have significant water quality impacts resulting from chloride.

Table 7-16: Comparison of Predicted Chloride Concentrations with Water Quality Criteria and Observed Concentrations in Santa Clara River Reach 5

Pollutant	Predicted Average Annual Concentration (mg/L)	LA Basin Plan Water Quality Objectives[1] (mg/L)	Range of Observed[2] Concentrations in Santa Clara River Reach 5 (mg/L)	Wasteload Allocations for MS4 Discharges into the Santa Clara River Reach 5 (mg/L)
Chloride	14	100	3 - 121	100

[1] There are no CTR criteria for chloride.
[2] Range of concentrations observed in the Santa Clara River during wet weather (Stations S29, NR1, and NR3, see Section 2.3.1).

7.2. Post Development Stormwater Impact Assessment for Pollutants and Basin Plan Criteria Addressed Without Modeling

7.2.1. Turbidity

Turbidity is a measure of suspended matter that interferes with the passage of light through the water or in which visual depth is restricted (Sawyer et al, 1994). Turbidity may be caused by a wide variety of suspended materials, which range in size from colloidal to coarse dispersions, depending upon the degree of turbulence. In lakes or other waters existing under relatively quiescent conditions, most of the turbidity will be due to colloidal and extremely fine dispersions. In rivers under flood conditions, most of the turbidity will be due to relatively coarse dispersions. Erosion of clay and silt soils may contribute to in-stream turbidity (see discussion of hydromodification impacts in Section 7.9 below). Organic materials reaching rivers serve as food for bacteria, and the resulting bacterial growth and other microorganisms that feed upon the bacteria produce additional turbidity. Nutrients in runoff may stimulate the growth of algae, which also contribute to turbidity.

Discharges of turbid runoff are primarily of concern during the construction phase of development. Construction-related impacts are addressed in Section 7.4 below. The Construction Stormwater Pollution Prevention Plan must contain sediment and erosion control BMPs pursuant to the Construction General Permit, and those BMPs must effectively control erosion and discharge of sediment, along with other pollutants, per the Best Available Technology Economically Achievable and Best Conventional Pollutant Control Technology (BAT/BCT) standards[6]. Additionally, fertilizer control and non-visible pollutant monitoring and trash control BMPs in the SWPPP will combine to help control turbidity during the construction phase.

In the post-development condition, placement of impervious surfaces will serve to stabilize soils and to reduce the amount of erosion that may occur from the NRSP projects during storm events,

[6] BAT/BCT are Clean Water Act technology-based standards that are applicable to construction site stormwater discharges. Federal law specifies factors relating to the assessment of BAT including: age of the equipment and facilities involved; the process employed; the engineering aspects of the application of various types of control techniques; process changes; the cost of achieving effluent reduction; non-water quality environmental impacts (including energy requirements); and other factors as the Administrator deems appropriate. Clean Water Act §304(b)(2)(B). Factors relating to the assessment of BCT include: reasonableness of the relationship between the costs of attaining a reduction in effluent and the effluent reduction benefits derived; comparison of the cost and level of reduction of such pollutants from the discharge from publicly owned treatment works to the cost and level of reduction of such pollutants from a class or category of industrial sources; the age of the equipment and facilities involved; the process employed; the engineering aspects of the application of various types of control techniques; process changes; non-water quality environmental impact (including energy requirements); and other factors as the Administrator deems appropriate. Clean Water Act §304(b)(4)(B). The Administrator of U.S. EPA has not issued regulations specifying BAT or BCT for construction site discharges.

and will therefore decrease turbidity in the runoff (see also hydromodification impacts discussed in section 7.9 below). Project PDFs, including source controls (such as common area landscape management and common area litter control) and treatment control BMPs in compliance with the SUSMP requirements, will prevent or reduce the release of organic materials and nutrients (which might contribute to algal blooms) to receiving waters. As shown in Section 7.1 above, post-development nutrients in runoff are not expected to cause significant water quality impacts. Based on implementation of the Project PDFs and the construction-related controls outlined in Section 7.4, runoff discharges from the NRSP projects will not cause increases in turbidity which would result in adverse affects to beneficial uses in the receiving waters. Based on these considerations, the water quality impacts of the NRSP projects on turbidity are considered less than significant.

7.2.2. Pathogens

Pathogens are viruses, bacteria, and protozoa that can cause illness in humans. Identifying pathogens in water is difficult as the number of pathogens is exceedingly small, thereby requiring sampling and filtering large volumes of water. Traditionally water managers have relied on measuring "pathogen indicators," such as total and fecal coliform, as an indirect measure of the presence of pathogens. Although such indicators were considered reliable for sewage samples, indicator organisms are not necessarily reliable indicators of viable pathogenic viruses, bacteria, or protozoa in stormwater because coliform bacteria, in addition to being found in the digestive systems of warm-blooded animals, are also found in plants and soil. Certain pathogen indicators can multiply in the field if the substrate, temperature, moisture, and nutrient conditions are suitable. Paulsen and List summarize the debate over the use of pathogenic indicators and point out that scientific studies show no correlation between fecal coliform densities and gastrointestinal illness in swimmers, therefore coliform may not indicate a significant potential for causing human illness (Paulsen and List, 2005, provided in Appendix D). In a recent field study conducted by Schroeder *et. al.*, pathogens (in the form of viruses, bacteria, or protozoa) were found to occur in 12 of 97 samples taken, but the samples that contained pathogens did not correlate with the concentrations of indicator organisms (Schroeder *et. al.* 2002). Most researchers who have correlated human illness to fecal indicator bacteria levels have conducted epidemiological studies in waters receiving point inputs of treated or raw sewage; few epidemiological studies have tested the health effects of exposure to water receiving direct and recent stormwater runoff. Thus there is no explicit documentation of the health effects of stormwater based on epidemiological studies (WERF, 2007).

There are numerous sources of pathogen indicators, including birds and other wildlife, as well as domesticated animals and pets, soils, and plant matter. Anthropogenic sources may include poorly functioning septic systems, cross-connections between sewer and storm drains, and the utilization of outdoor areas for human waste disposal by people without access to indoor sanitary facilities.

It is recognized that natural levels of bacteria are present in the Project's receiving waters and that control of such natural sources is not required nor desired by regulatory agencies. For example, the LARWQCB TMDL for bacteria in the Malibu Creek watershed makes provisions for background levels of bacteria associated with natural sources (LARWQCB, 2004). Bacteria TMDLs have not been developed for the Santa Clara River.

Data collected from undeveloped watersheds or watersheds with little development indicate that bacterial standards are often exceeded. For example, monitoring data obtained by Los Angeles County (LACDPW, 2000) for vacant land use showed a mean fecal coliform concentration of 1,397 MPN/100 mL in 21 samples (compared to the REC1 water quality criteria of 400 MPN/100 mL). The USEPA has recognized that routine exceedances of ambient water quality criteria due to natural sources of pollution occur. In response, the USEPA has recommended changes to designated uses as the most appropriate way to address these situations (Paulsen and List, 2005). The monitoring data collected in the tributaries of the Santa Clara River showed a range of fecal coliform concentrations from 953 MPN/100 mL to greater than 81,200 MPN/100 mL (see Table 2-19).

The USEPA has compiled an extensive database on stormwater data collected as part of its program to regulate stormwater (Pitt et al, 2003). These data were drawn from 65 programs in 17 states throughout the United States. The data indicate that median fecal concentrations range from about 4,500 to 7,700 MPN/100 mL for a range of commercial and residential land uses, compared to a median value of around 3,000 MPN/100 mL for open space and vacant land. These data represent urban areas that in general do not have source and treatment controls, and therefore are not indicative of runoff from the proposed Specific Plan build-out.

Runoff from agricultural watersheds involving horticulture and row cropping is known to similarly contain relatively high levels of indicator bacteria. Data from a stormwater drain serving an agricultural watershed with predominantly row crops in Ventura County showed similar median fecal coliform levels (~ 7,000 MPN/100 mL) to that found for general urban runoff (Ventura County, 2005). Agricultural land and open space areas likely share some of the same wildlife sources, but livestock may be present as well. These data indicate that wildlife, livestock, plants and/or soils can be a very important source of pathogens and/or pathogen indicators such as fecal coliform.

Additionally, a study conducted by PBS&J in coastal watersheds near Laguna Beach in Orange County (PBS&J, 1999) found that indicator bacteria concentrations in receiving waters downstream from the developed/urban watersheds were not significantly different than concentrations in receiving waters downstream from undeveloped watersheds. Additional analysis conducted by Paulsen and List (Paulsen and List, 2005) further supported these findings. These studies suggest that the development under the Specific Plan would not result in appreciable changes in pathogen levels in the receiving waters compared to the existing conditions.

The primary sources of fecal coliform from the Specific Plan development would likely be sediment, pet wastes, wildlife, and regrowth in the storm drain itself. Other sources of pathogens and pathogen indicators, such as cross connections between sanitary and storm sewers, are unlikely given modern sanitary sewer installation methods and inspection and maintenance practices.

The levels of bacteria in runoff from the Specific Plan projects would be reduced by:

- source controls, and
- treatment controls.

The most effective means of controlling pet wastes and wastes from human interaction with wildlife is through source control, specifically education of pet owners, education regarding feeding of waterfowl near waterbodies, providing products and disposal containers that encourage and facilitate cleaning up after pets, and storm drain cleaning practices. These BMPs are described in Section 5 Project Design Features.

Although, there are limited data on the effectiveness of extended detention basins to treat pathogen indicators, the treatment processes known to be occurring in extended detention basins involve sunlight (ultraviolet light) degradation, sedimentation, and infiltration, all of which can reduce pathogen concentrations and loads. Many of the proposed detention basins are to be located on relatively infiltrative soils and pathogen removal by filtration is a common and effective practice in wastewater treatment. The Center for Watershed Protection maintains a National Pollutant Removal Performance Database that indicates that removal performance for pathogen indicators in various types of extended detention basins ranged between 70 to 80 percent (CWP, 2000).

In addition to treatment by extended detention, bioretention areas and vegetated swales are proposed. Bioretention relies on filtration through an amended sand soil layer for water quality treatment, while vegetated swales provide sediment removal through settling and allow for infiltration of low flows. Again, filtration and infiltration are effective means of treating pathogen indicators. The city of Austin, Texas conducted a number of studies on the effectiveness of sedimentation/filtration treatment systems for treating stormwater runoff (City of Austin, 1990; CWP, 1996). Most of the structures were designed to treat one-half inch of runoff. Data from four sand filters indicated a range of removals from 37 percent to 83 percent for fecal coliform, and 25 percent to 81 percent for fecal streptococci. Research on the use of filtration to remove bacteria also has been conducted in Florida by the Southwest Florida Water Management District (Kurz, 1999). Significant reductions in total and fecal coliform bacteria and the other indicators were observed between inflow and outflow samples for sand filtration. Percent reductions were measured using flow-weighted sampling techniques. Total coliform bacteria removals were less than 70 percent, and fecal coliform bacteria reduction varied from 65 percent to 100 percent. In a literature summary, the USEPA reported typical pathogen removal for infiltration basins and trenches as 65 to 100 percent (USEPA, 1993).

In summary, stormwater discharges from the Project could potentially exceed the REC-1 Basin Plan standard for fecal coliform and therefore impacts from indicator bacteria may be significant prior to mitigation. However, although such fecal indicator bacteria were considered reliable for sewage samples, indicator organisms are not necessarily reliable indicators of viable pathogenic viruses, bacteria, or protozoa in stormwater because coliform bacteria, in addition to being found in the digestive systems of warm-blooded animals, are also found in plants and soil. Potential post-development pathogen sources include natural sources, and it is recognized that natural levels of bacteria are present in the Project's receiving waters and that control of such natural sources is not required nor desired by regulatory agencies. Anthropogenic sources include leaking septic and sewer systems and pet wastes. The Specific Plan projects will not include septic systems and the sewer system will be designed to current standards which minimizes the potential for leaks. The proposed Specific Plan development, consistent with the MS4 permit requirements, includes a comprehensive set of source and treatment control BMPs selected to manage pollutants of concern, including pathogens and pathogen indicators. With this series of BMPs, Specific Plan build-out would not result in substantial changes in pathogen levels in the receiving waters compared to existing conditions, and potential water quality impacts related to pathogens are considered less than significant.

7.2.3. Hydrocarbons

Various forms of hydrocarbons (oil and grease) are common constituents associated with urban runoff; however, these constituents are difficult to measure and are typically measured with grab samples, making it difficult to develop reliable EMCs for modeling. Based on this consideration, hydrocarbons were not modeled but are addressed qualitatively.

Hydrocarbons are a broad class of compounds, most of which are non-toxic. Hydrocarbons are hydrophobic (low solubility in water), have the potential to volatilize, and most forms are biodegradable. A subset of hydrocarbons, Polynuclear Aromatic Hydrocarbons (PAHs) can be toxic depending on the concentration levels, exposure history, and sensitivity of the receptor organisms. Of particular concern are those PAH compounds associated with transportation-related sources.

Although the concentration of hydrocarbons in runoff is expected to increase slightly under post-development conditions due to the increase in roadways, driveways, parking areas, and vehicle use, the PDFs are expected to prevent appreciable increases in hydrocarbon concentrations from leaving the project sites. Source control PDFs that address petroleum hydrocarbons include educational materials on used oil programs, carpooling, and public transportation alternatives to driving; BMP maintenance; and street sweeping private streets. Although vehicle emissions and leaks are the primary source of hydrocarbons in urban areas, it is anticipated that vehicles in the proposed development will in general be well maintained and newer models which will help to limit emissions and leaks. Lastly, the parking lot site design, source controls, treatment BMPs and vegetation and soils within the treatment control PDFs will adsorb the low levels of emulsified oils in stormwater runoff, preventing discharge of hydrocarbons and visible film in the discharge or the coating of objects in the receiving water.

The majority of PAHs in stormwater adsorb to the organic carbon fraction of particulates in the runoff, including soot carbon generated from vehicle exhaust (Ribes et al, 2003). For example, a stormwater runoff study by Marslek *et. al.* (1997) found that the dissolved-phase PAHs represented less than 11 percent of the total concentration of PAHs. Consequently, the extended detention basins, bioretention areas, and vegetated swales proposed as PDFs, which are designed to treat pollutants through settling, filtration, and infiltration, will be effective at treating PAHs.

Los Angeles County conducted PAH analyses on 27 stormwater samples from a variety of land uses in the period 1994-2000 (Los Angeles County, 2000). For those land uses where sufficient samples were taken and were above detection levels to estimate statistics, the mean concentrations of individual PAH compounds ranged from 0.04 to 0.83 µg/L. The reported means were less than the acute toxicity criteria available from the literature (Suter and Tsao, 1996). Moreover, the Los Angeles County data do not account for any treatment, whereas the treatment in the PDFs should result in a reduction in hydrocarbon concentrations inclusive of PAHs. This makes it very unlikely that impacts will occur to the receiving water due to hydrocarbon loads or concentrations. On this basis, the effect of the NRSP projects on petroleum hydrocarbon levels in the receiving waters post-development is considered less than significant.

During the construction phase of the NRSP projects, hydrocarbons in site runoff could result from construction equipment/vehicle fueling or spills. Construction related impacts are addressed in Section 7.4 below. However, pursuant to the Construction General Permit, the Construction Stormwater Pollution Prevention Plan must include BMPs that address proper handling of petroleum products on the construction site, such as proper petroleum product storage and spill response practices, and those BMPs must effectively prevent the release of hydrocarbons to runoff per the Best Available Technology Economically Achievable and Best Conventional Pollutant Control Technology standards. PAH that are adsorbed to sediment during the construction phase would be effectively controlled via the erosion and sediment control BMPs. For these reasons, construction-related water quality impacts related to hydrocarbons are considered less than significant.

7.2.4. Pesticides

Pesticides can be of concern where past farming practices involved the application of persistent organochlorine pesticides. Legacy pesticides Chlordane, Dieldrin, DDT, and Toxaphene are of particular concern, as TMDLs have been established for these pesticides in the Santa Clara River estuary, approximately 40 miles downstream of the NRSP subregion and this reach of the river. Historical pesticides should no longer be discharged in the watershed except in association with erosion of sediments to which these pollutants may have adhered in the past. Required remedial grading along with the placement of impervious surfaces will stabilize soils and prevent their transport from the development sites, actually reducing the potential for discharge of sediments to which historical pesticides may have adsorbed in pre-development conditions.

In the post-developed condition, pesticides will be applied to common landscaped areas and residential lawns and gardens. Pesticides that have been commonly found in urban streams include the organophosphate pesticides chlorpyrifos and diazinon (Katznelson and Mumley, 1997). However, only 0 to 13% of the samples in the LA County database had detectable levels of diazinon (depending on the land use) while levels of chlorpyrifos were below detection limits for all land uses in all samples taken between 1994 and 2000 (LA County, 2000). Other pesticides presented in the database were seldom measured above detection limits. Furthermore, these data represent flows from areas without treatment controls, unlike the NRSP projects which incorporate treatment control PDFs.

Diazinon and chlorpyrifos are two pesticides of concern due to their potential toxicity in receiving waters. The USEPA has banned all indoor uses of diazinon in 2002 and stopped all sales for all outdoor non-agricultural use in 2003 (USEPA, June, 2002)[7]. With no agricultural uses planned for the proposed Project, diazinon would not be used in the NRSP projects. The USEPA is also phasing out all indoor and outdoor residential uses of chlorpyrifos and has stopped all non-residential uses where children may be exposed. Use of chlorpyrifos in the NRSP subregion is not expected, with the possible exception of emergency fire ant eradications until such time as reasonable alternative products are available and only with appropriate application practices in accordance with the golf course and landscape pesticide management program.

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[7] Changes to the use of chlorpyrifos include reductions in the residue tolerances for agricultural use, phases out nearly all indoor and outdoor residential uses, and also stops non-residential uses where children may be exposed. In Orange County, residential use accounts for around 90% of total chlorpyrifos (USEPA, June 2002). Retail sales of chlorpyrifos were stopped by December 31, 2001, and structural (e.g. construction) uses will be phased out by December 31, 2005. Some continued uses will be allowed, for example public health use for fire ant eradication and mosquito control will be permitted by professionals.

Permissible uses of diazinon will also be restricted. All indoor uses are prohibited (as of 12/2002) and retailers were required to end sales for indoor use on December, 2002. All outdoor non-agricultural uses were phased out by December 31, 2004. Therefore it is likely that the USEPA agreement will eliminate most of the use of diazinon within the NRSP area. The use of diazinon for many agricultural crops has been eliminated (USEPA 2001), while some use of this chemical will continue to be permitted for some agricultural activities.

Diazinon had long been one of the most commonly used pesticides on the market (SFBRWQCB, 2005) before its use was phased-out. Although the U.S. Environmental Protection Agency's actions eliminated most urban diazinon uses by the end of 2004, phasing out diazinon likely has increased post-2004 reliance on alternative pesticides and encouraged new pesticides to enter the marketplace.

The San Francisco Regional Water Quality Control Board commissioned a study, Insecticide Market Trends and Potential Water Quality Implications, to evaluate pesticide use trends as they relate to water quality. In 2003, on the basis of current and projected pesticide use and possible water quality risks, the report considered the pesticide alternatives of potential concern for water quality to be pyrethrums; parathyroid's (bifenthrin, cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, and permethrin); carbaryl; malathion; and imidacloprid (SFBRWQCB, 2003). A more recent study also identified lambda cyhalothrin (a pyrethroid) and fipronil among pesticides of interest (SFEP, 2005).

The water quality risks posed by a pesticide relate to the quantity of the pesticide used, its runoff characteristics, and its relative toxicity in water and sediment. As urban diazinon applications are phased out, the use of some alternatives may inadvertently pose new water quality risks. Given what is known about alternative pesticide use trends, pyrethroids may be the alternatives that pose the greatest concerns for water quality (SFBRWQCB, 2005). Although pyrethroids tend to be toxic to Ceriodaphnia dubia test organisms at concentrations in water comparable to diazinon, pyrethroids do not dissolve well in water but instead adhere well to surfaces, including particles in the environment (SFBRWQCB, 2005). At equilibrium, pyrethroid concentrations in sediment are reported to be about 3,000 times greater than dissolved concentrations in water (SFBRWQCB, 2005). Thus, BMPs targeting reductions and removal of sediment loads will be effective to reduce and remove pyrethroids as well.

Source control measures such as education programs for owners, occupants, and employees in the proper application, storage, and disposal of pesticides are the most promising strategies for controlling the pesticides that will be used post-development. Structural treatment controls are less practical because of the variety of pesticides and wide range of chemical properties that affect their ability to treat these compounds. However, most pesticides, including historical pesticides that may be present at the site, are relatively insoluble in water and therefore tend to adsorb to the surfaces of sediment, which will be stabilized with development, or if eroded, will be settled or filtered out of the water column in the water quality treatment PDFs. Thus, treatment in the bioretention, vegetated swales, and extended detention basin should achieve some removal of pesticides from stormwater as TSS is reduced.

For common area landscaping in commercial areas, multi-family residential areas, and parks, an Integrated Pest Management (IPM) Program will be incorporated. The goal of an IPM is to keep pest levels at or below threshold levels, reducing risk and damage from pest presence, while eliminating the risk from the pest control methods used. IPM programs achieve these goals through the use of low risk management options by emphasizing use of natural biological methods and the appropriate use of selective pesticides. IPM programs also incorporate environmental consideration by implementing procedures that minimize intrusion and alteration of biodiversity in ecosystems.

While pesticides are subject to degradation, they vary in how long they maintain their ability to eradicate pests. Some break down almost immediately into nontoxic byproducts, while others can remain active for longer periods of time. While pesticides that degrade rapidly are less likely to adversely affect non-targeted organisms, in some instances it may be more advantageous to apply longer-lasting pesticides if it results in fewer applications or smaller amounts of pesticide use. As part of the Integrated Pest Management program, careful consideration will be made as to the appropriate type of pesticides for use in the NRSP subregion. While pesticide use is likely to occur due to maintenance of landscaped areas, particularly in the residential portions of the development, careful selection, storage and application of these chemicals for use in common areas per the IPM Program will help prevent adverse water quality impacts from occurring. Additionally, as discussed above, removal of sediments in the PDFs will also remove sediment-adsorbed pesticides.

Based on the incorporation of site design, source control, and treatment control BMPs pursuant to SUSMP requirements and the use of an Integrated Pest Management Program, potential post-development impacts associated with pesticides are expected to be less than significant.

Transport of legacy pesticides adsorbed to existing site sediments may be a concern during the construction phase of development. Construction-related impacts are addressed in Section 7.4 below. The Construction Stormwater Pollution Prevention Plan must contain sediment and erosion control BMPs pursuant to the Construction General Permit, and those BMPs must effectively control erosion and the discharge of sediment along with other pollutants per the BAT/BCT standards. Based on these sediment controls, construction-related impacts associated with pesticides are expected to be less than significant.

7.2.5. Trash and Debris

Urban development tends to generate significant amounts of trash and debris. Trash refers to any human-derived materials including paper, plastics, metals, glass and cloth. Debris is defined as any organic material transported by stormwater, including leaves, twigs, and grass clippings (DLWC, 1996). Debris can be associated with the natural condition. Trash and debris is often characterized as material retained on a 5-mm mesh screen. It contributes to the degradation of receiving waters by imposing an oxygen demand, attracting pests, disturbing physical habitats, clogging storm drains and conveyance culverts and mobilizing nutrients, pathogens, metals, and other pollutants that may be attached to the surface. Sources of trash in developed areas can be both accidental and intentional. During wet weather events, gross debris deposited on paved surfaces can be transported to storm drains, where it can be eventually discharged to receiving waters. Trash and debris can also be mobilized by wind and transported directly into waterways, imposing an oxygen demand on the water body as organic matter decomposes.

Urbanization could significantly increase trash and debris loads if left unchecked. However, the PDFs, including source control and treatment BMPs, will minimize the adverse impacts of trash and debris. Source controls such as street sweeping, public education, fines for littering, and storm drain stenciling can be effective in reducing the amount of trash and debris that is available for mobilization during wet and dry weather events. Common area litter control will include a litter patrol, covered trash receptacles, emptying of trash receptacles in a timely fashion, and noting trash violations by tenants/homeowners or businesses and reporting the violations to the owner/HOA for investigation. Catch basin inserts will be provided for parking lots. The PDFs will remove or prevent the release of floating materials, including solids, liquids, foam, or scum, from runoff discharges and will prevent impacts on dissolved oxygen in the receiving water due to decomposing debris. Based on these considerations, post-development trash and debris is not expected to significantly impact the receiving waters of the NRSP projects.

During the construction phase, there is potential for an increase in trash and debris loads due to lack of proper contractor good housekeeping practices at the construction site. Per the Construction General Permit, the SWPPP for the site will include BMPs for trash control (catch basin inserts, good housekeeping practices, etc.). Compliance with the Permit Requirements and inclusion of these BMPs, meeting BAT/BCT, included in the SWPPP will mitigate impacts from trash and debris to a level less than significant. See Section 7.4 below for a full discussion of Construction Related Impacts.

7.2.6. Methylene Blue Activated Substances (MBAS)

MBAS, which is related to the presence of detergents in runoff, may be incidentally associated with urban development due to commercial and/or residential vehicle washing or other outdoor washing activities. Surfactants disturb the surface tension which affects insects and can affect gills in aquatic life.

The presence of soap in project runoff will be controlled through the source control PDFs, including a public education program on residential and charity car washing, and the provision of a car wash pad connected to sanitary sewer in the multi-family residential areas. Other sources of MBAS, such as cross connections between sanitary and storm sewers, are unlikely given modern sanitary sewer installation methods and inspection and maintenance practices. Therefore, MBAS are not expected to significantly impact the receiving waters of the NRSP projects.

7.2.7. Cyanide

The information on cyanide levels in urban stormwater is relatively sparse. The incidence of detection of cyanide in urban stormwater is relatively low, except in some special cases. In the

Nationwide Urban Runoff Project (NURP), cyanide was detected in runoff from four cities out of a total of 15 cities that participated in the monitoring program (USEPA 1983). Overall, cyanide was detected in 23 percent of the urban runoff samples collected (16 out of a total of 71 samples), at concentrations ranging from 2 to 33 µg/L (Cole *et. al.* 1984). Of the 71 samples, only 3 percent (i.e., 2) exceeded the freshwater acute guideline of 22 µg/L (USEPA 1983). The predominant sources of cyanides found in urban runoff samples were reported to be products of gasoline combustion and anti-caking ingredients in road salts (Cole *et. al.* 1984).

A review of highway runoff (Colman *et. al.* 2001) suggested that deicing salts are the main source of cyanide in highway runoff. It has been estimated that approximately two million pounds of sodium ferrocyanide, which is used as an anticaking agent in road salts during the winter in the northeastern United States, are washed off from roads into streams and storm sewers (USEPA 1981; Gaffney *et. al.* 1987). Information on the quality of snow packs and snow melt support the premise that deicing salts are the major source of cyanide in stormwater. For example, concentrations of cyanide in snow packs ranged up to 314 µg/L in Milwaukee and Syracuse (Novotny *et. al.* 1999). An urban stream receiving snow melt in Milwaukee had an average cyanide concentration of 31 µg/L (<2 – 45 µg/L). Two urban streams in Syracuse had average cyanide concentrations of 8 µg/L (<2 – 27 µg/L) and 48 µg/L (<2 – 167 µg/L), respectively. Reconsidering the NURP findings, three of the four cities which detected cyanide are within the snowbelt, and may have used deicing salts containing anti-caking agents. One (Austin, Texas) presumably does not.

In contrast to these relatively high concentrations associated with deicing salts, runoff from cities which do not use deicing salts or from northern cities outside the snow season has lower concentrations of cyanides. The City of Fresno NURP study (Brown & Caldwell, 1984) found undetectable cyanide (< 10 µg/L) in 19 grab samples of stormwater runoff from four watersheds with different land uses. Highway runoff from three urban sites in Michigan had average cyanide concentrations ranging from 5.8 – 9.3 µg/L. Samples were collected from June through October, which was outside the season where deicing salts might be used. Traffic volumes were high and ranged from 40,000 to 120,000 vehicles per day.

It is highly probable that the reported concentrations which exceed the freshwater acute guideline in urban stormwater are associated with the use of deicing salts containing the de-caking agent ferrocyanide. In situations where deicing salts are not being used, and where vehicle exhaust may be the dominant source, concentrations are much less (e.g., typically < 10 µg/L), even with high traffic volumes. Anti-caking agents will not be a source of cyanide in urban stormwater in the NRSP subregion, and the forgoing discussion suggests that concentrations in stormwater runoff from the NRSP projects may reach concentrations of magnitude of approximately 10 µg/L, but are highly unlikely to exceed the acute CTR criteria of 22 µg/L.

The detectable concentrations observed in the Santa Clarita River at the mass emission station S29 (average of 10 µg/L) may be in part due to untreated urban stormwater runoff from the City of Santa Clarita. However, other sources are likely to be more significant. A potential source is cyanide from burnt catchments. For example, cyanide concentrations in run-off obtained from an area that had been burned in a wildfire that occurred in Tennessee and North Carolina averaged 49 µg/L (Barber *et. al.* 2003). Higher cyanide concentrations were reported in run off from a wild fire that occurred in New Mexico, with an average value of 80 µg/L.

In addition to the expected relatively low level of cyanide in untreated stormwater, cyanide in runoff from the NRSP projects would be readily removed by biological uptake, degradation by microorganisms, and by volatilization in the treatment PDFs, especially the dry extended detention basins. Therefore cyanide is not expected to significantly impact the receiving waters of the NRSP projects.

7.3. MS4 Permit Requirements for New Development as Defined in the SUSMP

Project Design Features (PDFs) include site design, source control, and treatment control BMPs in compliance with the SUSMP requirements, as described in Section 5.1 and summarized in Table 5-1. Treatment control PDFs will treat runoff from the entire urban portion of the NRSP subregion. Sizing criteria contained in the MS4 Permit and the SUSMP requirements will be met for all treatment control BMPs.

In summary, the proposed site design, source control, and treatment control PDFs have been selected based on:

- effectiveness for addressing pollutants of concern in project runoff, resulting in insignificant water quality impacts;
- sizing and outlet design consistent with the MS4 Permit and SUSMP requirements;
- additional design guidance consistent with the California BMP Handbook: New Development and Redevelopment, other literature, and best professional judgment;
- hydrologic and water quality modeling to verify performance;
- meeting mean annual percent capture criteria contained in the California BMP New Development Manual; and
- providing specific O&M requirements to inspect and maintain the facilities.

On this basis, the proposed PDFs meet the MS4 Permit requirements for new development.

7.4. Construction-Related Impacts

The potential impacts of construction activities, construction materials, and non-stormwater runoff on water quality during the construction phase focus primarily on sediment (TSS and turbidity) and certain non-sediment related pollutants. Construction-related activities that are primarily responsible for sediment releases are related to exposing soils to potential mobilization by rainfall/runoff and wind. Such activities include removal of vegetation from the site, grading of the site, and trenching for infrastructure improvements. Environmental factors that affect erosion include topographic, soil, and rainfall characteristics. Non sediment-related pollutants that are also of concern during construction relate to construction materials and non-stormwater flows and include construction materials (e.g., paint, stucco, etc); chemicals, liquid products, and petroleum products used in building construction or the maintenance of heavy equipment; and concrete-related pollutants.

Construction impacts due to project development, including the borrow source activities and in-stream construction elements, will be minimized through compliance with the Construction General Permit. This permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP), which must include erosion and sediment control BMPs that will meet or exceed measures required by the Construction General Permit, as well as BMPs that control the other potential construction-related pollutants. Erosion control BMPs are designed to prevent erosion, whereas sediment controls are designed to trap sediment once it has been mobilized. A SWPPP will be developed as required by, and in compliance with, the Construction General Permit and the County of Los Angeles Standard Conditions. The General Permit requires the SWPPP to include a menu of BMPs to be selected and implemented based on the phase of construction and the weather conditions to effectively control erosion and sediment to the BAT/BCT. The following types of BMPs from the Stormwater Best Management Practice Handbook - Construction (CASQA 2003) will be implemented during construction (CASQA Handbook BMP numbers are indicated in parenthesis):

- Erosion Control (EC-3 through EC-7 and WE-1)
  - Physical stabilization through hydraulic mulch, soil binders, straw mulch, bonded fiber matrices, and erosion control blankets (i.e., rolled erosion control products).
  - Limiting the area and duration of exposure of disturbed soils.
  - Soil roughening of graded areas (through track walking, scarifying, sheepsfoot rolling, or imprinting) to slow runoff, enhance infiltration, and reduce erosion.
  - Vegetation stabilization through temporary seeding to establish interim vegetation.
  - Wind erosion (dust) control through the application of water or other dust palliatives as necessary to prevent and alleviate dust nuisance.

- Sediment Control
  - Perimeter protection to prevent discharges through silt fences, fiber rolls, gravel bag berms, sand bag barriers, and straw bale barriers (SE-1, 5, 6, 8 and 9).
  - Storm drain inlet protection (SE-10).
  - Resource (Environmentally Sensitive Area) protection through silt fences, fiber rolls, gravel bag berms, sand bag barriers, and straw bale barriers (SE-1, 5, 6, 8, and 9).

- Sediment capture through sediment traps, storm drain inlet protection, and sediment basins (SE-3, 10, and 2).
- Velocity reduction through check dams, sediment basins, and outlet protection/velocity dissipation devices (SE-2, 4, and 10).
- Reduction in off-site sediment tracking through stabilized construction entrance/exit, construction road stabilization, and entrance /exit tire wash (TE-1, 2 and 3).

- Waste and Materials Management

  - Management of the following types of materials, products, and wastes: solid, sanitary, concrete, hazardous and equipment-related wastes (MW-1, 2, and 4 through 10 and NS-8 through 10).
  - Protection of soil stockpiles through covers, the application of water or soil binders, and perimeter control measures (MW-3).

- Non-stormwater Management

  - BMPs or good housekeeping practices to reduce or limit pollutants at their source before they are exposed to stormwater, including such measures as: water conservation practices, vehicle and equipment cleaning and fueling practices (NS-1 through 16).

- Training and Education

  - Training of individuals responsible for SWPPP preparation, implementation, and permit compliance, including contractors and subcontractors.
  - Signage (bilingual, if appropriate) to address SWPPP-related issues (such as site clean up policies, BMP protection, washout locations, etc).

- Maintenance, Monitoring and Inspections

  - Performing routine site inspections and inspections before, during (for storm events > 24 hours), and after storm events.
  - Implementing maintenance and repairs of BMPs as indicated by routine and storm-event inspections.
  - Preparation and implementation of a Sampling and Analysis Plan for non-visible pollutants.

These construction site management BMPs will be implemented within the NRSP subregion during the dry season and wet season as follows:

7.4.1.1. Dry Season Construction Phase BMPs

a. Wind erosion BMPs (dust control).
b. Soil roughening of graded areas (track walking, scarifying, sheepsfoot rolling, or imprinting).

c. Sediment control BMPs at the down gradient site perimeter and all operational storm drain inlets internal to the planning area.
d. Off-site tracking BMPs.
e. Appropriate waste management and materials pollution BMPs.
f. Appropriate non-storm water BMPs to prevent or reduce the contamination of stormwater by construction activities and materials.
g. A "weather triggered" action plan to deploy standby erosion and sediment control BMPs to protect exposed portions of the site within 48 hours of a predicted storm event.
h. Sufficient standby BMP materials to implement the above action plan.
i. Deployment of post-construction erosion control BMPs as soon as practicable.

7.4.1.2. Wet Season Construction Phase BMPs

In addition to the dry season BMPs noted above:

a. Limiting the area and duration of exposure of disturbed soil areas. This may be accomplished by retention of natural vegetation in areas not scheduled for immediate grading, phasing the grading, and stabilizing disturbed areas quickly.
b. Implementation of an effective combination of erosion and sediment control measures on all disturbed areas.
c. Sufficient standby BMP materials to implement the above weather triggered action plan.

The Construction General Permit does not recognize a wet season by dates; therefore, the wet season requirements will be implemented year round if there is a storm event predicted.

The significance criteria for the project construction phase is implementation of BMPs consistent with Best Available Technology Economically Achievable and Best Conventional Pollutant Control Technology (BAT/BCT), as required by the Construction General Permit and the general waste discharge requirements in the Dewatering General Permit. The projects will reduce or prevent erosion and sediment transport and transport of other potential pollutants from the project site during the construction phase through implementation of BMPs meeting BAT/BCT in order to prevent or minimize environmental impacts and to ensure that discharges during the project construction phase will not cause or contribute to any exceedance of water quality standards in the receiving waters. These BMPs will assure effective control of not only sediment discharge, but also of pollutants associated with sediments, such as and not limited to nutrients, heavy metals, and certain pesticides, including legacy pesticides. In addition, compliance with BAT/BCT requires that BMPs used to control construction water quality are updated over time as new water quality control technologies are developed and become available for use. Therefore, compliance with the BAT/BCT performance standard ensures mitigation of construction water quality impacts over time.

Construction on the project sites may require dewatering and non-stormwater related discharges. For example, dewatering may be necessary for the construction of bridge abutments, bank stabilization, and outfall protection; if groundwater is encountered during grading; or to allow discharges associated with testing of water lines, sprinkler systems and other facilities.

In general, the Construction General Permit authorizes construction dewatering activities and other construction related non-stormwater discharges as long as they (a) comply with Section A.9 of the General Permit; (b) do not cause or contribute to violation of any water quality standards, (c) do not violate any other provisions of the General Permit, (d) do not require a non-stormwater permit as issued by some RWQCBs, and (e) are not prohibited by a Basin Plan provision. Full compliance with applicable local, state and federal water quality standards by the applicant would assure that potential impacts from dewatering discharges are not significant.

An additional Project Design Feature will be implemented to protect receiving waters from dewatering and construction related non-stormwater discharges. Such discharges will be implemented in compliance with the Los Angeles RWQCB's General Waste Discharge Requirements (WDRs) under Order No. R4-2003-0111, NPDES No. CAG994004 governing construction-related dewatering discharges within the Project development areas. Typical BMPs for construction dewatering include infiltration of clean groundwater; on-site treatment using suitable treatment technologies; on-site or transport offsite for sanitary sewer discharge with local sewer district approval; or use of a sedimentation bag for small volumes of localized dewatering. Compliance with these WDRs constitutes a PDF, further assuring that the impacts of these discharges are not significant.

On this basis, the impact of project construction-related runoff is considered less than significant.

7.5. Pollutant Bioaccumulation

Certain pollutants have the potential to accumulate in treatment BMP vegetation and soils, potentially increasing the risk of exposure to wildlife and the food chain. Factors that could affect the extent of potential bioaccumulation include:

- The bioavailability of the pollutant;
- Conditions in the soils (*e.g.,* pH, acid-volatile sulfide concentration, organic content) that affect the form and bioavailability of the pollutant;
- The efficiency by which pollutants in the soils enter the plant community, the storage of these pollutants in plant tissues that are edible, and the utilization of the plants as a food source by animals;
- The type of habitats, organisms attracted to these habitats, and their feeding habits; and

- System design and maintenance.

The primary pollutants of concern with regard to bioaccumulation are mercury and selenium. However, as indicated by the water quality monitoring conducted by LACDPW at the Santa Clara River mass emission station S29 (LACDPW, 2005), selenium and mercury are not naturally present at levels of concern in this watershed. Since these pollutants would not be introduced during Specific Plan build-out, bioaccumulation of selenium and mercury is not expected.

The potential for bioaccumulation impacts from the Specific Plan projects' treatment control facilities, such as bioretention, vegetated swales, and extended detention basins, would be minimal. Since the tributary areas to the BMPs are largely impervious, very little coarse solids and associated pollutants are expected to be generated. The vegetation in the facilities would trap sediments and pollutants in the soils, which contain bacteria that metabolize and transform trace metals, thereby reducing the potential for these pollutants to enter the food chain. The facilities do not provide open water areas and are not likely to attract waterfowl.

Bioaccumulation of pollutants in the Santa Clara River would not be significant due to the low predicted concentrations of pollutants such as trace metals, which are predicted to be below the benchmark CTR criteria in the treated runoff. Also, sediments in the Santa Clara River are transported downstream in the wet season by storm flows, and therefore do not accumulate.

On this basis, the potential for bioaccumulation and adverse effects on waterfowl and other species is considered less than significant.

7.6. Dry Weather Runoff

While there are no specific requirements in the MS4 Permit and the SUSMP requirements to treat dry weather discharges from the NRSP project area, pollutants in dry weather flows could also be of concern because dry weather flow conditions occur throughout a large majority of the year, and because some of the TMDLs in downstream reaches of the Santa Clara River are applicable for dry weather conditions (e.g., nutrients and chloride).

Dry weather flows are typically low in sediment because the flows are relatively low and coarse suspended sediment tends to settle out or is filtered out by vegetation. As a consequence, pollutants that tend to be associated with suspended solids (e.g., phosphorus, some bacteria, some trace metals, and some pesticides) are typically found in very low concentrations in dry weather flows. The focus of the following discussion is therefore on constituents that tend to be dissolved, e.g., nitrate and trace metals, or constituents that are so small as to be effectively transported, e.g., pathogens and oil and grease.

In order to minimize the potential generation and transport of dissolved constituents, landscaping in public and common areas will utilize drought tolerant vegetation that requires little watering and chemical application. Landscape watering in common areas, commercial areas, multiple family residential areas, and in parks will use efficient irrigation technology utilizing evapotranspiration sensors to minimize excess watering.

In addition, educational programs and distribution of materials (source controls) will emphasize appropriate car washing locations (at commercial car washing facilities or the car wash pad in the multi-family residential areas) and techniques (minimizing usage of soap and water), encourage low impact landscaping and appropriate watering techniques, appropriate swimming pool dechlorination and discharge procedures, and discourage driveway and sidewalk washing. Illegal dumping will be discouraged by stenciling storm drain inlets and posting signs that illustrate the connection between the storm drain system and the receiving waters and natural systems downstream.

The bioretention areas, vegetated swales, and the extended detention basins will provide treatment for and infiltrate dry weather flows and small storm events. Water cleansing is a natural function of vegetation, offering a range of treatment mechanisms. Sedimentation of particulates is the major removal mechanism. However the performance is enhanced as plant materials allow pollutants to come in contact with vegetation and soils containing bacteria that metabolize and transform pollutants, especially nutrients and trace metals. Plants also take up nutrients in their root system. Some pathogens would be removed through ultraviolet light degradation. Any oil and grease will be effectively adsorbed by the vegetation and soil within the low flow wetland vegetation. Dry weather flows and small storm flows will infiltrate into the bottom of the basin after receiving treatment in the low flow wetland vegetation.

The treatment control PDFs, without consideration of additional volume reductions potentially achieved in hydromodification controls, will infiltrate or evapotranspire all expected dry weather runoff (see Section 7.9.2 below). It is expected that no dry weather discharge will occur to the Santa Clara River or tributaries. A special exception to the complete infiltration of dry weather flows in the treatment control PDFs would be if it is desired to direct treated dry weather flows from the treatment control PDFs to mitigation habitat adjacent to the tributaries in order to support that habitat. In that case, the treatment PDFs may be lined, and treated dry weather flows would be directed to and fully contained within the mitigation habitat. Based on source control PDFs reducing the amount of dry weather runoff and treatment control PDFs capturing and treating the dry weather runoff that does occur, the impact from dry weather flows is considered less than significant.

7.7. <u>Summary of Surface Water Quality Impacts</u>

7.7.1. Direct Impacts

While runoff volume; ammonia, trace metal, and chloride loads; and dissolved zinc concentration are predicted to increase, concentrations of all modeled constituents (except for dissolved zinc) are predicted to decrease under proposed conditions when compared to existing conditions. The modeled concentrations in runoff from developed areas with PDFs are below all benchmark water quality objectives and criteria and TMDL waste load allocations for the Santa Clara River and are addressed by a comprehensive site design, source control, and treatment control strategy, and compliance with SUSMP, Construction General Permit, and General De-Watering Permit requirements.

Concentrations of hydrocarbons are expected to increase, while concentrations of pathogens, pesticides, and trash and debris may or may not increase under proposed conditions when compared to existing conditions, but none of the qualitatively assessed constituents are expected to significantly impact receiving waters due to the implementation of a comprehensive site design, source control, and treatment control strategy in compliance with the MS4 Permit requirements, Construction General Permit, and General De-Watering Permit requirements. Therefore potential impacts from the NRSP projects on receiving water quality are not expected to be significant.

7.7.2. Cumulative Impacts

This section defines the geographic area of potential impact for the cumulative impacts analysis, and evaluates impacts from probable future projects together with the incremental effects of the proposed NRSP projects to determine effects on water quality and hydromodification within this geographic area. The model results presented below are used in addition to consideration of the other projects reflected in adopted plans and projections for areas tributary to Santa Clara River Reach 5 to get a better overall assessment of cumulative water quality effects on the Santa Clara River.

The geographic area for evaluating cumulative impacts includes the unincorporated area of Los Angeles County west of The Old Road to the Ventura County line. This geographic area includes the Newhall Ranch subregion, the Entrada subregion, the Legacy Village subregion, and the Valencia Commerce Center, as well as existing development in the Six Flags Magic Mountain area and the existing Valencia Water Reclamation Plant.

The proposed Entrada Project site is located directly east of the NRSP area and west of Interstate 5 (Figure 2-1). Entrada is bounded by the Santa Clara River to the east and north, the Mission Village Project within the NRSP to the west, and the Westridge Project to the south. The existing Six Flags Magic Mountain Theme Park is located adjacent to the NRSP and Entrada. The Entrada Project proposes development of single and multi-family residential units, commercial/retail uses, and a hotel on 813 acres. The project also includes private recreational facilities and various trail and road improvements.

The proposed Legacy Village Project is located south of the NRSP area, bordering the Mission Village and Homestead Projects, and north of Stevenson Ranch. The 1,750 acre Legacy Project proposes construction of residential areas and commercial space. Over 1,000 acres of open space will be incorporated into the Legacy Village Project, including 50 acres of parks and trails.

The remaining unbuilt portions of the Valencia Commerce Center are located approximately one-half mile upstream of the confluence of Castaic Creek and the Santa Clara River. Approximately 4 million square feet of building floor area will be developed over the next five to ten years. Additionally, bank stabilization improvements to Castaic Creek and Hasley Creek would be constructed in conjunction with these remaining phases of the Commerce Center.

Urban runoff from the NRSP, Entrada, Legacy Village, and the Valencia Commerce Center project areas will discharge to the Santa Clara River after treatment. Each of the projects will utilize vegetated swales, bioretention areas, and/or dry extended detention basins, as well as a full suite of site design and source control BMPs, to address pollutants of concern in stormwater runoff and dry weather discharges from the proposed projects. Urban runoff from the Magic Mountain Theme Park and the Valencia WRP currently drains to the Santa Clara River and will continue to do so in proposed conditions without any anticipated change to stormwater management controls.

The combined effect on modeled pollutant loads and concentrations of the NRSP, Entrada, Legacy Village, and the Valencia Commerce Center proposed projects and the existing Magic Mountain Theme Park and Valencia WRP are summarized in Tables 7-17 and 7-18 below, respectively. Note that only stormwater impacts from runoff from the Valencia WRP site are included in modeled loads and concentrations; wastewater discharges are not included. As shown in Table 7-17, when considered cumulatively, runoff volumes and loads of TKN, total nitrogen, total phosphorus, metals, and chloride are predicted to increase from the NRSP, Entrada, Legacy Village, and Valencia Commerce Center projects, while pollutant loads are expected to decrease for TSS and nitrate-N + nitrite-N. Pollutant concentrations from the combined projects are predicted to decrease for all modeled parameters (Table 7-18). Increases in pollutant loadings are not anticipated to be significant based on the fact that predicted pollutant concentrations are well below benchmark water quality standards and TMDL wasteload allocations and are primarily within the range of observed concentrations in Santa Clara River Reach 5 (Table 7-19).

Table 7-17: Predicted Average Annual Combined Runoff Volume and Pollutant Loads for the NRSP, Legacy Village, Entrada, and Valencia Commerce Center Projects

Modeled Parameter	Units	Development Condition		Change
		Existing	Developed w/ PDFs	
Volume	acre-ft	1245	3968	2723
Total Suspended Solids	tons	483	302	-181
Nitrate-N + Nitrite-N	tons	5.4	3.3	-2.1
Total Kjeldahl Nitrogen	tons	5.2	9.6	4.4
Total Nitrogen	tons	10.6	12.9	2.3
Total Phosphorus	tons	1.3	1.5	0.2
Total Aluminum	lbs	4030	7396	3366
Dissolved Aluminum	lbs	732	1508	776
Dissolved Copper	lbs	39	99	60
Total Lead	lbs	37	77	40
Dissolved Zinc	lbs	477	670	193
Chloride	tons	44	93	49

7-18: Predicted Average Annual Combined Pollutant Concentrations for the NRSP, Legacy Village, Entrada, and Valencia Commerce Center Projects

Modeled Parameter	Units	Development Condition		Change
		Existing	Developed w/ PDFs	
Total Suspended Solids	mg/L	285	56	-229
Nitrate-N + Nitrite-N	mg/L	3.2	0.6	-2.6
Total Kjeldahl Nitrogen	mg/L	3.1	1.8	-1.3
Total Nitrogen	mg/L	6.3	2.4	-3.9
Total Phosphorus	mg/L	0.8	0.3	-0.5
Total Aluminum	ug/L	1191	685	-506
Dissolved Aluminum	ug/L	216	140	-76
Dissolved Copper	ug/L	12	9	-3
Total Lead	ug/L	11	7	-4
Dissolved Zinc	ug/L	141	62	-79
Chloride	mg/L	26	17	-9

Table 7-19: **Comparison of Predicted Pollutant Concentrations for the NRSP, Entrada, Legacy Village, and Commerce Center 26363 Projects with Water Quality Criteria and Observed Concentrations in Santa Clara River Reach 5**

Modeled Parameter	Units	Predicted Average Annual Concentration	TMDL/ LA Basin Plan Water Quality Objectives	California Toxics Rule Criteria [1]	Wasteload Allocations for MS4 Discharges into the Santa Clara River Reach 5	Range of Observed [2] Concentrations in Santa Clara River Reach 5
Total Suspended Solids	mg/L	56	Water shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect beneficial uses	NA	NA	32 – 6,591
Nitrate-N + Nitrite-N	mg/L	0.6	5	NA	6.8 [3]	0.5 – 4.8
Total Ammonia	mg/L	0.5	2.2 [4]	NA	1.75 [5]	<0.005 – 1.1
Total Nitrogen	mg/L	2.4	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses	NA	NA	<0.04 – 46 [6]
Total Phosphorus	mg/L	0.3		NA	NA	0.18 – 13.4
Dissolved Copper	µg/L	9	NA	32	NA	3.3 – 22.6
Total Lead	µg/L	7	NA	260	NA	0.6 – 40
Dissolved Zinc	µg/L	62	NA	250	NA	3 – 37
Total Aluminum	µg/L	685	NA	750	NA	131 – 19,650
Chloride	mg/L	17	100	NA	100	3 - 121

[1] Hardness = 250 mg/L, based on minimum observed value at USGS Station 11108500. Lead criteria is for total recoverable lead. NAWQC aluminum criteria for pH 6.5 – 9.0.
[2] Range of concentrations observed in the Santa Clara River during wet weather (see Section 2.3.1).
[3] 30-day average.
[4] 4-day average, ELS present, 90th percentile pH and temperature pairing observed at USGS Monitoring Station 11108500.
[5] 30-day average in Reach 5 below Valencia.
[6] Observed values for TKN (ammonia plus organic nitrogen).
NA – not applicable

As discussed above, the anticipated quality of effluent expected from the NRSP projects' PDFs will not contribute concentrations of pollutants of concern that would be expected to cause or contribute to a violation of the water quality standards in the NRSP projects' receiving waters. Therefore, the NRSP projects' incremental effects on surface water quality are not expected to be significant.

The NRSP projects' surface runoff water quality, after PDFs, both during construction and post-development, is predicted to comply with adopted regulatory requirements that are designed by the LARWQCB to assure that regional development does not adversely affect water quality, including: MS4 Permit and SUSMP requirements; Construction General Permit and General Dewatering Permit requirements; and benchmark Basin Plan water quality objectives, CTR criteria, and TMDLs. Any future urban development occurring in the Santa Clara River watershed must also comply with these requirements. By extrapolating the results of the direct and cumulative impact analysis modeling done for this NRSP Sub-Regional Stormwater Mitigation Plan, it can be predicted that analysis of other proposed development combined with existing conditions would have similar water quality results. Therefore, cumulative impacts on surface water quality of receiving waters from the NRSP projects and future urban development in the Santa Clara Watershed are addressed through compliance with the MS4 Permit and SUSMP requirements; Construction General Permit and General Dewatering Permit requirements; and benchmark Basin Plan water quality objectives, CTR criteria, and TMDLs, which are intended to be protective of beneficial uses of the receiving waters. Based on compliance with these requirements designed to protect beneficial uses, cumulative water quality impacts are mitigated to a level that is less than significant.

7.7.2.1. Impacts of Newhall Ranch Reclaimed Water on Santa Clara River Water Quality and Hydrology

In an average rainfall year, all tertiary treated wastewater from the Newhall Ranch WRP would be reclaimed for irrigation, except in the months of October through March. During these months, approximately 286 to 1,025 acre-feet of tertiary-treated wastewater would not be needed to meet non-potable demand and would therefore be discharged to the Santa Clara River. The water quality and hydrologic impacts associated with the discharge of tertiary treated reclaimed water to the Santa Clara River were previously analyzed at the project-level in the Newhall Ranch Specific Plan Revised Draft EIR (Impact Sciences, 1999) as well as the Newhall Ranch Specific Plan Revised Additional Analysis (Impact Sciences, 2003). The conclusions from this project-level impact analysis are summarized below.

Title 22 of the California Administrative Code (Title 22) specifies California's Wastewater Reclamation Criteria (WRC) and all reclaimed water in California must meet or exceed these criteria. These criteria apply to the treatment processes; treatment performance standards, such as removal efficiencies and effluent water quality; process monitoring programs, including type and frequency of monitoring; facility operation plans; and necessary reliability features.

The water quality of the Newhall Ranch WRP discharge will have to comply with federal CWA requirements as specified in a Waste Discharge Requirement (WDR) that must be obtained from the LARWQCB. As required by the CWA, this permit will include effluent limitations for discharges to the Santa Clara River that will be protective of receiving water quality and designated beneficial uses. Effluent limits in the WDR will be developed based on the most stringent of applicable technology-based and water quality-based standards, including Basin Plan objectives, CTR criteria, and applicable TMDL waste load allocations.

As discussed in Final EIR Section 5.0, Subsection 5.2, Flood, the approximately 286 to 1,025 acre-feet of tertiary-treated wastewater that might be discharged to the river from October through March would not represent a significant increase in the volume of floodwaters or in the annual average river flow.

Based on required compliance with State and Federal water quality requirements and the project-level analysis contained in the Newhall Ranch Specific Plan Revised Draft EIR and the Newhall Ranch Specific Plan Revised Additional Analysis, no significant impacts related to discharge of Newhall Ranch reclaimed water would occur on Santa Clara River water quality or hydrology.

7.8. <u>Groundwater Impacts</u>

7.8.1. Direct Groundwater Quality Impacts

Discharge from the NRSP projects' developed areas to groundwater will occur in three ways: (1) through general infiltration of irrigation water, (2) through incidental infiltration of urban runoff in the proposed treatment control and hydromodification control PDFs after treatment, and (3) infiltration of urban runoff, after treatment in the PDFs, in the Santa Clara River, which is the primary recharge zone for groundwater in the Santa Clara Valley. Groundwater quality will be fully protected through implement of the NRSP projects' site design, source control, and treatment control PDFs prior to discharge of project runoff to groundwater.

Per the LARWQCB Clarification Letter (LARWQCB, 2006), generally, the common pollutants in stormwater are filtered or adsorbed by soil, and unlike hydrophobic solvents and salts, do not cause groundwater contamination. In any case, infiltration of one to two inches of rainfall in semi-arid areas like Southern California where there is a high rate of evapotranspiration presents minimal risks.

The pollutant of concern with respect to groundwater is nitrate-N plus nitrite-N. The Basin Plan groundwater quality objective for nitrate-nitrogen plus nitrite-nitrogen is 10 mg/L (which is more stringent than the objective for nitrate-nitrogen alone (10 mg/L) and for nitrite-nitrogen alone (1 mg/L)). The predicted nitrate-nitrogen plus nitrite-nitrogen concentration in runoff after treatment in the project PDFs is 0.6 mg/L, which is well below the groundwater quality objective.

Wastewater generated by the Specific Plan projects will be treated in the Newhall Water Reclamation Plant (WRP). Treatment at the Newhall Ranch WRP will consist of screening, activated sludge secondary treatment with membrane bioreactors, nitrification/denitrification, ultraviolet disinfection, and partial reverse osmosis. Discharges from the Newhall Ranch WRP treatment facility are permitted by a NPDES Permit and Waste Discharge Requirements (WDRs) issued by the LARWQCB in October 2007 (LARWQCB, 2007). Treated effluent from the Newhall Ranch WRP will be used to supply distribution of recycled water throughout the Specific Plan area in the form of irrigation of landscaping and other approved uses. The Newhall Ranch WRP Permit contains effluent limitations that will control the amount of conventional, non-conventional, and toxic pollutants discharged to the receiving waters. These effluent limits are a combination of technology-based limits (per 40 CFR section 122.44(a)) and water quality-based limits (per 40 CFR section 122.44(d)). The effluent limitation contained in the Newhall Ranch WRP Permit for nitrate-N plus nitrite-N is 5 mg/L and the limitation for nitrite-N is 0.9 mg/L (average monthly). As the Basin Plan groundwater quality objective for nitrate-nitrogen plus nitrite-nitrogen is 10 mg/L or 1 mg/L for nitrite-nitrogen, the Newhall Ranch WRP irrigation water supply that will serve the NRSP projects will be well below the groundwater quality objectives.

On this basis, the potential for the NRSP projects to adversely affect groundwater quality is considered less than significant.

7.8.2. Cumulative Groundwater Quality Impacts

As discussed above, the anticipated quality of runoff discharges from the NRSP projects' developed areas and irrigation to groundwater will not contribute loads or concentrations of pollutants of concern that would be expected to cause or contribute to a violation of the groundwater quality standards. By extrapolating these results to existing and proposed development throughout the watershed and based on a review of adapted plans and projections, it is concluded that no adverse cumulative effects would occur to groundwaters. Therefore, the NRSP projects' incremental effects on groundwater quality are not expected to be significant.

The NRSP projects' discharges to groundwater, after PDFs, both during construction and post-development, is predicted to comply with adopted regulatory requirements that are designed by the LARWQCB to assure that regional development does not adversely affect water quality, including: MS4 Permit and SUSMP requirements; Construction General Permit and General Dewatering Permit requirements; and benchmark Basin Plan groundwater quality objectives. Any future urban development occurring in the Santa Clara River watershed must also comply with these requirements. Therefore, cumulative impacts on groundwater quality from the proposed Project and future urban development in the Santa Clara Watershed are addressed through compliance with the MS4 Permit and SUSMP requirements, Construction General Permit requirements, General Dewatering Permit requirements, and benchmark Basin Plan groundwater quality objectives, which are intended to be protective of beneficial uses of the groundwater. Based on compliance with these requirements designed to protect beneficial uses, cumulative groundwater quality impacts are mitigated to a level that is less than significant.

7.8.3. Groundwater Recharge Impacts

7.8.3.1. Direct Project Impacts

In a groundwater basin, the effect of urbanization on recharge to underlying groundwater is dependent on land uses, water uses, vegetative cover, and geologic conditions. Groundwater recharge from undeveloped lands occurs from precipitation alone, whereas areas that are developed for agricultural or urban land uses receive both precipitation and irrigation of vegetative cover. In an urban area, groundwater recharge occurs directly beneath irrigated lands and in drainages whose bottoms are not paved or cemented. A memorandum prepared by CH2M Hill entitled “Effect of Urbanization on Aquifer Recharge in the Santa Clarita Valley” (Appendix E) discusses the general effects of urbanization on groundwater recharge and the specific effects in the Santa Clarita Valley.

Currently the site is irrigated agricultural land. As a result, in the existing condition recharge occurs within the Project site from irrigation and precipitation. On one hand, development of the site will introduce impervious surface over approximately 30 percent of the NRSP subregion, which will tend to reduce recharge. In addition, development of agricultural lands will eliminate agricultural irrigation as a source of recharge. On the other hand, development of the site will increase runoff volume discharged after treatment to the Santa Clara River, whose channel is predominantly natural and consists of vegetation and coarse-grained sediments (rather than concrete). The porous nature of the sands and gravels forming the streambed will allow for significant infiltration to occur to the underlying groundwater. Also, the Project will introduce landscaping, irrigation, and PDFs designed to infiltrate runoff. These project effects will increase groundwater recharge from the Project. On balance, it is unlikely that the NRSP projects will result in a significant change in groundwater recharge in the project vicinity. Based on the above discussion, the NRSP projects’ impact on groundwater recharge is considered less than significant.

7.8.3.2. Cumulative Impacts

Increased urbanization in the Valley has resulted in the irrigation of previously undeveloped lands. The effect of irrigation is to maintain higher soil moisture levels during the summer than would exist if no irrigation were occurring. Consequently, a greater percentage of the fall/winter precipitation recharges groundwater beneath irrigated land parcels than beneath undeveloped land parcels. In addition, urbanization in the Santa Clarita Valley has occurred in part because of the importation of State Water Project (SWP) water, which began in 1980. SWP water use has increased steadily, reaching nearly 44,500 acre-feet (AF) in 2003. Two-thirds of this water is used outdoors, and a portion of this water eventually infiltrates to groundwater. The other one-third is used indoors and is subsequently routed to local water reclamation plants (WRPs) and then to the Santa Clara River (after treatment). A portion of this water flows downstream out of the basin, and a portion infiltrates to groundwater.

Records show that groundwater levels and the amount of groundwater in storage were similar in both the late 1990s and the early 1980s, despite a significant increase in the urbanized area during these two decades. This long-term stability of groundwater levels is attributed in part to the significant volume of natural recharge that occurs in the streambeds, which do not contain paved, urban land areas. On a long term historical basis, groundwater pumping volumes have not increased due to urbanization, compared with pumping volumes during the 1950s and 1960s when water was used primarily for agriculture. Also, the importation of SWP water is another process that contributes to recharge in the Valley. In summary, urbanization has been accompanied by long-term stability in pumping and groundwater levels, plus the addition of imported SWP water to the Valley, which together have not reduced recharge to groundwater, nor depleted the amount of groundwater that is in storage within the Valley.

Based on the above discussion, the cumulative impact on groundwater recharge is considered less than significant.

7.9. Hydromodification Impacts

Development typically increases impervious surfaces on formerly undeveloped (or less developed) landscapes, reducing the capture and infiltration of rainfall. The result is that, as a watershed develops, a larger percentage of rainfall becomes runoff during any given storm. In addition, runoff reaches the stream channel more efficiently due to the development of storm drain systems, so that the peak discharge rates for rainfall events and floods are higher for an equivalent event than they were prior to development. Further, the introduction of irrigation and other dry weather flows can change the seasonality of runoff reaching natural receiving waters. These changes, in turn, affect the stability and habitat of natural drainages, including the physical and biological character of these drainages. This process, termed “hydromodification” (SCCWRP, 2005a) is addressed in this section.

Significant adverse hydromodification impacts are presumed to occur if the proposed project would:

- Substantially alter the existing drainage pattern of a natural drainage, stream, or river causing substantial erosion, siltation, or channel instability; or

- Substantially increase the rates, velocities, frequencies, duration and/or seasonality of flows causing channel instability and harming sensitive habitats or species in natural drainages in a manner that substantially adversely affects beneficial uses.

Natural or naturalized drainages[8] which will receive flows from developed areas within the NRSP subregion are: the Santa Clara River, Long Canyon, Potrero Canyon, Chiquito Canyon, and San Martinez Grande Canyon. Flows from developed areas within the NRSP subregion will not be discharged to the other tributaries shown on Figure 2-3. Therefore, this analysis addresses the potential for hydromodification impacts to the Santa Clara River, Long Canyon, Potrero Canyon, Chiquito Canyon, and San Martinez Grande Canyon as a result of the NRSP projects.

The physical alteration of natural drainages, such as bank protection, energy dissipaters, and bridge abutments, are not impacts created by changes in runoff seasonality, volume, duration, or flow associated with development. Instead, these types of alterations are physical alterations to the stream bed and bank, with associated effects on stream habitat and species. These type of effects are analyzed in the Newhall Ranch Resource Management and Development Plan and Spineflower Conservation Plan Draft Joint Environmental Statement and Environmental Impact Report (SCH #2000011025).

7.9.1. Wet Weather Flows

7.9.1.1. Direct Impacts to the Santa Clara River and Tributaries

The NRSP projects would develop approximately 31 percent (3,665 acres) of the total 11,999 acre NRSP area. The size of the NRSP area in comparison to both the 1,618 square mile total Santa Clara River watershed area and the expected total impervious area in the watershed in the existing conditions and at build-out is small. It is estimated, based on the land use data provided by LACDPW from adopted General Plans within the watershed, that the NRSP projects will comprise approximately five percent of the total impervious area in the Santa Clara River watershed above the NRSP area at ultimate planned build-out for the watershed. See Section 4.4.3 above for information regarding adopted plans and projections used to derive build-out assumptions for the watershed.

Three strategies will be used in the NRSP projects to prevent and control hydromodification impacts to the Santa Clara River and the Tributaries:

- Project-based hydrologic source control,
- Project-based flow duration control, and
- Geomorphically-referenced channel design.

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[8] The term naturalized drainage means a drainage with some geomorphically-referenced engineering, but which retains natural bed and/or bank throughout the drainage, thereby retaining certain natural functions and habitat.

Geosyntec Consultants has developed and used a state-of-the-art analytical technique to evaluate and address hydromodification impacts that result from watershed development (see Appendix G for further detail). This unique approach has been developed to provide a more accurate comparison of the changes that take place in stormwater runoff, stream flows, and sediment transport characteristics due to watershed development than traditional hydrologic analysis methodologies. Hydromodification control PDFs developed with this methodology are intended to protect the tributaries Long Canyon, Potrero Canyon, Chiquito Canyon, and San Martinez Grande Canyon (the "Tributaries") from excessive erosion and degradation by discharges from the NSRP projects. Direct and indirect discharges to the Santa Clara River from the NRSP projects are not expected to cause channel instability (Balance Hydrologics, 2005, see further *Cumulative Impacts* below), particularly with design controls that will protect the stability and integrity of the Tributaries.

Three hydromodification control management approaches are available to protect the Tributaries:

1. Hydromodification control using hydrologic source control and flow duration control basins only (called "on-site control").

2. Hydromodification control using naturalized in-stream grade stabilization (or drop) structures to provide an equilibrium slope that maintains the existing sediment transport capacity (called "in-stream control").

3. Hydromodification control using a combination of on-site control and in-stream control.

The choice of a hydromodification management approach or approaches will be dictated by the strategies that are appropriate given the conditions of each channel and its contributing watershed within the NRSP project and the standards and criteria set forth in this report. Consequently, a suite of the above management approaches will be applied to provide a comprehensive solution to managing potential increases in runoff to the Tributaries due to land use change.

Hydromodification control PDF selection for each NRSP project will be finalized at the time of Project Water Quality Technical Report preparation subject to the requirement that the final hydromodification control PDFs selected for each project shall meet or exceed the hydromodification control performance standard set forth below. The Project Water Quality Technical Report will provide project-level information and detail concerning how the provisions of this NRSP Sub-Regional SWMP will be implemented within the area covered by the individual Project Water Quality Technical Report.

The following performance standard has been defined for discharges from the NRSP projects to the Tributaries:

The erosion potential (Ep) of stormwater discharges from the Project shall be maintained within 20% of the target value in the tributary drainages that will receive post-development flows. The target erosion potential (Ep) will consider changes in sediment supply.

The hydromodification performance standard will be met for all of the NRSP projects as follows:

1. The NRSP projects shall provide hydromodification controls for discharges to the tributary drainages as needed to meet the performance criteria stated above, as further prescribed in 2) and 3) below.

2. Hydromodification controls shall consist of on-site or in-stream controls, or a combination thereof.

3. In-stream controls shall be designed to achieve the hydromodification performance standard from the point of discharge to the drainage channel downstream to the confluence of the tributary drainage with the Santa Clara River.

7.9.1.2. Project-based Hydrologic Source Control

Disconnecting impervious areas from the drainage network and adjacent impervious areas is a key approach to protecting channel stability. Several hydrologic source controls will be included in the NRSP projects that will limit impervious area and disconnect imperviousness:

Low Impact/Site Design PDFs. Low impact/site design PDFs will help to reduce the increase in runoff volume, including the clustering of development into village areas, leaving large amounts of undeveloped open space within the NRSP subregion; routing of impervious area runoff to vegetated areas; use of native and drought tolerate plants in landscaped areas; and the use of efficient irrigation systems in common area landscaped areas. The reduction in runoff volume attributable to some of these low impact/site design PDFs were not quantified in the runoff modeling, so these PDFs will reduce the predicted increase in runoff volumes discussed below. These measures will help to protect the stability of both the Santa Clara River and the Tributaries and to avoid and minimize direct impacts to those drainages.

Treatment Controls. The projects' treatment control PDFs will also serve as hydromodification source control BMPs. Vegetated BMPS such as vegetated swales, filter strips, extended detention basins, and bioretention areas with underdrains can provide volume reduction on the order of 20 to 30 percent through infiltration and evaporation. Some bioretention areas, if site conditions are suitable, may not utilize underdrains. In these cases, all water captured in the bioretention areas without underdrains would be effectively removed from the project's stormwater discharges. Collectively, these vegetated treatment facilities are expected to provide significant reduction in wet weather runoff. In addition, these facilities will also receive and eliminate dry weather flows.

The increase in impervious surface within the NRSP area is predicted to increase the average annual stormwater runoff volume from the project area by approximately 2,001 acre-feet per year, after accounting for the estimated 20 percent volume reduction in the proposed treatment control PDFs (see Section 7.1 above). The hydromodification control PDFs discussed below, on-site controls and geomorphically-referenced in-stream controls, will be implemented such that direct impacts to the Santa Clara River or the Tributaries from the increased runoff volume are avoided, minimized, and mitigated.

7.9.1.3. Project-based On-Site Control

Flow duration control basins for on-site control, discussed in Appendix G, would be sized to ensure no change in cumulative duration of flows greater than the critical flow for bed or bank mobility. Appendix G presents a set of normalized sizing charts developed for the Specific Plan area that can be used to estimate the unit total storage volume and capture volume (acre-inches per acre of tributary area) based on the imperviousness of the flow duration basin's tributary catchment area and the tributary area soil type (or infiltration rate). These sizing charts are intended for planning purposes only. At the time that Project Water Quality Technical Reports are prepared, flow duration control facilities, if utilized, would be sized using more detailed project level information. This sizing would maintain the standard for assuring no change in the cumulative duration of flows greater than critical flow for bed/bank mobility. Flow duration control basins may be used alone or in conjunction with in-stream hydromodification controls (geomorphically-referenced channel design) to prevent exceedances of the critical flow to the Tributaries.

7.9.1.4. Geomorphically-Referenced Channel Design

The hydromodification management approach for the Santa Clara River and the Tributaries will incorporate "geomorphically-referenced river engineering" for in-stream controls as described in SCCWRP Technical Report 450 (SCCWRP, 2005a). The goal of this approach is to preserve the appearance of the natural stream channel to the maximum extent practicable while maintaining stability in stream channel morphology. In the Tributaries, geomorphic principles will be used in combination with on-site controls to design stable stream channels given the expected hydrologic and sediment regimes of each tributary. A minimum of hard, engineered structural elements will be used within the stream channel so that a natural appearance will be preserved while the new stream channel form can remain stable.

Within the Santa Clara River, the development footprint will allow for the greatest freedom possible for "natural stream channel" activity. This includes establishing buffer zones and maintaining setbacks to allow for channel movement and adjustment to changes in energy associated with runoff.

The engineered structural elements that will be implemented include energy dissipation, bank stabilization, and grade stabilization structures, described below.

- *Energy Dissipation*. Erosion protection will be provided in areas where discharges have the potential to cause stream erosion. Erosion protection will be provided at all storm drain outlets to the Santa Clara River and the Tributaries.

- *Bank Stabilization*. Bank protection will be installed along portions of the Santa Clara River and the Tributaries where necessary to protect against flooding and erosion pursuant to Federal Emergency Management Administration (FEMA) and Los Angeles County Department of Public Works' requirements. The locations for the bank stabilization will be selected so that bank protection along the river would generally be placed in non-jurisdictional upland areas adjacent to the river. Installing bank protection in non-jurisdictional areas reduces and/or avoids impacts to the river and has the potential to create new riverbed areas, allows for channel movement and adjustment to changes in energy associated with runoff, and increases riparian habitat.

- *Grade Stabilization Structures.* Grade stabilization structures will be installed in four Tributaries (Long Canyon, Potrero Canyon, Chiquito Canyon, and San Martinez Grande Canyon) to maintain sediment equilibrium and protect the channel bed and banks from hydromodification impacts. Grade stabilization structures will also be installed in Lion Canyon in order to stabilize and restore the drainage. The grade stabilization structures are intended to create stable drainage channels that will support in-channel habitat following project implementation.

7.9.1.5. Conclusion

In summary, although Project runoff volumes, flow rates, and durations will increase, potential impacts of hydromodification (i.e., the potential to cause erosion, siltation, or channel instability) will be minimized by the Project PDFs in the following ways:

- Project low impact/site design and on-site treatment and flow duration control PDFs will avoid and/or minimize increases in runoff volume from the development area, the preferred method for controlling hydromodification impacts from new development (SCCWRP, 2005a).

- Concentrated flows will be mitigated with energy dissipaters at the discharge points to the Santa Clara River and to the Tributaries. The Santa Clara River and Tributary banks will be protected primarily with vegetated buried bank stabilization in non-jurisdictional upland areas adjacent to the river. This type of biostabilization technique is the preferred approach for bank stabilization (SCCWRP, 2005a). In the Tributaries, geomorphic principles will be used in combination with on-site controls to design stable stream channels given the expected hydrologic and sediment regimes of each tributary. A minimum of hard, engineered structural elements will be used within the stream channel so that a natural appearance will be preserved while the new stream channel form can remain stable.

Hydromodification control PDFs, including a combination of on-site controls and/or in-stream controls designed to meet the performance standard set forth in this Report and by reference to the framework set forth in Appendix G, will protect the Santa Clara River and Tributaries from excessive erosion and degradation by discharges from the NSRP projects. For this reason, the wet weather direct hydromodification impacts of the NRSP projects with PDFs on the Santa Clara River and the Tributaries are considered less than significant.

7.9.1.6. Cumulative Impacts

The assessment of direct hydromodification impacts to the Tributaries above constitutes a cumulative analysis for those drainages because it takes into account total permissible development within each Tributary watershed.

As identified in the MS4 Permit, increased volume, velocity, and discharge duration of stormwater runoff from the cumulative existing and future developed areas in watersheds of natural drainages, including the Santa Clara River, has the potential to accelerate downstream erosion and impair stream habitat. Given the very large size of the Santa Clara River watershed, the contribution of the NRSP projects to cumulative hydromodification impacts to the Santa Clara River is difficult to assess quantitatively. Therefore, a qualitative assessment that references total predicted development per adopted General Plans and projections for the Santa Clara River watershed is provided below.

Effect of Watershed Impervious Area

The limited hydromodification impact research to date has focused on empirical evidence of channel failures in relationship to directly connected impervious area (DCIA) or total impervious area. However, more recent research has established the importance of size of watershed, channel slope and materials, and climatic and precipitation patterns (SCCWRP 2005a, Balance Hydrologics 2005 (provided in Appendix F)). Impervious area that drains directly to a storm drain system and then to the receiving water is considered “directly connected,” whereas impervious area that drains through vegetation or to infiltration facilities is considered “disconnected.”

Booth and Jackson (1997) reported finding a correlation between loss of channel stability and increases in DCIA. In Washington State, streams were found to display the onset of degradation when the DCIA increases to ten percent or more, and a lower imperviousness of five percent was found to cause significant degradation in sensitive watersheds (Booth and Jackson, 1997). The Center for Watershed Protection (Schuler and Holland, 2000) described the impacts of urbanization on stream channels and established thresholds based on total imperviousness within the tributary drainage area. It states “a threshold for urban stream stability exists at about 10 percent imperviousness." It further states that a "sharp threshold in habitat quality exists at approximately 10 percent to 15 percent imperviousness." These studies, however, addressed changes in a very different climatic region than Southern California.

Geosyntec's work in the San Francisco Bay area's Santa Clara Valley (Geosyntec, 2004) also evaluated the relationship between imperviousness and stream channel degradation in an area that had predominately directly connected impervious areas. Geosyntec found similar results to those published by Booth and Schuler, where channel erosion was observed at approximately six to nine percent imperviousness for two separate watershed systems. More recent studies conducted by Geosyntec in this same watershed area showed that levels as low as two to three percent total imperviousness could lead to stream channel degradation, depending on channel characteristics. This region also has different climatic characteristics than Southern California.

Although physical degradation of stream channels in semi-arid climates of California may be detectable when watershed imperviousness is between three and five percent, not all streams will respond in the same manner (SCCWRP, 2005b). Management strategies need to account for differences in stream type, stage of channel adjustment, current and expected amount of basin imperviousness, and existing or planned hydromodification control strategies.

The absolute measure of watershed imperviousness that could cause stream instability in the Santa Clara River depends on many factors, including watershed area, land cover, and soil type; development impervious area and connectedness; reduced sediment yield; longitudinal slope of the river; channel geometry; and local boundary materials, such as bed and bank material properties and vegetation characteristics. Based on land use data provided by the County of Los Angeles (see Section 4.4.3 above), the estimated cumulative level of percent impervious area at build-out in the Santa Clara River watershed upstream from the NRSP area is nine percent.

Effect of Catchment Drainage Area

The Southern California Coastal Water Research Project (SCCWRP) found signs of hydromodification impacts in Southern California streams when watershed percent imperviousness was around two to three percent for streams with a catchment drainage area of less than five square miles (mi^2) (SCCWRP, 2005a). Recognizing that their findings were based on the type and size of catchments that were measured, the researchers in the SCCWRP study attempted to develop a framework by which their results could be extended to other stream types. They developed a classification system based on watershed characteristics, stream channel characteristics (including level of vegetative development), and stream channel resistance, and suggested these features could be important in selecting management strategies and approaches to control hydromodification impacts. The Level 1 classification is based on watershed characteristics that include the size, shape, and topography of the watershed.

The catchment drainage area (CDA) is stated to be the most obvious differentiator among watersheds, as this is likely to have the greatest effect on runoff. The SCCWRP study focused on small watersheds (< 5 mi^2), whereas the CDA of the Santa Clara River at the Los Angeles County line, near the western edge of the NRSP area (the Upper Watershed), is about 640 mi^2. Based on the differences in CDA, the SCCWRP findings with respect to CDA would not be applicable to the Santa Clara River. Information in the SCCWRP report, based in part on the work of Zielinski (2002), suggests that smaller watersheds are more responsive and sensitive to changes in land use, whereas larger watersheds (> 30 mi^2) were said to be less responsive to land use changes. Geosyntec's work in the San Francisco Bay area found significant hydromodification impacts on streams of watersheds that were 40 mi^2 in size; however, this is still substantially smaller than the Santa Clara River watershed at the Los Angeles County line. Given the large CDA for the Santa Clara River, the river is likely less responsive to potential hydromodification effects, but channel morphology must still be examined to determine the level and potential significance of Santa Clara River response.

Application to the Santa Clara River

Balance Hydrologics assessed the potential effects of the planned cumulative urbanization within the Santa Clara River upstream of the County line (the upper watershed) on channel morphology by examining historical changes in the Santa Clara River channel pattern in response to different types of major disturbance using historical rainfall and other relevant records and aerial channel photography (Balance Hydrologics, 2005 (provided in Appendix F)). The findings of this analysis are summarized below.

The Santa Clara River is a dynamic, episodic system. Understanding the magnitude of geomorphic change over the course of recent history in response to natural and human disturbances in the watershed is a key factor in assessing the potential response to future urbanization within the watershed.

For example, the report examines the construction of Castaic Dam in the 1974 (affecting approximately 30 percent of the Santa Clara River watershed above Castaic Creek), which cut off a significant supply of sediment to the Santa Clara River. This change, however, does not appear to have had an effect on the channel dimensions of the Santa Clara River mainstem. The width of the active corridor as well as the general form of the channel are generally consistent before and after construction of the dam. It appears that the Santa Clara River had enough buffering capacity to absorb this change. The report finds that the depletion of sediment supply to the mainstem, which would typically be expected to cause erosive effects, did not, in fact, result in those effects, perhaps because reductions in sediment were offset by additional available sediment stored in the basin in the upper watershed as a result of movement along the San Gabriel fault.

Similarly, the report examines the amount of vegetation within the Santa Clara River corridor, which appears to have generally increased since the 1960s, likely due to the increase in available summer flows due to the Valencia and Saugus Water Reclamation Plants' discharges. However, this vegetation does not seem to provide enough erosion resistance to maintain a "stable" channel capable of withstanding regular 're-sets', large events that completely alter the form of the Santa Clara River channel which occur at intervals averaging about a decade, or much less than the expected lifetime of the riparian woodlands which do get established. Despite heavy vegetation on the channel banks near the NRSP area and in areas of ground-water upwelling, the stream still responds to large events by a general widening and/or shift of the active channel within the River corridor.

After studying the response of the river to several different anthropogenic and natural disturbances, the report concludes that the Santa Clara River, as with many streams in semi-arid southern California, is highly episodic. Concepts of "normal" or "average" sediment-supply and flow conditions have limited value in this "flashy" environment, where episodic storm and wildfire events have enormous influence on sediment and storm flow conditions. In these streams, a large portion of the sediment movement events can occur in a matter of hours or days. Other perturbations which can potentially affect channel geometry appear to have transitory or minor manifestations. For example, effects on the channel width due to the 1980s levee construction were barely discernible by the first few years of the 21st century, probably mostly due to morphologic compensation associated with the storm events in the mid- to late-1990s. As a result, channel morphology, stability, and character of the Santa Clara River is almost entirely determined by the "reset" events that occur within the watershed.

Fluvial Study

Additional study of the Santa Clara River has been performed by Pacific Advanced Civil Engineering, Inc., who prepared a comprehensive fluvial analysis for Santa Clara River through the NRSP area (PACE, 2006) for LACDPW. A river fluvial analysis is the study of the river bed and bank sediment movement over time and as a result of flow in the river and changes in the tributary watershed.

The fluvial analysis had three distinct components:

1. Analysis of long term trends of river bed and bank sediment build-up (aggradation) or removal (degradation) was performed. More than 80 years of available historic topographic mapping of the river indicated no real trend of aggredation or degradation in the study reach.

2. General (capital storm event) aggredation/degradation calculations were performed to determine the expected fluvial response of the river to the LACDPW design storm event (>140,000 cfs). US Army Corps of Engineers computer modeling software (SAM) was

used to evaluate existing and proposed project conditions. Only minor variations in the fluvial response were shown in the modeling.

3. Local aggredation/degradation resulting from river curvature, bridges, river bed material, and various other components were considered and estimates of aggredation and degradation were calculated.

To complete the fluvial analysis, long term, general, and local aggredation/degradation components were added together to obtain the total aggredation/degradation for each river section within the study reach.

One of the purposes for the fluvial analysis, which has been approved by LACDPW, was to provide a level of understanding of the Santa Clara River Newhall Ranch reach fluvial mechanics related to existing conditions and proposed NRSP development conditions to identify any potential project impacts. The fluvial analysis showed very little change between the pre- and post-development conditions and therefore concluded that there is no potential adverse impact to the fluvial mechanics of the river.

Conclusion

As discussed above, the NRSP projects will include a number of hydrologic source control PDFs that will substantially lessen any potential contribution to cumulative hydromodification impacts to the Santa Clara River. In addition, it is presumed that all future development within the watershed will implement hydromodification controls to meet flow criteria that will be adopted by the LACDPW under Part 4, § D.1 of the MS4 Permit. These measures are designed to mitigate and prevent direct and cumulative hydromodification impacts.

Within the Santa Clara River watershed, major perturbations (urbanization, dam construction, levee construction, decadal changes in climate, and increases in woody vegetation) do not appear to have had a significant impact on the geomorphic expression of the Santa Clara River. Large "re-set" events (those which are typically not as affected by increases in impervious area) have episodically completely altered the form of the Santa Clara River channel. These events, occurring on average once every ten years, are a dominant force in defining channel characteristics. The geomorphic dominance of "re-set" events determines the geomorphic character of the Santa Clara River and the Santa Clara River's response to anthropogenic perturbations, including hydromodification impacts associated with development, is expected to be minimal in light of the "re-set" driven nature of the Santa Clara River channel. Due to these episodic "re-sets," "unraveling" of the Santa Clara River mainstem due to hydromodification associated with cumulative urban development within the watershed, as is seen in many smaller southern California watersheds, is not expected to occur. The "re-set" events appear to adequately buffer changes that may occur in short-term sediment transport, between re-set events.

Based upon the above discussion, that the NRSP projects include hydromodification controls as Project Design Features, that the NRSP projects will be conditioned to include Project Design Features to meet the performance standard established in this Report to protect the Tributaries from hydromodification impacts, that future development projects within the watershed will control flow in compliance with the regional program, and that large-scale changes naturally occur in the Santa Clara River in response to major episodic events, the NRSP projects' contribution to cumulative hydromodification impacts to the Santa Clara River and the Tributaries will be less than significant and consistent with the requirements of the MS4 permit.

7.9.2. Dry Weather Runoff

7.9.2.1. Direct Impacts

In order to quantitatively address dry weather impacts, a dry weather water balance was performed. The quantity of dry weather flows from urban sources is variable and not easily quantified. Information available from the Irvine Ranch Water District suggests an average dry weather flow from urban areas of 2.9×10^{-4} cfs per urbanized acre (IRWD, 2003). Dry weather flow estimates in Santa Monica, used to design a dry weather flow recycling facility, indicate a range of dry weather flows between 8.3×10^{-5} to 1.8×10^{-4} cfs per urbanized acre (Antich *et. al.*, 2003). For purposes of conservatively estimating the impacts of dry weather flows, a dry weather discharge of 3.0×10^{-4} cfs per urbanized acre was used in this report. Table 7-20 presents a monthly dry weather flow balance for the NRSP area. The treatment control BMPs were conservatively assumed to infiltrate at 0.05 inches per hour, which is representative of compacted Hydrologic Group Type C soils (e.g., clay loams, shallow sandy loams, soils low in organic matter, and soils usually high in clay). Infiltration volume was calculated as the BMP bottom area times the infiltration rate. Evapotranspiration rates were conservatively assumed to be 60% of reference rates from the California Irrigation Management Information System (CIMIS) Zone 14, in which the NRSP area is located. It was assumed that open space in the NRSP area would result in no dry weather runoff.

It is predicted that all dry weather flows will be infiltrated or removed by evapotranspiration in the treatment control PDFs, which also provide hydrologic source control. As a result, no appreciable change in seasonality of flows is anticipated to result from development.

Based on comprehensive site planning, source control, and treatment control strategy and the water balance analysis, the impact of the NRSP projects on dry weather water quality and seasonality of flow in the Tributaries and the River is considered less than significant.

Table 7-20: Predicted Dry Weather Water Balance

Month	Dry Weather Flow (af)[1]	ETo Capacity (af)[2]	Infiltration Capacity (af)[3]	Excess Capacity (af)[4]
January	65.1	2.1	85.4	22.4
February	58.8	3.1	77.1	21.4
March	65.1	5.1	85.4	25.4
April	63.0	7.0	82.6	26.6
May	65.1	9.4	85.4	29.7
June	63.0	10.7	82.6	30.4
July	65.1	12.0	85.4	32.2
August	65.1	10.7	85.4	30.9
September	63.0	7.8	82.6	27.5
October	65.1	5.6	85.4	25.8
November	63.0	2.9	82.6	22.5
December	65.1	2.1	85.4	22.4

[1] Based on dry weather flow of 0.0003 cfs/acre from a range of researched values.
[2] 60% of reference evapotranspiration rate (ETo) from CIMIS Zone 14.
[3] Equal to 0.05 in/hr over BMP bottom area.
[4] Equal to (ETo + Infiltration Capacity) – Dry Weather Flow.

8. CONCLUSIONS

This section summarizes the potential effects, if any, of the NRSP projects on water quality and hydromodification in Santa Clara River Reach 5.

8.1. Water Quality Impacts

The following are the conclusions regarding the significance of impacts for the pollutants of concern under wet and dry weather conditions:

- ***Sediments*****:** MS4 Permit, Construction General Permit, Dewatering General Permit, and SUSMP-compliant BMPs will be incorporated into the NRSP projects to address sediment in both the construction phase and post-development. Mean total suspended solids concentration and load are predicted to be less in the post-development condition than in the existing condition. Turbidity in stormwater runoff will be controlled through implementation of a Construction SWPPP and will be permanently reduced through the stabilization of erodible soils with development. On this basis, the impact of the NRSP projects on sediments is considered less than significant.

- ***Nutrients (Phosphorus and Nitrogen (Nitrate-N + Nitrite-N and Ammonia-N))***: MS4 Permit, Construction General Permit, Dewatering General Permit, and SUSMP-compliant BMPs will be incorporated into the NRSP projects to address nutrients in both the construction phase and post-development. Although total ammonia loads are predicted to increase, total nitrogen and nitrate-nitrogen plus nitrite-nitrogen concentrations and loads are predicted to decrease in the post-developed condition. Total phosphorus loads and concentration are predicted to decrease in post-development conditions and concentrations are predicted to be below the minimum observed value in the Santa Clara River. Nitrate-N plus nitrite-N and ammonia-N concentrations are predicted to decrease with development to a point well below LA Basin Plan objectives and below or in the low range of observed values in the Santa Clara River Reach 5. The predicted nutrient concentrations are not expected to cause increased algal growth. On this basis, the impact of the NRSP projects on nutrients is considered less than significant.

- ***Trace Metals*****:** MS4 Permit, Construction General Permit, General Dewatering Permit, and SUSMP-compliant BMPs will be incorporated into the NRSP projects to address trace metals in both the construction phase and post-development. The trace metals mean loads and dissolved zinc concentration are predicted to increase with NRSP project development, while total aluminum, dissolved copper, and total lead concentrations are predicted to decrease. Mean concentrations of dissolved copper, total lead, dissolved zinc, and total aluminum are below benchmark Basin Plan objectives, CTR criteria, and the NAWQC criterion for aluminum. Cadmium is not expected to be present in runoff discharges from the NRSP projects. On this basis, the impact of the NRSP projects on trace metals is considered less than significant.

- ***Chloride*****:** MS4 Permit, Construction General Permit, Dewatering General Permit, and SUSMP-compliant BMPs will be incorporated into the NRSP projects to address chloride in both the construction phase and post-development. Although the chloride load is predicted to increase, the mean concentration of chloride is predicted to decrease with development and the predicted concentration is well below the LA Basin Plan objective and is near the low range of observed values in the Santa Clara River Reach 5. On this basis, the impact of the NRSP projects on chloride is considered less than significant.

- ***Pesticides*****:** Pesticides in runoff may or may not increase in the post-development phase as a result of landscape applications. Proposed pesticide management practices, including source control, removal with sediments in treatment control PDFs, and advanced irrigation controls, in compliance with the requirements of the MS4 Permit and the SUSMP will minimize the presence of pesticides in runoff. During the Construction phase of the NRSP projects, erosion and sediment control BMPs implemented per General Permit and General De-Watering Permit requirements will prevent pesticides associated with sediment from being discharged. Final site stabilization will limit mobility of legacy pesticides that may be present in pre-development conditions. On this basis, the impact of the NRSP projects on pesticides is considered less than significant.

- ***Pathogens*****:** Post-development pathogen sources include both natural and anthropogenic sources. The natural sources include bird and mammal excrement. Anthropogenic sources include leaking septic and sewer systems and pet wastes. The NRSP projects will not include septic systems and the sewer system will be designed to current standards which minimizes the potential for leaks. Thus pet wastes are the primary source of concern. The PDFs will include source controls and treatment controls which in combination should help to reduce pathogen indicator levels in post-construction stormwater runoff. Pathogens are not expected to occur at elevated levels during the construction-phase of the NRSP projects. On this basis, the NRSP projects' impact on pathogen and pathogen indicators is considered less than significant.

- ***Hydrocarbons*****:** Hydrocarbon concentrations will likely increase in post-development because of vehicular emissions and leaks. In stormwater runoff, hydrocarbons are often associated with soot particles that can combine with other solids in the runoff. Such materials are subject to treatment in the proposed extended detention basins, bioretention areas, and vegetated swales. Source control BMPs incorporated in compliance with the MS4 Permit and the SUSMP requirements will also minimize the presence of hydrocarbons in runoff. During the construction phase of the NRSP projects, pursuant to the Construction General Permit, the Construction Stormwater Pollution Prevention Plan must include BMPs that address proper handling of petroleum products on the construction site, such as proper petroleum product storage and spill response practices, and those BMPs must effectively prevent the release of hydrocarbons to runoff per the Best Available Technology Economically Achievable and Best Conventional Pollutant

Control Technology standards. On this basis, the impact of the NRSP projects on hydrocarbons is considered less than significant.

- ***Trash and debris*****:** Trash and debris in runoff are likely to increase in post-development if left unchecked. However, the PDFs, including source control and treatment BMPs incorporated in compliance with the MS4 Permit and the SUSMP requirements, will minimize the adverse impacts of trash and debris. Source controls such as street sweeping, public education, fines for littering, covered trash receptacles, and storm drain stenciling are effective in reducing the amount of trash and debris that is available for mobilization during wet weather. Trash and debris will be captured in catch basin inserts in the commercial area parking lots and in the treatment control PDFs. During the construction phase of the NRSP projects, PDFs implemented per General Permit and General De-Watering Permit requirements will remove trash and debris through the use of BMPs such as catch basin inserts and by general good housekeeping practices. Trash and debris are not expected to significantly impact receiving waters due to the implementation of the NRSP project PDFs.

- ***Methylene Blue Activated Substances (MBAS):*** In the post-development phase, the presence of soap in runoff from the project will be controlled through the source control PDFs, including a public education program on residential and charity car washing and the provision of a centralized car wash area directed to sanitary sewer in the multi-family residential areas. Other sources of MBAS, such as cross connections between sanitary and storm sewers, are unlikely given modern sanitary sewer installation methods and inspection and maintenance practices. During the construction phase of the NRSP projects, equipment and vehicle washing will not use soaps or any other MBAS sources. Therefore, MBAS are not expected to significantly impact the receiving waters of the NRSP projects.

- ***Cyanide:*** In addition to the expected relatively low level of cyanide in untreated stormwater, cyanide in runoff from the NRSP projects would be readily removed by biological uptake, degradation by microorganisms, and by volatilization in the treatment PDFs, especially the dry extended detention basins. Therefore cyanide is not expected to significantly impact the receiving waters of the NRSP projects.

- ***Bioaccumulation***: In the literature, the primary pollutants that are of concern with regard to bioaccumulation are mercury and selenium. However, selenium and mercury are not of concern in this watershed, so bioaccumulation of selenium and mercury is also not expected to result either during the construction or post-development project phases. On this basis, the potential for bioaccumulation (in the NRSP projects' PDFs or in the receiving waters) to cause adverse effects on waterfowl and other species is considered less than significant.

- ***Construction Impacts***: Construction impacts on water quality are generally caused by soil disturbance and subsequent suspended solids discharge. These impacts will be minimized through implementation of construction BMPs that will meet or exceed measures required by the Construction General Permit, as well as BMPs that control the other potential construction-related pollutants (i.e., PAHs, metals). A SWPPP will be developed as required by, and in compliance with, the Construction General Permit and Los Angeles County Standard Conditions. Erosion control BMPs, including but not limited to hydro-mulch, erosion control blankets, and energy dissipaters will be implemented to prevent erosion, whereas sediment controls, including but not limited to silt fence, sedimentation ponds, and secondary containment on stockpiles, will be implemented to trap sediment once it has been mobilized. On this basis, the construction-related impact of the NRSP projects on water quality is considered less than significant.

- ***Regulatory Requirements***: The NRSP projects satisfy MS4 Permit requirements for new development, including SUSMP requirements and SQMP requirements, and satisfy construction-related requirements of the Construction General Permit and General Dewatering Permit, and therefore comply with water quality regulatory requirements applicable to stormwater runoff.

8.2. Groundwater Impacts

- ***Groundwater Quality Impacts (Nitrate-N+Nitrite-N)***: MS4 Permit, Construction General Permit, Dewatering General Permit, and SUSMP-compliant BMPs will be incorporated into the NRSP projects to address nutrients in both the construction phase and post-development. Nitrate-nitrogen plus nitrite-nitrogen concentrations are predicted to decrease in the post-developed condition. The predicted nitrate-nitrogen plus nitrite-nitrogen concentration in stormwater runoff after treatment in the projects' PDFs and in irrigation water is well below the groundwater quality objective. On this basis, the potential for adversely affecting groundwater quality is considered less than significant.

- ***Groundwater Recharge Impacts***: Project stormwater runoff will be discharged directly or indirectly to the Santa Clara River after treatment, whose channel is predominantly natural and consists of vegetation and coarse-grained sediments (rather than concrete). The porous nature of the sands and gravels forming the streambed will allow for significant infiltration to occur to the underlying groundwater. Also, irrigation water is predicted to be fully infiltrated during dry weather, which will increase groundwater recharge from the NRSP projects. On this basis, the NRSP projects' impact on groundwater recharge is considered less than significant.

8.3. Hydromodification Impacts

The following are the conclusions regarding the significance of impacts for hydromodification impacts under wet- and dry weather conditions:

- ***Wet Weather Project Impacts****:* Although NRSP projects' runoff volumes, flow rates, and durations will increase, potential impacts of hydromodification (i.e., the potential to cause erosion, siltation, or channel instability) will be avoided, minimized, and mitigated by the Project PDFs in the following ways:

- o Project low impact/site design and on-site treatment and flow duration control PDFs, especially open space retention, routing of impervious area runoff to vegetated areas, efficient irrigation, bioretention areas, and flow duration control basins will avoid and/or minimize increases in runoff volume from the development area, the preferred method for controlling hydromodification impacts from new development (SCCWRP, 2005a).

- o Concentrated flows will be mitigated with energy dissipaters at the discharge points to the Santa Clara River and to the Tributaries. The Santa Clara River and Tributary banks will be protected primarily with vegetated buried bank stabilization in non-jurisdictional upland areas adjacent to the river. This type of biostabilization technique is the preferred approach for bank stabilization (SCCWRP, 2005a). In the Tributaries, geomorphic principles will be used in combination with on-site controls to design stable stream channels given the expected hydrologic and sediment regimes of each tributary. A minimum of hard, engineered structural elements will be used within the stream channel so that a natural appearance will be preserved while the new stream channel form can remain stable.

- o Hydromodification control PDFs, including a combination of on-site controls and/or in-stream controls designed to meet the performance standard set forth in this Report and by reference to the framework set forth in Appendix G, will protect the Santa Clara River and Tributaries from excessive erosion and degradation by discharges from the NSRP projects.

For these reasons, direct hydromodification impacts of the NRSP projects on the Santa Clara River and Tributaries are considered less than significant.

- ***Cumulative Wet Weather Impacts:*** The NRSP projects contribute only five percent of total potential impervious surface at build out within the watershed, the NRSP projects include hydromodification controls as Project Design Features, the NRSP projects will be conditioned to include Project Design Features to meet the performance standard established in this Report to protect the Tributaries from hydromodification impacts, future development projects within the watershed will control flow in compliance with the regional program, and large-scale changes naturally occur in the Santa Clara River in response to major episodic events, therefore, the NRSP projects' contribution to cumulative hydromodification impacts to the Santa Clara River and the Tributaries will be less than significant and consistent with the requirements of the MS4 permit.

- ***Dry Weather Hydromodification Impacts:*** It is predicted that all dry weather flows will be removed in the treatment control PDFs, which also provide hydrologic source control.

As a result, no appreciable change in seasonality of flows is anticipated to result from development. Based on the comprehensive site planning, source control, and treatment control strategy and that no dry weather flows are predicted to be discharges to the Santa Clara River or Tributaries, the impact of the NRSP projects on dry weather water quality and seasonality of flow in the River and Tributaries is considered less than significant.

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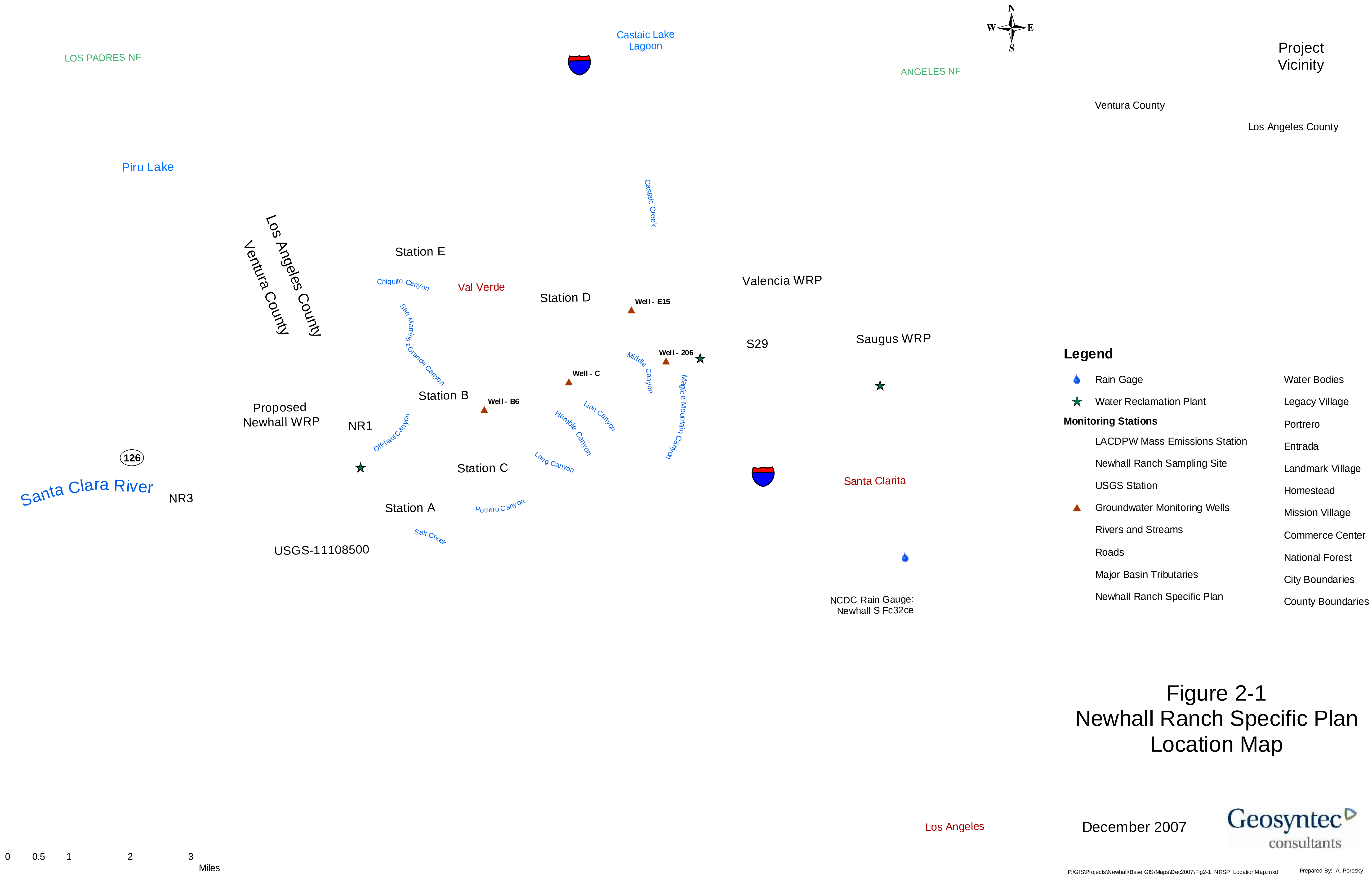

Figure 2-1
Newhall Ranch Specific Plan
Location Map

December 2007

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N
W E
S

Ventura County

Los Angeles County

Legend

Roads

Land Use

Estate

Low Density Residential

Low-Medium Residential

Medium Residential

High Density Residential

Mixed-Use

Commercial

Business Park

Vistor Serving

Open Area

River Corridor

High Country

Figure 2-2
NRSP Land Uses

December 2007

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0 0.5 1 2
Miles

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Prepared By: A. Poresky

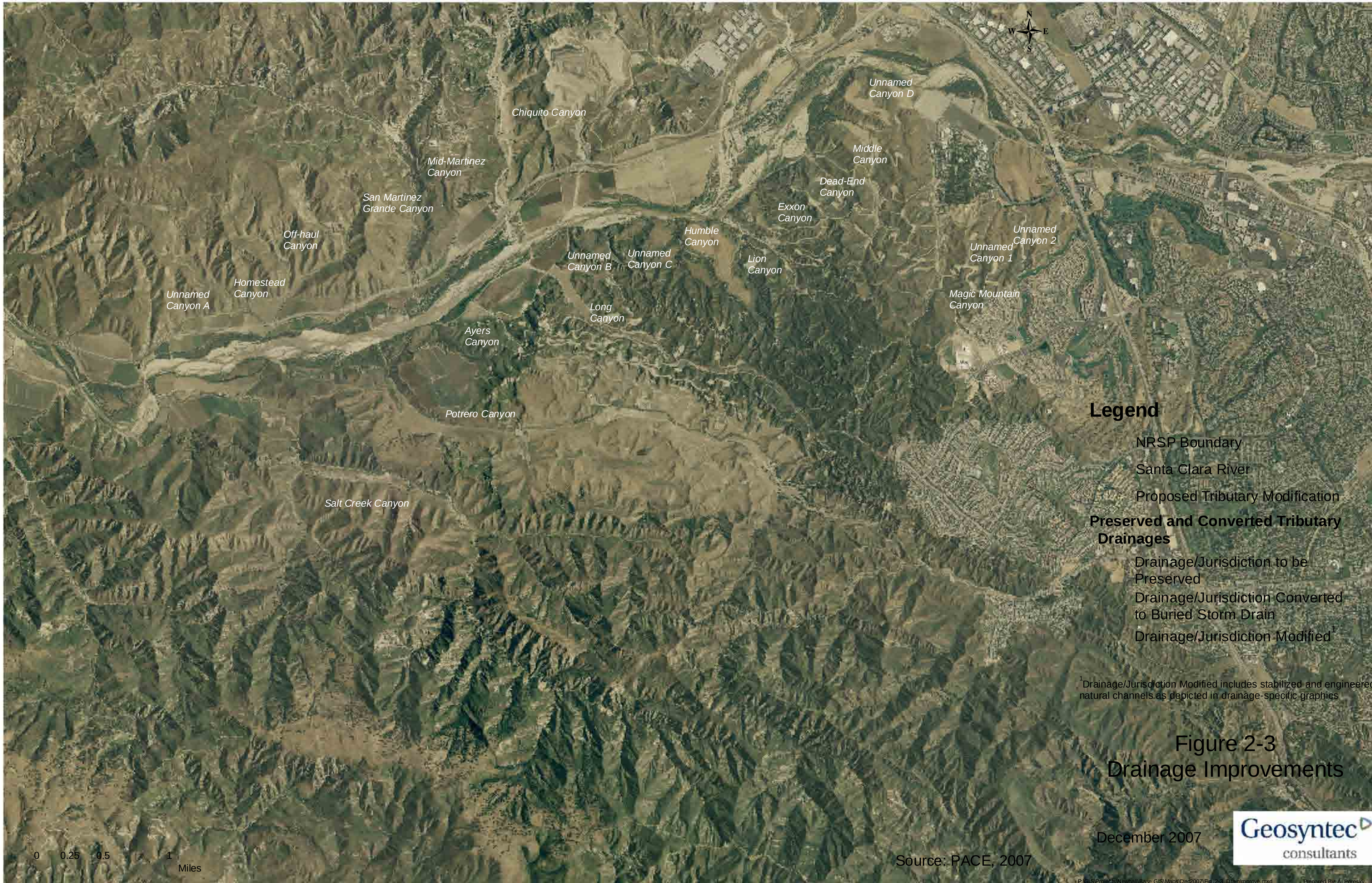
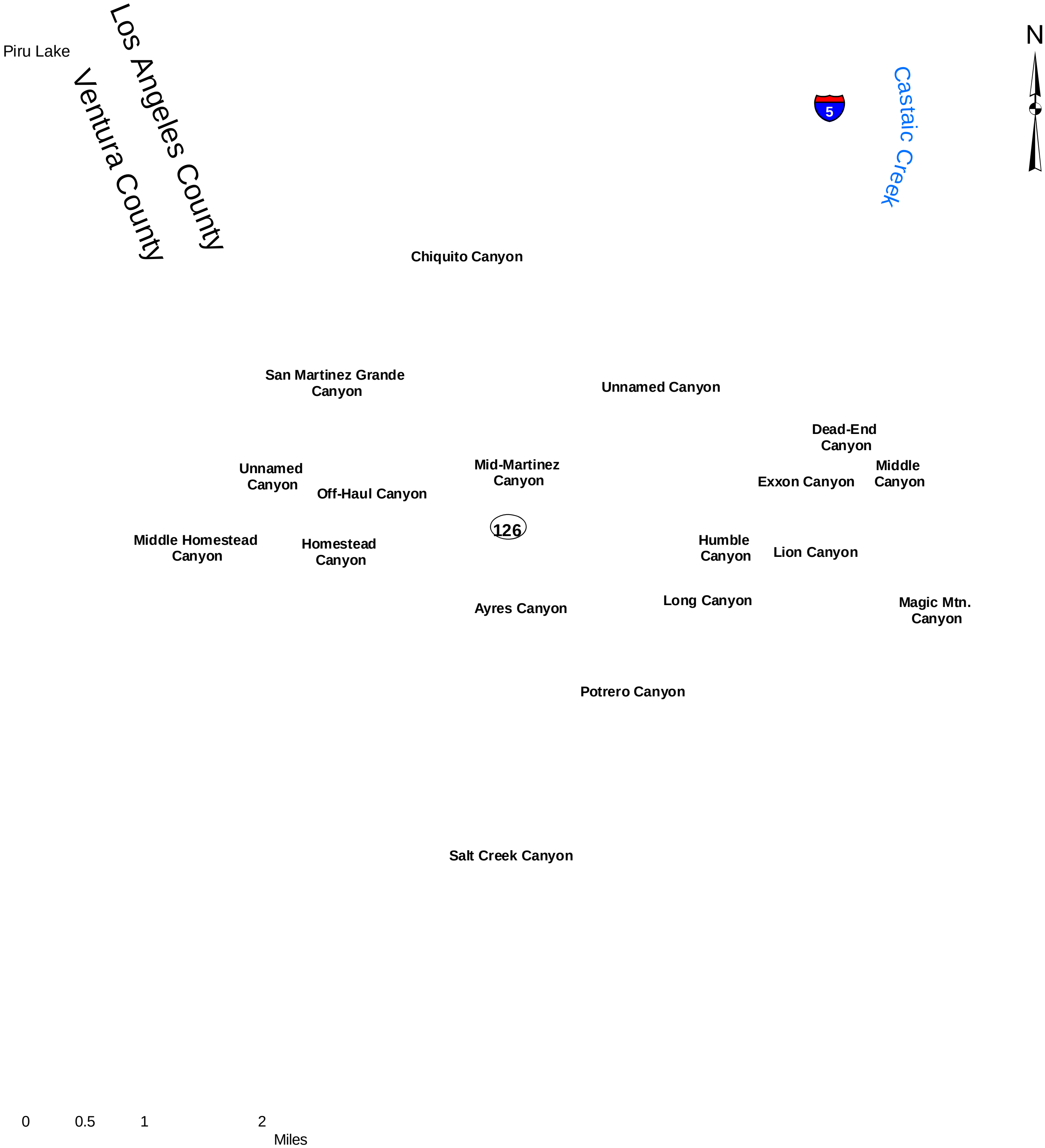


Figure 2-3
Drainage Improvements



Legend

Highway	Subwatersheds
Canyon Tributary	Los Angeles County
Santa Clara River	Ventura County
Water Bodies	NRSP Boundary

Figure 2-4
Newhall Ranch Specific Plan Subwatershed Boundaries

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Prepared By: A. Poresky

Legend

LA RWQCB Reach Boundary

EPA Reach Boundary

Project Boundary

Highways

Santa Clara River

Ventura County

Los Angeles County

Orange County

Figure 2-5
Santa Clara River
Reach Boundaries

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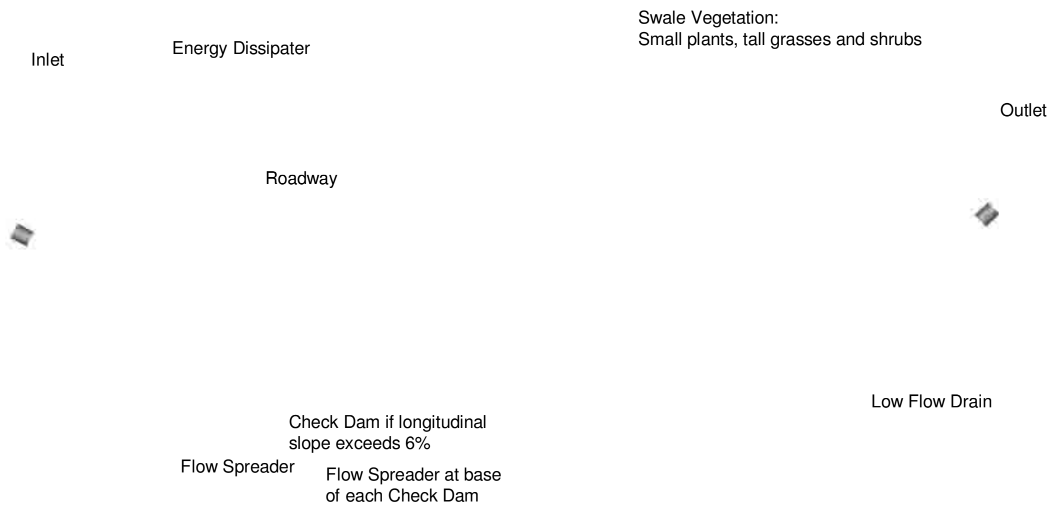
Prepared By: A. Poresky

Plan View



Profile

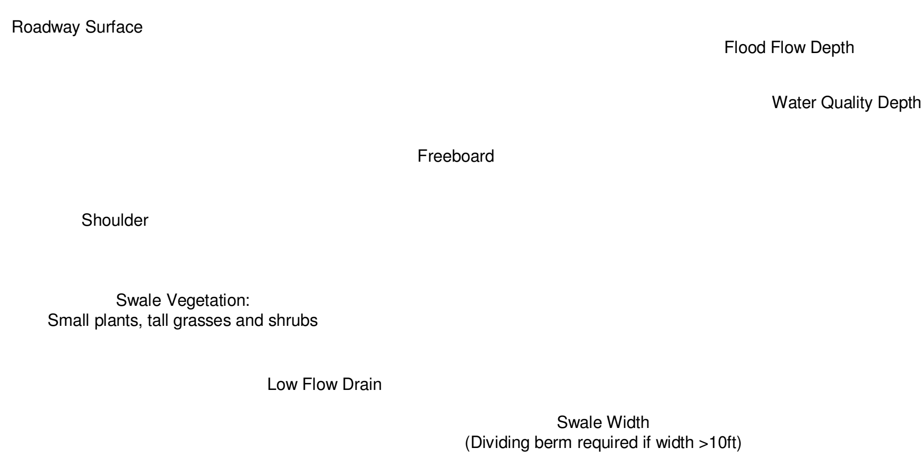
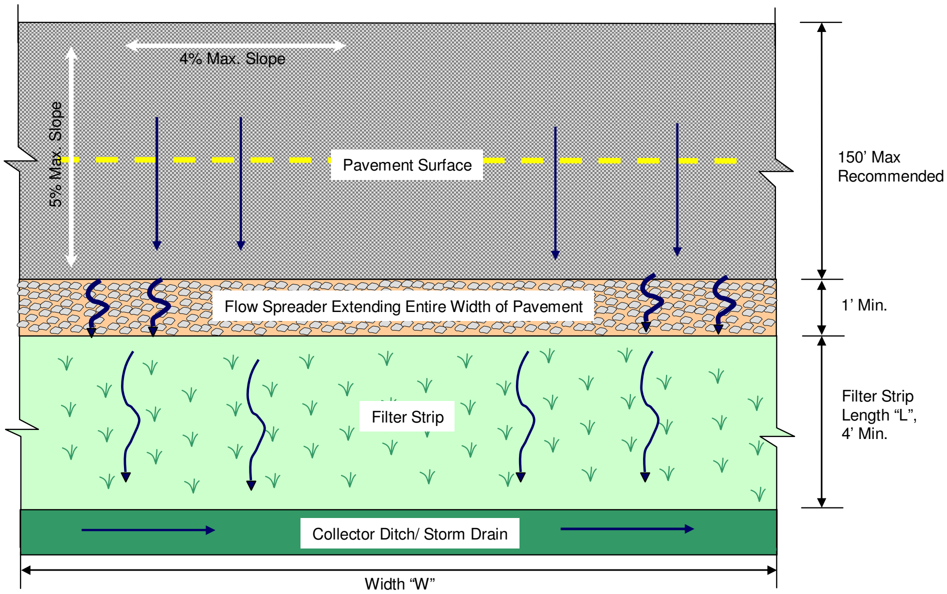


Figure 5-1
Conceptual Illustration of a Vegetated Swale

Figure 5-2
Examples of Vegetated Swales

Plan View



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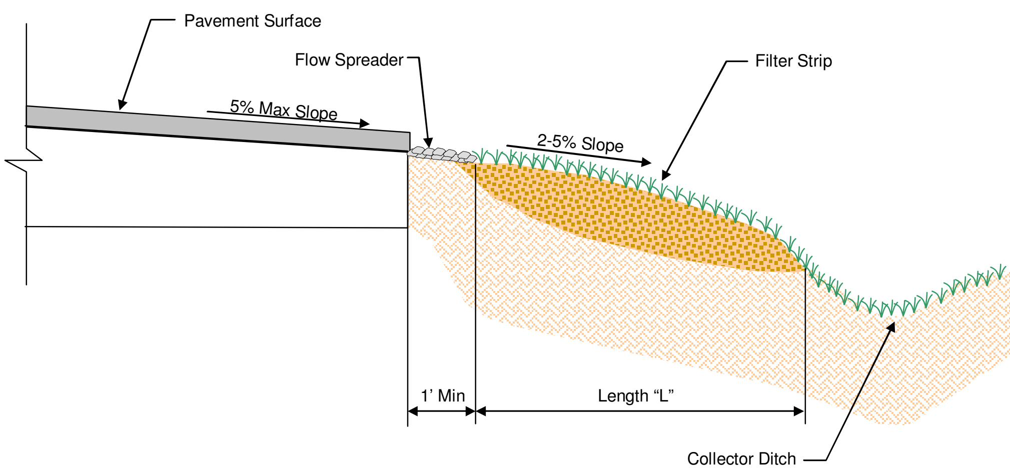

Figure 5-3
Conceptual Illustration of a Filter Strip

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Plan View

Parking Lot Sheet Flow

Curb Stops

Stone Diaphragm

Grass
Filter Strip

Optional
Sand Layer

Overflow
Catch Basin

Outlet

Gravel Curtain
Drain Overflow

Underdrain Collection System (If Required)

Profile

Curb Stop

Stone Diaphragm

Planting Soil

Gravel
Curtain
Drain
Overflow

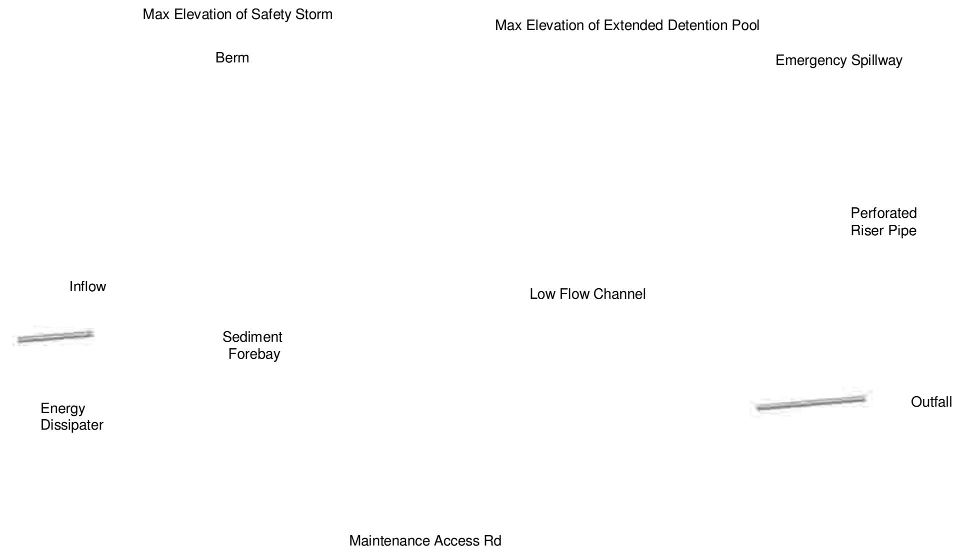
Optional Sand
Filter Layer

Underdrain (If Required)

Figure 5-4
Conceptual Illustration of a Bioretention Facility

Figure 5-5
Examples of Bioretention Facilities

Plan View



Profile

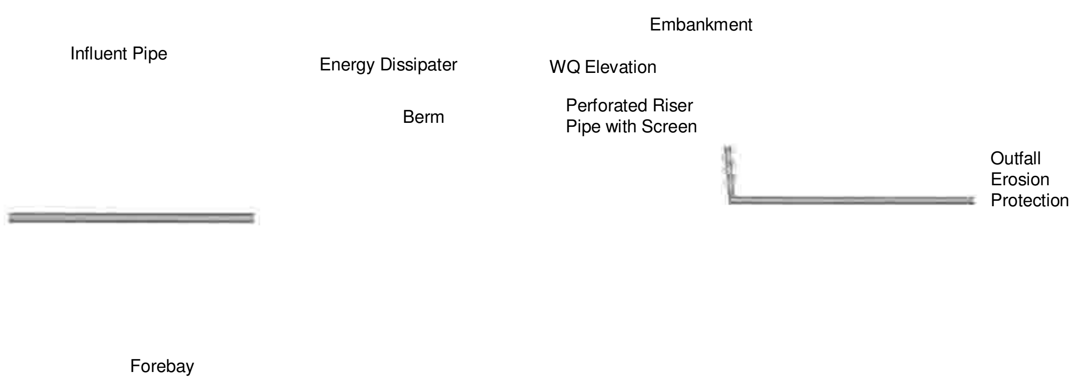


Figure 5-6
Conceptual Illustration of a Dry Extended Detention Basin

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Subregional Stormwater
Mitigation Plan

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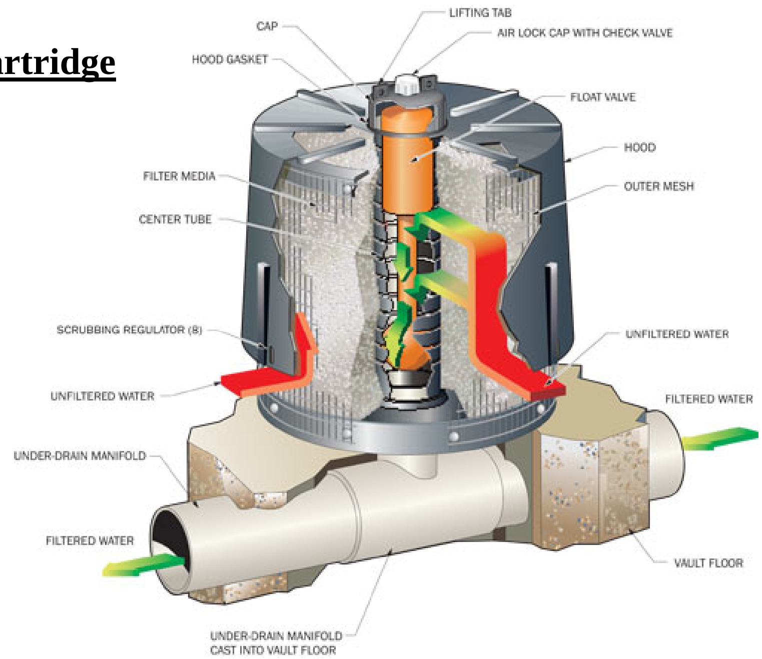
Figure 5-7
Examples of Extended Detention Basins

StormFilter Media Cartridge



Example configuration of Catch Basin Storm Filter

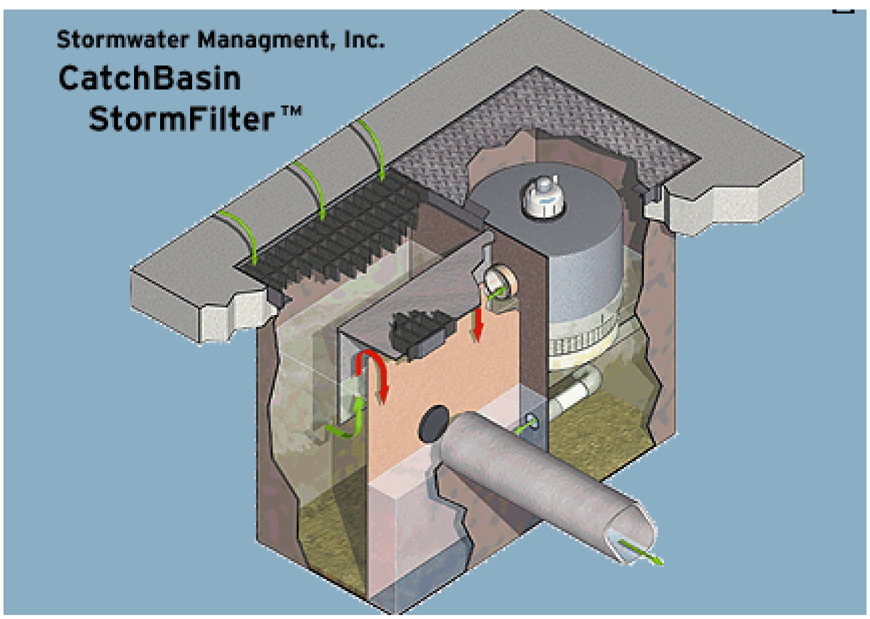


Figure 5-8
Conceptual Illustration of a StormFilter™ Media Filter

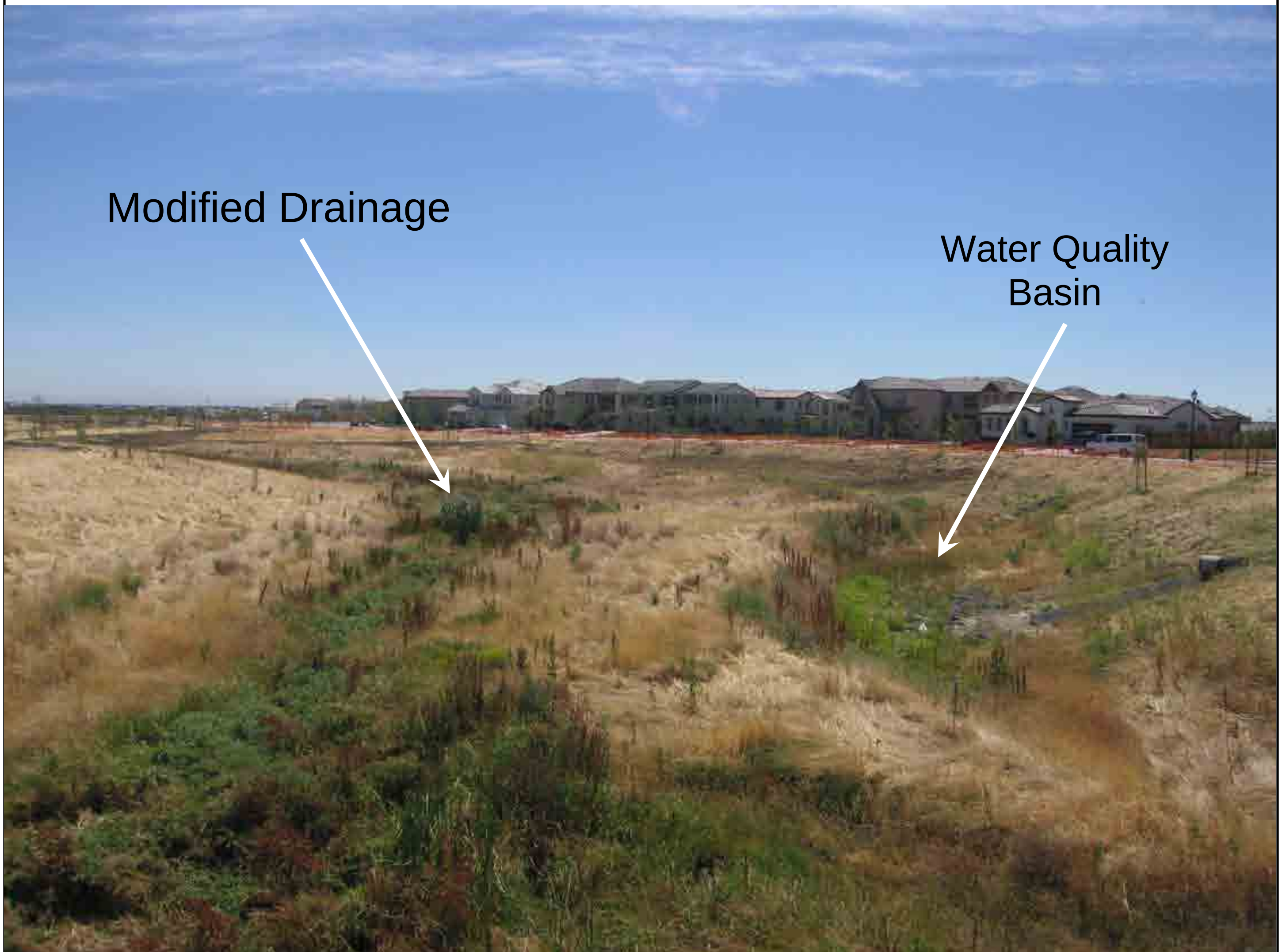


Figure 5-9
Example of Modified Channel/Engineered Natural Channel

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Newhall Ranch Specific Plan
Sub-Regional Stormwater Mitigation Plan
Technical Appendices

(A) Pollutants of Concern

(B) Modeling Parameters & Methodology

(C) Newhall Ranch Stormwater Monitoring Data

(D) Review of Bacteria Data from Southern California Watersheds

(E) Effect of Urbanization on Groundwater Recharge in the Santa Clarita Valley

(F) Assessment of Potential Impacts Resulting from Cumulative Hydromodification Effects, Selected Reaches of the Santa Clara River, Los Angeles County, California

(G) Newhall Ranch Hydromodification Control

APPENDIX A

POLLUTANTS OF CONCERN

A.1. Pollutants of Concern

Pollutant of Concern [1]	Rationale for Selection / Exclusion	Significance Criteria
Sediment: Total Suspended Solids (TSS) & Turbidity	1. Sediment is a common component of stormwater, and can be a pollutant. Sediment can be detrimental to aquatic life (primary producers, benthic invertebrates, and fish) by interfering with photosynthesis, respiration, growth, reproduction, and oxygen exchange in water bodies. Sediment can transport other pollutants that are attached to it including nutrients, trace metals, and hydrocarbons. Sediment is the primary component of total suspended solids (TSS), a common water quality analytical parameter (CASQA, 2003). 2. Turbidity is a measure of suspended matter that interferes with the passage of light through the water or in which visual depth is restricted. Turbidity may be caused by a wide variety of suspended materials, which range in size from colloidal to coarse dispersions, depending upon the degree of turbulence. In lakes or other waters existing under relatively quiescent conditions, most of the turbidity will be due to colloidal and extremely fine dispersions. In rivers under flood conditions, most of the turbidity will be due to relatively coarse dispersions. Erosion of clay and silt soils may contribute to in-stream turbidity. Organic materials reaching rivers serve as food for bacteria, and the resulting bacterial growth and other microorganisms that feed upon the bacteria produce additional turbidity. Nutrients in runoff may stimulate the growth of algae, which may also contribute to turbidity. Discharges of turbid runoff are primarily of concern during the construction phase of development.	1. Narrative objective in the Basin Plan: "Water shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect beneficial uses." 2. Basin Plan objective for turbidity: "Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in natural turbidity attributable to controllable water quality factors shall not exceed the following limits: <u>Natural Turbidity</u> <u>Max Increase</u> 0-50 NTU 20% > 50 NTU 10% Allowable zones of dilution within which higher concentrations may be tolerated may be defined for each discharge in specific Water Discharge Requirements."

Pollutant of Concern (1)	**Rationale for Selection / Exclusion**	**Significance Criteria**
Nutrients: Ammonia, Nitrite, Nitrate, Total Nitrogen, and Total Phosphorus	1. Nutrients including nitrogen and phosphorus are the major plant nutrients used for fertilizing landscapes, and are often found in stormwater. These nutrients can result in excessive or accelerated growth of vegetation, such as algae, resulting in impaired use of water in lakes and other sources of water supply. For example, nutrients have led to a loss of water clarity in Lake Tahoe. In addition, un-ionized ammonia (one of the nitrogen forms) can be toxic to fish (CASQA, 2003).	1. Basin Plan standards for ammonia: "In order to protect aquatic life, ammonia concentrations in receiving waters shall not exceed the values listed for the corresponding in-stream conditions in Tables 3-1 to 3-4." The criterion for ammonia in Tables 3-1 to 3-4 varies with pH and temperature; the criterion is lower for lower pH and temperature. The basin plan amendment for updated ammonia standards (dated 04/02, effective July 15, 2003) will be used. 2. Basin Plan surface water standards for nitrogen: "Waters shall not exceed 10 mg/L nitrogen as nitrate-nitrogen plus nitrite-nitrogen (NO_3-N + NO_2-N), 45 mg/L as nitrate (NO_3), 10 mg/L as nitrate-nitrogen (NO_3-N), or 1 mg/L as nitrite-nitrogen (NO_2-N) or as otherwise designated in Table 3-8." Table 3-8 lists Santa Clara River Reach 5 with a water quality objective of 5 mg/L nitrate-N + nitrite-N. 3. Basin Plan groundwater standards for nitrogen: "Ground waters shall not exceed 10 mg/L nitrogen as nitrate-nitrogen plus nitrite-nitrogen (NO_3-N + NO_2-N), 45 mg/L as nitrate (NO_3), 10 mg/L as nitrate-nitrogen (NO_3-N), or 1 mg/L as nitrite-nitrogen (NO_2-N)." 4. Resolution 03-011 (LARWQCB, 08/2003) promulgates Nitrogen Compounds TMDLs for Santa Clara River Reach 5. The numeric target for NO3-N + NO2-N in the Nitrogen Compounds TMDL was based on achieving the existing water quality objective of 5 mg/L NO3-N + NO2-N. The numeric target that was used to calculate the wasteload allocations included a 10% margin of safety; thus the numeric target is 4.5 mg/L NO3-N + NO2-N (30-day average). The water quality objectives for ammonia in Reach 5 used in the

Pollutant of Concern [1]	Rationale for Selection / Exclusion	Significance Criteria
		Nitrogen Compounds TMDL are: TMDL Ammonia Water Quality Objective (mg/L as N) <table><tr><td></td><td>1-hr average</td><td>30-day average</td></tr><tr><td>Reach 5 at County Line</td><td>3.4</td><td>1.2</td></tr><tr><td>Reach 5 below Valencia</td><td>5.5</td><td>2.0</td></tr><tr><td>Reach 5 above Valencia</td><td>4.8</td><td>2.0</td></tr></table> 5. Narrative objective for biostimulatory substances in the Basin Plan: "Waters shall not contain biostimulatory substances in concentrations that promote algal growth to the extent that such growth causes nuisance or adversely affects beneficial uses."
Trace metals: Aluminum, Copper, Lead, and Zinc	1. Trace metals are commonly found in stormwater. Many of the artificial surfaces of the urban environment (e.g., galvanized metal, paint, automobiles, or preserved wood) contain metals, which enter stormwater as the surfaces corrode, flake, dissolve, decay, or leach. Over half the trace metal load carried in stormwater is associated with sediments. Metals are of concern because they can be toxic to aquatic organisms, can bioaccumulate (accumulate to toxic levels in aquatic animals such as fish), and have the potential to contaminate drinking water supplies (CASQA, 2003). 2. Aluminum has been identified by the DPW as a constituent of concern for the Santa Clara River based on monitoring conducted at mass emission station S29 (LACDPW, 2005).	1. Narrative objective in the Basin Plan: "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. …" 2. The CTR criteria are the applicable water quality objectives for protection of aquatic life (40 CFR §131.38). The CTR criteria are expressed for acute and chronic (4-day average) conditions; however, only acute conditions are applicable for stormwater discharges because the duration of stormwater discharge is typically less than 4 days in the NRSP subregion. 3. CTR criteria are determined on the basis of hardness in the receiving water. In application of criteria to the NRSP sub-regional projects, a hardness value of 250 mg/L based on the minimum observed value at USGS monitoring station will be used.

Pollutant of Concern (1)	Rationale for Selection / Exclusion	Significance Criteria
		4. CTR criteria at 250 mg/L hardness are as follows: a. Dissolved copper – 32 µg/L. b. Total lead – 260 µg/L. c. Dissolved zinc – 250 µg/L. 5. The CTR does not include aluminum. The NAWQC contains an acute criterion for acid soluble aluminum (750 µg/L for a pH range of 6.5 to 9.0).
Chloride	1. Resolution No. R03-008, Amendment to the Water Quality Control Plan (Basin Plan) for the Los Angeles Region to Incorporate a Total Maximum Daily Load for Chloride in the Upper Santa Clara River (07/03) states: Elevated chloride concentrations are causing impairments of the water quality objective in Reach 5 and Reach 6 of the Santa Clara River. This objective was set to protect all beneficial uses; agricultural beneficial uses have been determined to be most sensitive, and not currently attained at the downstream end of Reach 5 and Reach 6 in the Upper Santa Clara River. Irrigation of salt sensitive crops such as avocados and strawberries with water containing elevated levels of chloride results in reduced crop yields. Chloride levels in groundwater are also rising.	1. The Basin Plan chloride objective for Reach 5 of the Santa Clara River is 100 mg/L. 2. The TMDL wasteload allocation for MS4 discharges into Santa Clara River Reach 5 is 100 mg/L.

Pollutant of Concern [1]	Rationale for Selection / Exclusion	Significance Criteria
Pathogens (Bacteria, Viruses, and Protozoa)	1. Bacteria and viruses are common contaminants of stormwater. For separate storm drain systems, sources of these contaminants include animal excrement and sanitary sewer overflow. High levels of indicator bacteria in stormwater have led to the closure of beaches, lakes, and rivers to contact recreation such as swimming (CASQA, 2003). 2. Fecal and total coliform are frequently monitored indicator organisms of pathogens. 3. Human-related activities can increase coliform concentrations. 4. Concentrations of coliform in stormwater also can be elevated due to the presence of coliform bacteria from natural sources.	1. Basin Plan objectives are based on the designated uses of the water body. Santa Clara River Reach 5 is listed with a REC1 beneficial use. Resolution No. 01-018 (LARWQCB, 2001) amended the Basin Plan objectives for bacteria in waters with a contact recreation beneficial use. These standards for freshwaters are Geometric Mean Single Sample E. coli ≤ 126/100 mL ≤ 235/100 mL fecal coliform ≤ 200/100 mL ≤ 400/100 mL
Petroleum Hydrocarbons: Oil & Grease and Polycyclic Aromatic Hydrocarbons (PAHs)	1. Oil and grease includes a wide array of hydrocarbon compounds, some of which are toxic to aquatic organisms at low concentrations. Sources of oil and grease include leakage, spills, cleaning and sloughing associated with vehicle and equipment engines and suspensions, leaking and breaks in hydraulic systems, restaurants, and waste oil disposal (CASQA, 2003). 2. Hydrocarbons are hydrophobic (low solubility in water), have the potential to volatilize, and most forms are biodegradable. A subset of hydrocarbons, Polynuclear Aromatic Hydrocarbons (PAHs) can be toxic depending on the concentration levels, exposure history, and sensitivity of the receptor organisms. Of particular concern are those PAH compounds associated with transportation-related sources. 3. Petroleum hydrocarbons are ubiquitous, and used in a wide variety of applications. Potential sources are generally expected to increase with urban development and potentially during construction of the Project.	1. Narrative objective in the Basin Plan for oil & grease: "Waters shall not contain oils, greases, waxes, or other materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water, that cause nuisance or that otherwise adversely affect beneficial uses." 2. PAHs are a class of compounds. CTR values for individual PAHs are available for protection of human health only. There are no regulatory standards for PAHs for the protection of aquatic health.

Pollutant of Concern [1]	**Rationale for Selection / Exclusion**	**Significance Criteria**
Pesticides	1. Pesticides (including herbicides, fungicides, rodenticides, and insecticides) have been repeatedly detected in stormwater at toxic levels, even when pesticides have been applied in accordance with label instructions. As pesticide use has increased, so too have concerns about adverse effects of pesticides on the environment and human health. Accumulation of these compounds in simple aquatic organisms, such as plankton, provides an avenue for biomagnification through the food web, potentially resulting in elevated levels of toxins in organisms that feed on them, such as fish and birds (CASQA, 2003). 2. Pesticides loads may be present in runoff from developed areas due to pesticide use for urban landscaping.	1. Narrative objective in the Basin Plan: "Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of pesticides in excess of the limiting concentrations specified in … Title 22 of the California Code of Regulations …." Title 22 contains maximum contaminant levels for a range of pesticides. 2. CTR lists numeric objectives for some, but not all pesticides. There are no CTR criteria for diazinon and chlorpyrifos, but these pesticides, along with other toxic legacy pesticides such as Chlordane, Dieldrin, DDT, and Toxaphene, are now banned from most residential uses.

Pollutant of Concern [(1)]	**Rationale for Selection / Exclusion**	**Significance Criteria**
Trash and Debris	1. Gross Pollutants (trash, debris, and floatables) may include heavy metals, pesticides, and bacteria in stormwater. Typically resulting from an urban environment, industrial sites and construction sites, trash and floatables may create an aesthetic "eye sore" in waterways. Gross pollutants also include plant debris (such as leaves and lawn-clippings from landscape maintenance), animal excrement, street litter, and other organic matter. Such substances may harbor bacteria, viruses, vectors, and depress the dissolved oxygen levels in streams, lakes, and estuaries sometimes causing fish kills (CASQA, 2003). 2. During the construction phase, there is potential for an increase in trash and debris loads due to lack of proper contractor good housekeeping practices at the construction site.	1. Basin Plan narrative floating material objective: "Waters shall not contain floating materials, including solids, liquids, foams, and scum, in concentrations that cause a nuisance or adversely affect beneficial uses." 2. Basin Plan narrative settleable materials objective: "Waters shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect beneficial uses." 3. Basin Plan narrative Biochemical Oxygen Demand (BOD5) objective: "Waters shall be free of substances that result in increases in the BOD which adversely affect beneficial uses." 4. Basin Plan objectives for dissolved oxygen (DO): "At a minimum (see specifics below), the mean annual dissolved oxygen concentration of all waters shall be greater than 7 mg/L, and no single determination shall be less than 5.0 mg/L, except when natural conditions cause lesser concentrations. The dissolved oxygen concentration of all surface waters designated as WARM shall not be depressed below 5 mg/L as a result of waste discharges."
MBAS (Methylene blue activated substances)	1. MBAS are related to the presence of detergents in water. Positive results may indicate the presence of wastewater or be associated with urban runoff due to commercial and/or residential vehicle washing or other outdoor washing activities. Surfactants disturb the surface tension which affects insects and can affect gills in aquatic life.	1. Basin Plan objective for MBAS: "Waters shall not have MBAS concentrations greater than 0.5 mg/L in water designated (MUN)."
Cyanide	1. Cyanide has been identified by the Los Angeles County Department of Public Works as a constituent of concern for the Santa Clara River based on monitoring conducted at mass emission Station S29	1. The CTR criteria are the applicable water quality objectives for protection of aquatic life (40 CFR 131.38). The CTR criteria are expressed for acute and chronic (4-day average)

Pollutant of Concern [1]	Rationale for Selection / Exclusion	Significance Criteria
	(LACDPW, 2005). Cyanide is used in electroplating, metallurgy, and gold mining. It is also used to make synthetic fibers, plastics, dyes, pharmaceuticals, and pesticides, including fumigants. In addition, cyanide serves as a chemical intermediate in various production processes. Natural cyanides are produced by certain bacteria, fungi, and algae, and they are present in a number of plants and foods as cyanogenic glycosides. Man-made cyanides typically enter the environment from metal finishing and organic chemical industries. Other sources include iron and steel works, municipal waste burning, cyanide-containing pesticides, road deicers, and vehicle exhaust.	conditions; however, only acute conditions are applicable for stormwater discharges because the duration of stormwater discharge is typically less than 4 days in the Project area. CTR freshwater aquatic life protection acute criteria is 22 µg/L.
Bioaccumulation	1. Some pollutants of concern in stormwater runoff, such as metals or pesticides, have the potential to bioaccumulate in aquatic organisms potentially affecting the health of those organism or other species higher up the food chain.	1. Although bioaccumulation is not a pollutant, it is a condition of concern. The Basin Plan objective for bioaccumulation is: "Toxic pollutants shall not be present at levels that would bioaccumulate in aquatic life to levels which are harmful to aquatic life or human health."
Oxygen, Dissolved & BOD (Biochemical oxygen demand)	1. Adequate DO levels are required to support aquatic life. Depressed levels may lead to anaerobic conditions. 2. BOD can result in decreased dissolved oxygen levels affecting beneficial uses such as habitat designations. 3. DO & BOD are correlated to nutrients and other organic compounds and are subsumed by those categories.	1. Basin Plan objective for dissolved oxygen: "The dissolved oxygen content of all surface waters designated as WARM shall not be depressed below 5 mg/L as a result of waste discharges." 2. Basin Plan objective for BOD: "Waters shall be free of substances that result in increases in the BOD which adversely affect beneficial uses."

Pollutant of Concern (1)	**Rationale for Selection / Exclusion**	**Significance Criteria**
Biostimulatory substances	1. Biostimulatory substances include excess nutrients and other compounds that stimulate aquatic growth resulting in impaired aesthetics and water quality impairments such as lowered dissolved oxygen values. 2. Biostimulatory substances are correlated to nutrients and other organic compounds and are subsumed by those categories.	1. Basin Plan objectives for biostimulatory substances: "Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance of adversely affects beneficial uses."
Chemical Pollutants	3. Chemical pollutants in excessive amounts in drinking water are harmful to human health. 4. The chemical pollutants referenced under this water quality objective, such as trace metals and nitrate, are either subsumed by the categories above, or are not found in urban runoff (e.g., fluoride).	2. Basin Plan objectives for chemical Pollutants: "Surface waters shall not contain concentrations of chemical Pollutants in amounts that adversely affect any designated beneficial use."
Temperature	1. Elevated temperatures are typically associated with discharges of process wastewaters or non-contact cooling waters. Increase in temperature can result in lower dissolved oxygen levels impairing habitat and other beneficial uses of receiving waters. Stormwater runoff from the Project site is expected to cool somewhat during treatment in structural BMPs and will be diluted in the receiving water. As the beneficial uses in the receiving waters for the Project include warm freshwater habitat to support warm water ecosystems, any increase in temperature resulting from stormwater runoff from the project is expected to be less than significant.	1. Basin Plan objectives for temperature: "For waters designated WARM, water temperature shall not be altered by more than 5 ºF above the natural temperature. At no time shall these WARM-designated waters be raised above 80 ºF as a result of waste discharges".

Pollutant of Concern [(1)]	**Rationale for Selection / Exclusion**	**Significance Criteria**
Total Residual Chlorine	1. Municipal pools and private pools in areas served by a municipal sanitary system are required to be discharged into the sanitary system. Chlorine disinfection will not take place on the project site and there will not be any sources of elemental chlorine. Chloride sources (e.g. fertilizers or other compounds with salts) are evaluated separately. Therefore, total residual chlorine will not be present in runoff from the project.	1. Basin Plan objectives for total residual chlorine: "Chlorine residual shall not be present in surface water discharges at concentrations that exceed 0.1 mg/L and shall not persist in receiving waters at any concentration that causes impairment for beneficial uses".
Color, Taste, and Odor	1. Undesirable tastes and odors in water may be a nuisance and may indicate the presence of a pollutant(s). Odor associated with water can result from decomposition of organic matter or the reduction of inorganic compounds, such as sulfate. Other potential sources of odor causing substances, such as industrial processes, will not occur as part of the project. Color in water may arise naturally, such as from minerals, plant matter, or algae, or may be caused by industrial pollutants. 2. The Project will contain no heavy industrial uses. Commercial areas of the project are not expected to be a significant source of pollutants that might impart color or odor to stormwater flows from the Project area. Source controls are expected to reduce the amount of plant material and BMPs will reduce sediment which could contribute to color or odor nuisances. Therefore, color-, taste-, or odor-producing substances are not pollutants of concern for the project.	1. Basin Plan objective for color: "Waters shall be free of coloration that causes nuisance or adversely affects beneficial uses". 2. Basin Plan objectives for taste and odor: "Ground waters shall not contain taste or odor-producing substances in concentration that cause nuisance or adversely affect beneficial uses".

Pollutant of Concern [1]	**Rationale for Selection / Exclusion**	**Significance Criteria**
Exotic Vegetation	1. Exotic vegetation typically provides little habitat value and can out compete native vegetation that is more suitable habitat for aquatic and terrestrial organisms. 2. The landscape management plan will not use exotic vegetation, and undesirable invasive vegetation will be eradicated to the extent possible. Therefore, exotic vegetation is not a pollutant of concern for the Project.	1. Basin Plan objective for exotic vegetation: “Exotic vegetation shall not be introduced around stream courses to the extent that such growth causes nuisance or adversely affects designated beneficial uses.”
Mineral Quality (TDS, Boron, Sulfate, Sodium Absorption Ratio - SAR)	1. LADPW stormwater monitoring data arithmetic mean concentrations for TDS, sulfate, and boron for urban land uses are below the water quality objectives for minerals. Calculated SAR values are 0.6 for SF residential and 1.9 for commercial based on LADPW data. The minerals listed in the Basin Plan, except chloride and nitrogen, are not believed to be pollutants of concern due to the absence of river impairments and /or anticipated runoff concentrations below the Basin Plan objectives	1. Basin Plan objectives for minerals: Reach 5 TDS (mg/L) 1000 Sulfate (mg/L) 400 Boron (mg/L) 1.5 SAR (mg/L) 10
pH	1. Mean runoff concentrations in the Los Angeles County stormwater monitoring data ranged from 6.5 for mixed- and single-family residential land uses to 7.0 for commercial land use. Therefore, pH in the Santa Clara River is not expected to be affected by runoff discharges from the project.	1. Basin Plan objective for pH: “the pH of inland waters shall not be depressed below 6.5 or raised above 8.5 as a result of waste discharges. Ambient pH levels shall not be changed more than 0.5 units from natural conditions as a result of waste discharge.”

Pollutant of Concern [1]	**Rationale for Selection / Exclusion**	**Significance Criteria**
PCBs	1. PCBs are highly toxic persistent chemicals that have been historically released into the environment from industrial uses, such as transformers. Due to their persistence, PCBs can still be detected in urban runoff due to historic industrial sources of these chemicals. 2. The project area did not historically include PCB-producing land uses and industrial land uses are not included in the proposed project. Therefore, PCBs are not a pollutant of concern for the project.	1. Basin Plan narrative regarding PCBs: "The purposeful discharge of PCBs to waters of the Region, or at locations where the waste can subsequently reach waters of the Region, is prohibited. Pass-through or uncontrollable discharges to waters of the Region, or at locations where the waste can subsequently reach waters of the Region, are limited to 70 pg/L (30 day average) for protection of human health and 14 ng/L and 30 ng/L (daily average) to protect aquatic life in inland fresh waters and estuarine waters respectively".
Radioactive Substances	1. Some activities such as mining or industrial activities can increase the amount of radioactive substances impairing beneficial uses. 2. The project will not have industrial or other activities that would be a source of any radioactive substances, and development will stabilize any naturally radioactive soils, though unlikely to be present in the project area. Therefore, radioactive substances are not a pollutant of concern for the project.	1. Basin Plan narrative objective for radioactive substances: "Radionuclides shall not be present in concentrations that are deleterious to human, plant, animal, or aquatic life or that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal, or aquatic life".

1. The pollutants of concern for the water quality analysis are those that are anticipated or potentially could be generated by the project at concentrations, based on water quality data collected in Los Angeles County from land uses that are the same as those included in the NRSP, that current loadings or historic deposits of the pollutant are impacting the beneficial uses of a receiving water, elevated levels of the pollutant are found in sediments of a receiving water and/or have the potential to bioaccumulate in organisms therein, or the detectable inputs of the pollutant are at concentrations or loads considered potentially toxic to humans and/or flora and fauna.

A.2. References

California Association of Stormwater Quality Agencies (CASQA), 2003. *Stormwater Best Management Practices Handbook New Development & Redevelopment*.

Los Angeles Regional Water Quality Control Board, 1995. Water Quality Control Plan Los Angeles Region Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties.

APPENDIX A

Los Angeles Regional Water Quality Control Board, October, 25th, 2001. Resolution 01-018: Amendment to the Water Quality Control Plan for the Los Angeles Region to Update the Bacteria Objectives for Water Bodies Designated for Water Contact Recreation

Los Angeles Regional Water Quality Control Board, July, 10th, 2003. Resolution R03-008 Revision of interim waste load allocations for chloride in the Amendment to the Water Quality Control Plan for the Los Angeles Region to include a TMDL for Chloride in the Upper Santa Clara River.

Los Angeles Regional Water Quality Control Board, August, 7th, 2003. Resolution R03-011 Amendment to the Water Quality Control Plan for the Los Angeles Region to include a TMDL for Nitrogen Compounds in the Santa Clara River.

US Environmental Protection Agency California Toxics Rule (CTR), 40 C.F.R. §131.38.

APPENDIX B

WATER QUALITY MODEL METHODOLOGY

APPENDIX B TABLE OF CONTENTS

1. WATER QUALITY MODEL METHODOLOGY

1.1. Model Description

1.1.1. Model Overview

The model used to assess stormwater quality impacts associated with the proposed Newhall Ranch Specific Plan is an empirical, volume-based pollutant loads model. This type of loadings model is generally applicable in the planning and evaluation stages of a project. The model was developed to assess the potential impact of development on water quality and to evaluate the effectiveness of the structural Best Management Practices (BMPs) that will treat storm water runoff as part of the project storm water treatment system. Two project conditions were evaluated with the water quality model:

1. Pre-development
2. Post-development with treatment BMPs

Measured runoff volumes and water quality characteristics of storm water are highly variable. To account for this variability, a statistical modeling approach was used to estimate the volume of storm water, the concentration of pollutants in storm water, and the overall pollutant load (total mass of pollutants) in storm water runoff. A statistical description of storm water provides an indication of the average characteristics and variability of the water quality parameters of storm water. It does not forecast runoff characteristics for specific storms or monitoring periods.

The statistical model is based on relatively simple rainfall/runoff relationships and estimated concentrations in storm water runoff. The volume of storm water runoff is estimated using a modification to the Rational Formula, an empirical expression that relates runoff volume to the rainfall depth and the basin characteristics such as imperviousness, and soils infiltration characteristics. The pollutant concentration in storm water runoff is represented by an expected average pollutant concentration, called the event mean concentrations (EMC). The EMCs are estimated from available monitoring data and are strongly dependent on the land-use type.

The flow chart in Figure 1-1 provides an overview of the modeling methodology.

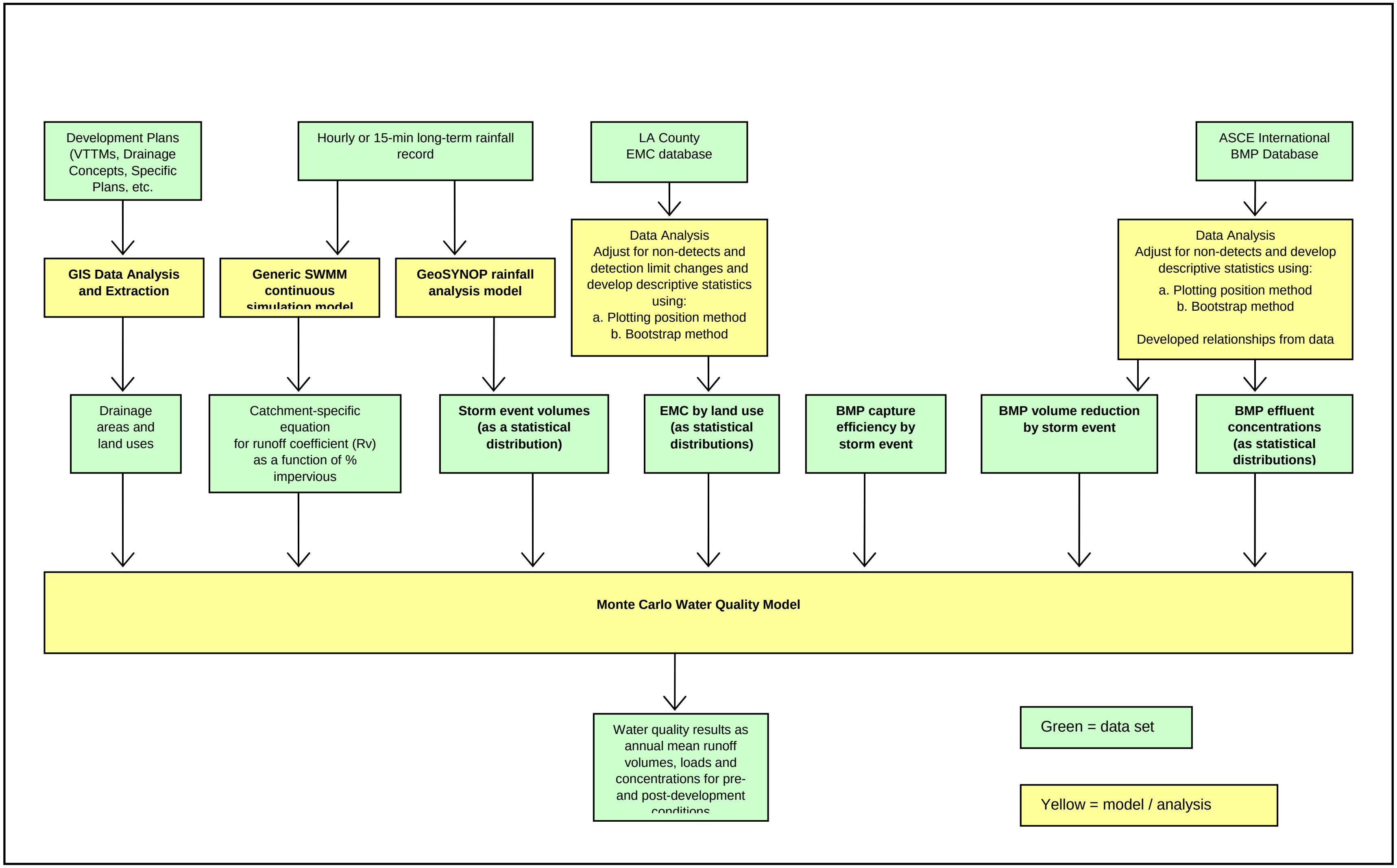

Figure 1-1: Overview of Water Quality Analysis Methodology

The model does not incorporate the detailed hydraulics or hydrology of the site, which would be more appropriate for design stages and requires additional data and more sophisticated modeling. The model includes water quality benefits achieved by structural BMPs but not source control BMPs because data is generally not available or conclusive for the latter. Model results are presented for average annual runoff volumes, pollutant loads, and pollutant concentrations.

As with all environmental modeling, the precision of results is heavily dependent on how well the hydrologic, water quality and BMP effectiveness data describe the actual site characteristics. Local and regional data are used to the fullest extent possible to help minimize errors in predictions, but such data are limited and traditional calibration and verification of the model is not feasible. It is important to note that the predictions of relative differences should be more accurate than absolute values.

1.1.2. Model Assumptions

The water quality modeling methodology requires that some assumptions are made for both the model input parameters and the way the modeling calculations are carried out. Section 1.2.6 discusses the assumptions that were made in specifying the model parameters and Section 1.3.4 discusses the assumptions regarding the modeling approach. Section 1.4 discusses model accuracy.

1.2. Model Input Parameters

Many parameters that can affect pollutant loads and concentrations vary spatially and may not be adequately represented by stormwater monitoring data collected at discrete locations. Examples include source concentrations, topography, soil type, and rainfall characteristics all of which can influence the buildup and mobilization of pollutants. The following model parameters represent the best data currently available for representation of existing and developed site conditions in the water quality model.

1.2.1. Storm Events

Rainfall analysis was conducted with data from the National Climatic Data Center (NCDC) Newhall rain gauge (station number 046162), located in the town of Newhall, California. Figure 1-2 shows the location of the Newhall gauge in relation to the Newhall Ranch Project area. This gauge is located approximately 7 miles from the project. The gauge elevation of 1,243 ft above mean sea level (AMSL) is comparable to the Project area elevation of approximately 1,000-1,500 ft AMSL.

While the period of record rainfall data collected at the Newhall rain gauge is quite long (35 years), there are still some gaps in the record. In order to improve the characterization of rainfall at the project site, estimates of the missing rainfall data were made through correlation of the Newhall rain gauge with the San Fernando rain gauge (NCDC station number 047762) which is located approximately 5 miles away (south and slightly east).

The Castaic Junction gauge monitored by LADPW is located closer to the Project; however the usable period of record at this gauge is limited to approximately 12 years which is considered too short to produce significant results in long-term simulation.

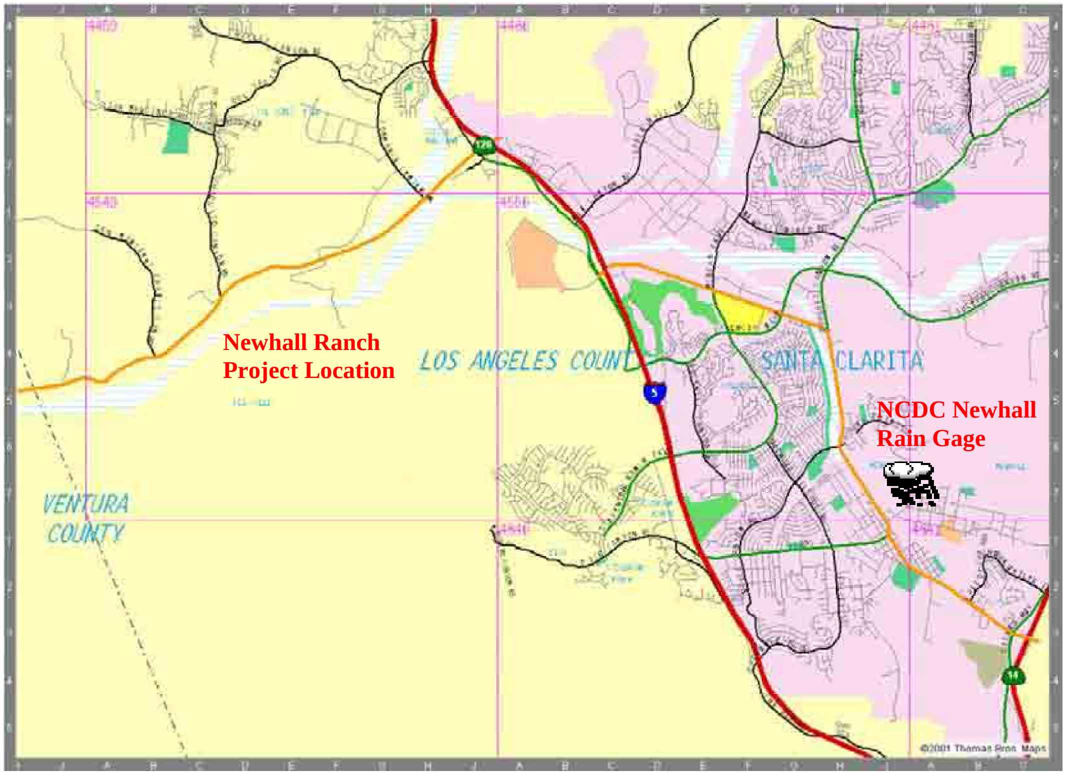

Figure 1-2: Location of Newhall Rain Gauge in the Vicinity of the Project Area

First a comparison of daily rainfall totals was made from the available data to assess the similarity in rainfall amounts between the two stations. Daily data from 1969 to 2003 was screened to keep only the 24-hour totals with measured rainfall at both stations, which eliminated missing data at either station. Correlation of the 24-hour rainfall totals is shown in Figure 1-3.

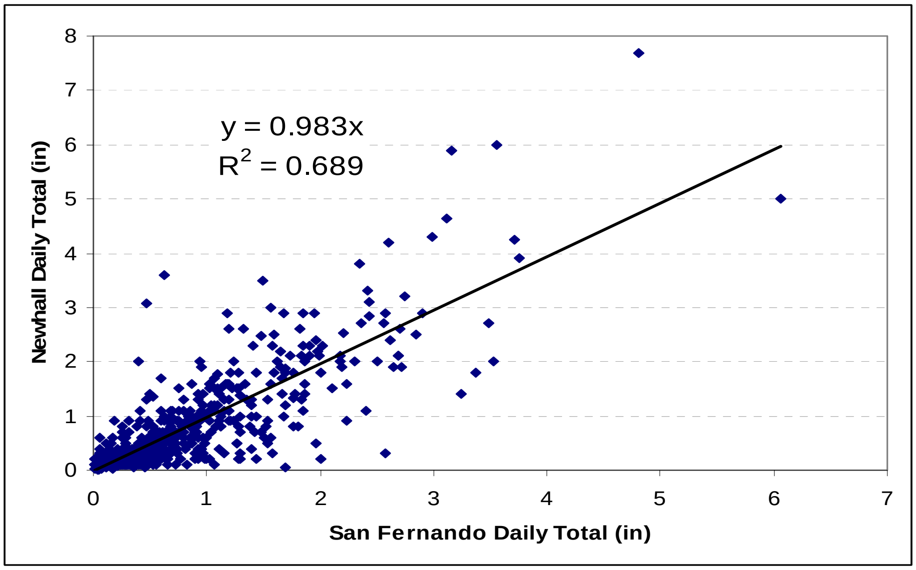

Figure 1-3: Correlation of 24-hour Totals between Newhall & San Fernando Gauges

The correlation is reasonably strong considering that the comparison is between the daily accumulations, i.e. a storm could result in appreciable rainfall at one gauge and little rainfall at the other. This comparison indicates that daily precipitation depths are similar between the two gauges. Another comparison was made using only months with a complete rainfall record and measured rainfall at both stations (Figure 1-4). This monthly correlation was much stronger due to the longer comparison period, and indicated slightly higher rainfall amounts at the Newhall gauge compared to the San Fernando gauge.

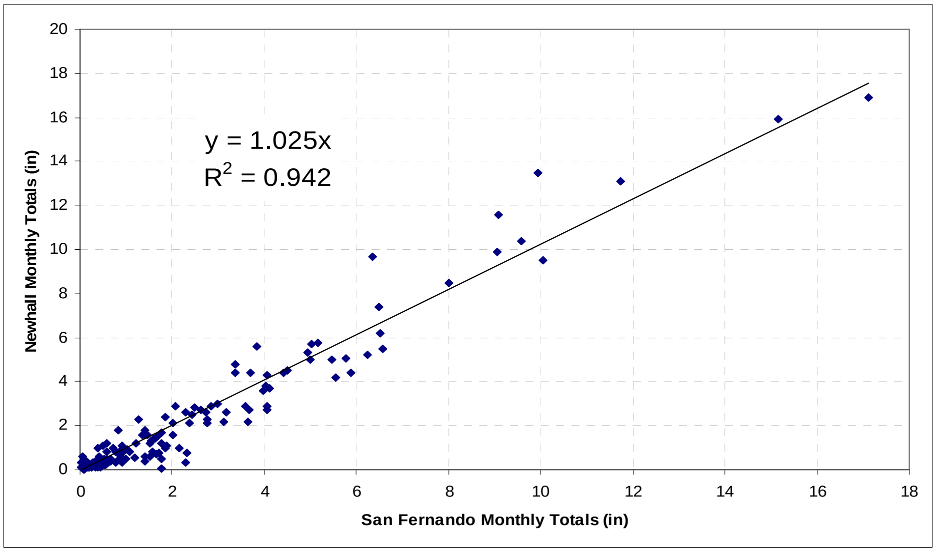

Figure 1-4: Correlation of Monthly Totals Newhall & San Fernando Gauges

Based on the relationship developed through the monthly comparison, a multiplier of 1.025 was applied to the hourly rainfall data from the San Fernando gauge to fill in the missing periods of rainfall data at the Newhall gauge. Values were rounded to the nearest 1/100 inch after the adjustment.

Rainfall analysis was conducted for all storm events and for the storms that are expected to contribute to stormwater runoff (storms >0.1 inches). The rainfall data were analyzed using a code similar in performance to EPA's Synoptic Rainfall Analysis Program (SYNOP). The customized code (GeoSYNOP) was used as it facilitates filling in missing periods of data and is more robust when handling the date and time of storms. GeoSYNOP subdivides the rainfall record into discrete events separated by a dry inter-event period, which in this case was set to a minimum of 6 hours. Small rainfall events whose depth was less than or equal to 0.10 inches were deleted from the record as such events tend to produce little if any runoff (USEPA, 1989; Schueler, 1987). For the Newhall gauge, a total of 538 storm events (>0.1 inches) were segregated from the continuous data. Storm statistics for the full (all the storms) and the trimmed (storms > 0.1 inch) data sets are shown in Table 1-1.

Table 1-1: Analysis Results for the Actual and Filled Newhall Rainfall Data

Storms	Newhall Gauge 1969 – 2003	Original Record	Augmented Record[1]
	Total Missing Records (days):	427	52
All Storms	Average annual rainfall (in):	17.4	18.8
	Total number of storms:	840	890
	Average number of storms per year:	24.0	25.4
	Average storm volume (in):	0.72	0.74
	Average storm duration (hrs):	6.87	7.35
	Average storm intensity (in/hr):	0.103	0.101
Storms >0.1 inch	Average annual rainfall (in):	16.2	17.9
	Total number of storms:	493	538
	Average number of storms per year:	14.1	15.4
	Average storm volume (in):	1.15	1.16
	Average storm duration (hrs):	11.0	11.5
	Average storm intensity (in/hr):	0.107	0.105

[1] Augmented record includes adjusted data from San Fernando gauge to fill gaps in Newhall gauge record.

1.2.2. Runoff Coefficients

One of the most variable parameters is the runoff coefficient, which is a function of the percent impervious and many other catchment parameters to lesser degrees. Novotny and Olem (1994), when discussing the Rational Formula, state "...the runoff coefficient is the most important task of the entire calculation." The following describes how the runoff coefficients were estimated in the model.

1.2.2.1. SWMM Runoff Coefficient Modeling Parameters

The Water Quality model uses a linear equation to estimate a runoff coefficient for sub-basins as a function of the percent impervious. The format of this equation is described as:

$$\text{Runoff Coefficient} = \text{Slope} \times \%\ \text{Impervious} + \text{Intercept}$$

The appropriate slope and intercept to define the runoff coefficient equation may be taken from region-specific data, regulatory guidance or developed using hydrologic models. The Los Angeles County Standard Urban Stormwater Mitigation Plan (SUSMP) Manual and the LA County Hydrology Manual use the following equation to calculate developed runoff coefficient:

$$C_D = (0.9 \times I) + (1.0 - I) \times C_U$$

Where: C_D = Developed Runoff Coefficient
I = Proportion Impervious (0 to 1)
C_U = Undeveloped Runoff Coefficient

The undeveloped runoff coefficient (C_U) in this equation is a function of soil type and rainfall intensity. For most soils found in LA County area and the range of intensities associated with water quality storms, C_U may be assumed to equal 0.1. Substituting this value into the equation above yields:

$$\text{Runoff Coefficient} = 0.008 \times \%\ \text{Impervious} + 0.1$$

Note: This equation was <u>not</u> used in water quality modeling. It was only used as a basis for comparison with project-specific runoff coefficient equations developed as described below.

As the Newhall Ranch Project area contains a variety of soil conditions, continuous simulation modeling using the Storm Water Management Model (SWMM) was conducted to determine the appropriate slope and intercept parameters to use in the linear runoff coefficient equation. Key parameters for the SWMM model are shown in Table 1-2.

Table 1-2: SWMM Runoff Module Parameters

SWMM Runoff Parameters	Units	Values
Wet time step	seconds	600
Wet/dry time step	seconds	600
Dry time step	seconds	14,400
Impervious Manning's n		0.012

SWMM Runoff Parameters	Units	Values
Pervious Manning's n		0.25
Drainage area modeled for Rv determination	acres	10
Shape		Rectangular, 500 ft flow path length for pervious areas, 250 ft flow path length for impervious area
Impervious Fractions Modeled		0%, 33.3%, and 100%. See Table 1-3 for specific runoff block dimensions.
Slope	ft/ft	0.10 for pre-development project conditions and 0.05 for post-development project conditions.
Evaporation	inches / month	60% of reference ET values contained in Table 1-5 were used for the existing site conditions to reflect existing uses and the post-development project condition.
Soil properties / infiltration		Green-Ampt soil parameters per Maidment (1993).
Depression storage, impervious	inches	0.02, based on Table 5-14 in SWMM manual (James and James, 2000)
Depression storage, pervious	inches	0.06, based on Table 5-14 in SWMM manual (James and James, 2000)

Runoff path lengths will affect ET and runoff volumes. As the path length increases, ET and infiltration increase and runoff decreases. For consistency in model runs three scenarios were modeled as shown in Table 1-3 with consistent runoff path lengths for pervious surfaces and impervious surfaces. Rectangular catchments were assumed, thus the catchment width for input to SWMM was calculated as the catchment area divided by the total path length. As only one width may be assigned for each catchment, modeled impervious fractions were chosen specifically to result in consistent runoff path lengths for pervious and impervious surfaces. Maintaining consistent path lengths ensures that the results of SWMM can be well-approximated by a linear trendline.

Table 1-3: SWMM Runoff Block Modeled Percent Impervious Values

Area (ac)	% Impervious	SWMM Width (ft)	Pervious Flow Length (ft)	Pervious Flow Length (ft)
10	0	871	500	0
10	33.3	581	500	250
10	100	1742	0	250

The Newhall Ranch Project contains a variety of soil conditions including 34% group B soils comprised mostly of loams and sandy loams, 59% group C soils comprised mostly of silty clay loams, and the remainder group A sandy soils and rock outcropping. For the general level of analysis being conducted, it was considered appropriate to use a soil type that represents average conditions for all of Newhall Ranch. The soil type used was a moderately permeable soil representative of a silt loam which results in little surface runoff for the existing condition and a conservative estimate for the developed condition when further reducing the hydraulic conductivity by 25 percent to account for compaction. The Green-Ampt soils properties used for the SWMM modeling are shown in Table 1-4.

Table 1-4: Green-Ampt Soil Parameters

Soil Texture Class	Suction Head (in)	Ks (in/hr)	Initial Moisture Deficit (in/in)
Silt Loam – Existing Condition	6.57	0.27	0.32
Silt Loam – Developed Condition	6.57	0.20	0.32

Soil properties estimated from information contained in Table 5.5.5 of the Handbook of Hydrology (Maidment, ed. 2003)

Reference ET values for estimating actual ET rates was taken from Figure 1-5 produced by the California Department of Water Resources. The Newhall Ranch Project site is located in zone 14. Reference ET values for zone 14 are reproduced in Table 1-5.

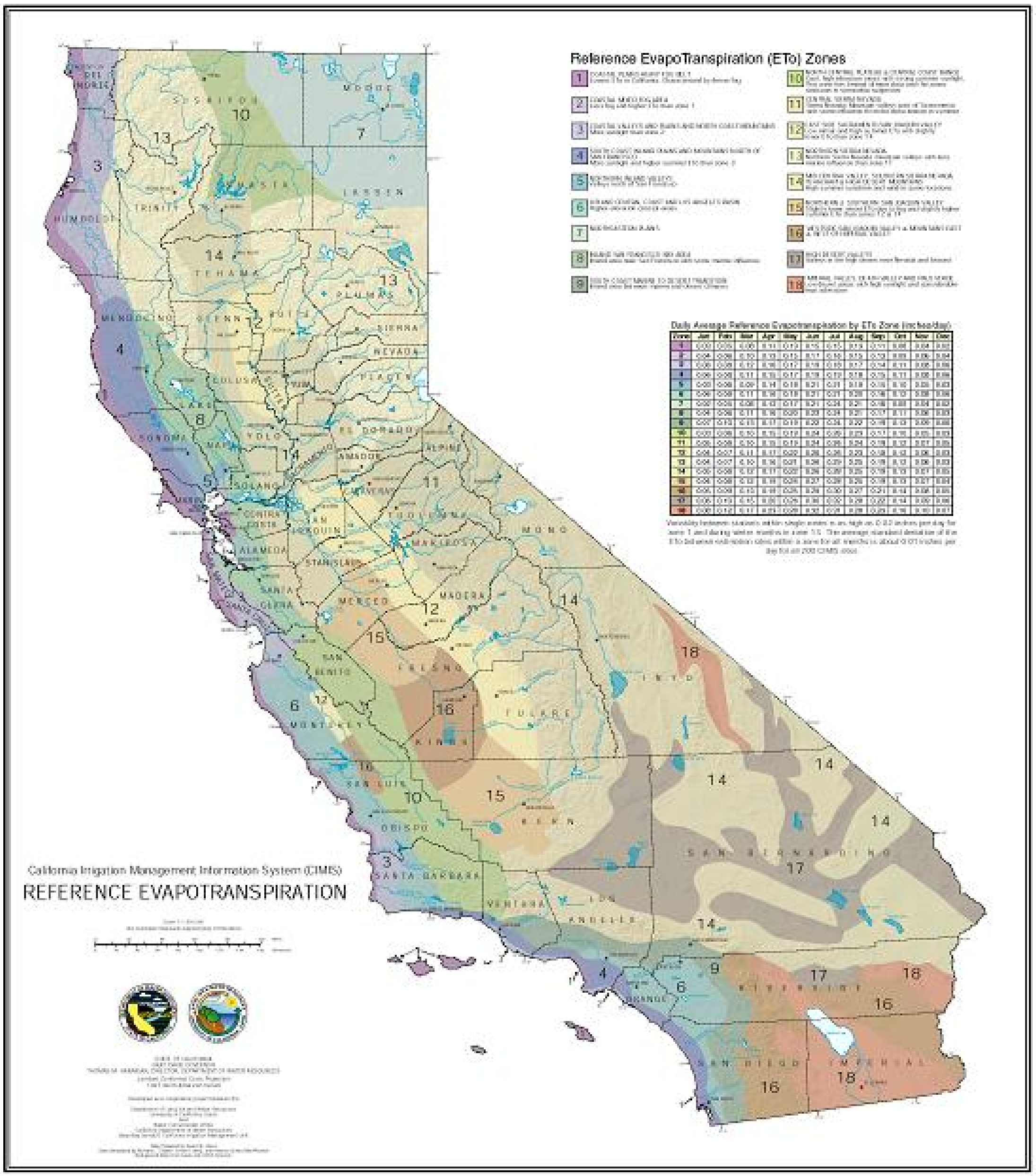

Figure 1-5: Reference ET for CA Zones

Existing site conditions consist of natural grasses, shrubs, and small trees; agricultural row crops, both irrigated and dry farming; and mineral extraction areas including gravel/dirt roads, and unvegetated clearings. To represent average existing site conditions, 60% of the reference ET values were used to reflect partially shaded conditions, semi-arid vegetation, dry crops and bare soil. Sixty percent of the reference ET values were also used to simulate the landscaped areas in the post-development condition.

Table 1-5: Evaporation Parameters for Hydrology Model (from CA ET map)

Month	Evapotranspiration Rates			60%
	Inch / day	**Days / month**	**Inch / Month**	**Inch / Month**
January	0.05	31	1.55	0.93
February	0.08	28	2.24	1.34
March	0.12	31	3.72	2.23
April	0.17	30	5.1	3.06
May	0.22	31	6.82	4.09
June	0.26	30	7.8	4.68
July	0.28	31	8.68	5.21
August	0.25	31	7.75	4.65
September	0.19	30	5.7	3.42
October	0.13	31	4.03	2.42
November	0.07	30	2.1	1.26
December	0.05	31	1.55	0.93
	Total	365	57.04	34.22

1.2.2.2. SWMM Runoff Coefficient Results

Using the model input parameters described above, runoff coefficient equations have been developed for the Newhall Ranch Specific Plan area. Figure 1-6 and Figure 1-7 display the SWMM results (as diamonds) and the best fit line for existing and developed conditions, respectively, for the entire Project site.

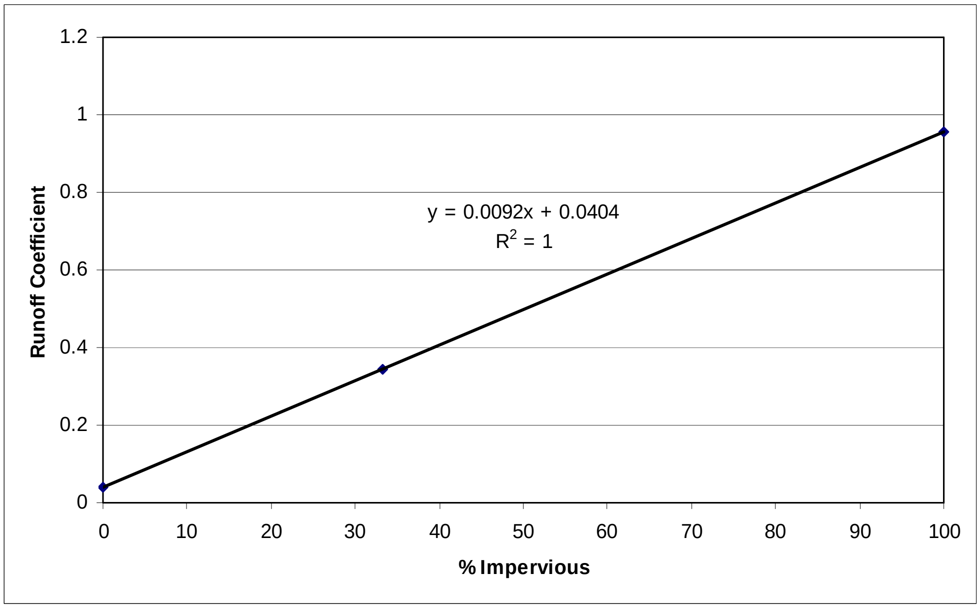

Figure 1-6: Existing Conditions Runoff Coefficient Equation

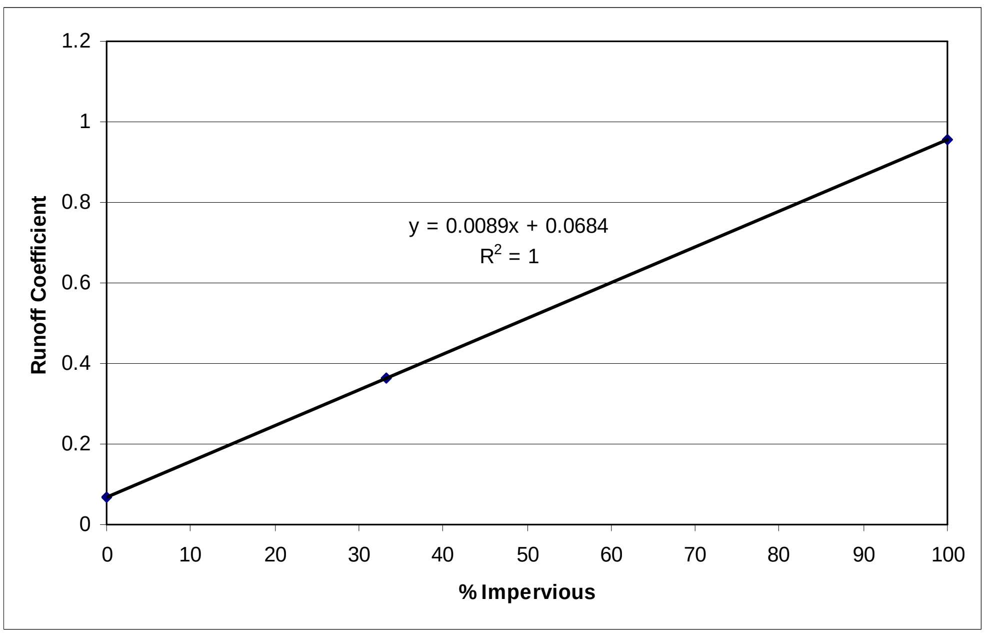

Figure 1-7: Developed Conditions Runoff Coefficient Equation

The SWMM continuous simulation results for the Project model as a whole agree relatively closely with the LA County runoff coefficient equation discussed above. The intercept was rounded to three decimal places resulting in the following equations used to estimate runoff coefficients in the water quality model as a function of imperviousness:

Existing Conditions:

- Total Project Runoff Coefficient = 0.0092 × % Impervious + 0.0404

Developed Conditions:

- Total Project Runoff Coefficient = 0.0089 × % Impervious + 0.0684

1.2.3. Land Use & Treatment BMPs

The delineation of existing land uses and areas within Newhall Ranch were determined from the Los Angeles County Department of Public Works (LADPW) existing land use coverage and Newhall Land records of existing agriculture areas. Based on an inspection of recent aerial photography, project areas designated with the existing land use "Mineral Extraction- Oil and Gas" were divided into open space land use (85%) and light industrial land use (15%) to better define the origin of stormwater runoff and pollutants. High country areas discharge to the Santa Clara River near the project boundary therefore, these areas and the Santa Clara River Corridor were not included in the water quality modeling. The modeled project area was 7,003 acres. Table 1-6 provides the existing condition land uses and areas for Newhall Ranch as well as the land use category for water quality modeling, percent impervious value, and runoff coefficient used for the land uses. The modeled land uses were based on the most representative land use within the available data sets (see Section 1.2.4).

Table 1-6: Modeled Existing Conditions

Land Use	Area (acres)	Land Use Category for Modeling	% Impervious[1]	Runoff Equation Type
Open Space	3,825.8	Open	1	Undeveloped
Oil and Gas Extraction	1309.6	Light Industrial/ Open Space[2]	10	Undeveloped[3]
Agriculture – Dry	1,016.3	Agriculture	2	Developed
Agriculture - Irrigated	810.9	Agriculture	2	Developed
SR-126	40.4	Transportation	100	Developed
High Country	4234.3	Not Modeled		
River Corridor	761.9	Not Modeled		

Land Use	Area (acres)	Land Use Category for Modeling	% Impervious[1]	Runoff Equation Type
Total Modeled	7,003.0			
Total	11,999.2			

[1] Percent impervious values are based on the LA County Hydrology Manual.
[2] Areas zoned Oil and Gas Extraction were assumed to be 85% vacant land use with 1% imperviousness and 15% light industrial land use with 60% imperviousness, equivalent to 10% composite imperviousness.
[3] Areas zoned Oil and Gas Extraction were modeled using the undeveloped runoff coefficient since the oil and gas pads (modeled as light industrial) are well distributed and are a small portion (15%) of the total land use area. Overall, it was assumed that the total land use area is best represented by the undeveloped runoff coefficient.

The delineation of developed land uses and areas within Newhall Ranch were determined from the Newhall Ranch Specific Plan land use data provided by PSOMAS Engineering. As with the existing condition, high country areas discharge to the Santa Clara River near the project boundary therefore, these areas and the Santa Clara River Corridor were not included in the water quality modeling. The modeled project area was 7,003 acres.

The BMPs included in the water quality modeling were swales for the majority of the Landmark Village Project and dry extended detention water quality basins for the remaining developed areas within the Newhall Ranch Project area. Although bioretention areas will be incorporated into the Newhall Ranch Project area to reduce stormwater runoff volumes in order to protect receiving waters, these BMPs were not modeled.

Table 1-7 provides developed condition land uses and areas for Newhall Ranch as well as the land use category for water quality modeling, percent impervious value, runoff coefficient used for the land uses. Table 1-7 also divides the total area for each land use between areas treated by swales and water quality basins and areas not treated by a BMP. In addition, area weighted percent impervious values for areas treated by swales and water quality basins and areas not treated by a BMP are provided. Percent imperviousness values for each BMP are required for the water quality model.

Detention basins have been incorporated into the water quality model as it has not yet been determined where and to what extent it will be possible to incorporate bioretention areas into the stormwater (and dry weather flows) treatment systems for the Newhall Ranch. Detention basins have been modeled as the water quality BMP for the majority of the Newhall Ranch area, as this is representative of the minimum level of treatment that will be provided for stormwater runoff. Treatment in bioretention facilities will provide for greater volume and pollutant load reduction than detention basins. Therefore, the water quality model results based on dry extended detention basin treatment are conservative and represent the maximum stormwater runoff volumes and pollutant loads anticipated for the developed project condition. Stormwater runoff volumes and pollutant loads will be reduced in areas treated with bioretention.

Table 1-7: Modeled Developed Conditions

Land Use	Area (acres)	Land Use Category for Modeling	% Impervious[1]	Runoff Eqn Type	Area (acres) by BMP			Area Weighted % Impervious by BMP		
					No Treatment	Swales	WQ Basins	No Treatment	Swales	WQ Basins
Commercial	463.2	Commercial	91	Developed		34.2	429.0		8.80	11.8
Estate Residential	352.6	Single Family Residential	30	Developed			352.6			3.2
Low Density SF Residential	419.3	Single Family Residential	42	Developed			419.3			5.3
Low-Med Density SF Residential	978.4	Single Family Residential	42	Developed			978.4			12.4
Medium Density SF Residential	610.9	Single Family Residential	55	Developed		49.0	561.9		7.6	9.3
High Density MF Residential	151.2	Multi-Family Residential	68	Developed		76.5	74.7		14.7	1.5
Education	100.5	Education	68	Developed		9.0	91.5		1.7	1.9
Road	340.0	Roadways[2]	100	Developed		130.3	209.7		36.8	6.3
Open Space	3,337.9	Open Space	1	Undeveloped	3,303.3	34.6		1.0	0.1	
Park	52.3	Open Space	15	Developed		20.0	32.3		0.8	0.1
Golf Course	172.5	Open Space	10	Developed			172.5			0.5
Water	24.2	Water[3]	100	Undeveloped	24.2			0.7		
High Country	4234.3	Not modeled	-	-						
River Corridor	761.9	Not modeled	-	-						
Total Modeled	7,003.0				3327.5	353.6	3,321.9	1.7	70.7	52.3
Total	11,999.2									

[1] Percent impervious values are based on the LA County Hydrology Manual.

[2] Of the 340 acres of roadways, 193 acres are high use roads (>30,000 vehicles per day) and were modeled as transportation land use. The remaining 147 acres of roads are lower use (<30,000 vehicles per day) and were modeled as 100% impervious residential areas. The residential stormwater monitoring data used to represent pollutant concentrations includes residential roadways.

[3] All rainfall on water surfaces is modeled as 100% impervious because rainfall is equal to runoff. It is assumed that 100% of the rainfall that falls on the water surface is captured in the waterbody. Since the runoff is immediately captured in the waterbody and does not travel across impervious surfaces, it is assumed that the runoff does not generate any pollutant loads.

1.2.4. Stormwater Runoff Pollutant Concentrations

Stormwater monitoring data collected by the Los Angeles Department of Public Works (LADPW) was used to derive estimates of pollutant concentrations in runoff from urban land uses. The existing conditions of the Newhall Ranch Project site contain agricultural uses. Stormwater monitoring data collected by Ventura County was used to estimate stormwater pollutant concentrations for agricultural land use.

1.2.4.1. Los Angeles County Monitoring Data

Recent and regional land-use based stormwater quality monitoring data was collected through the LA County Stormwater Monitoring Program. This program was initiated with the goal of providing technical data and information to support effective watershed stormwater quality management programs in Los Angeles County. Specific objectives of this project included monitoring and assessing pollutant concentrations from specific land uses and watershed areas. In order to achieve this objective, the County undertook an extensive stormwater sampling project that included 8 land use stations and 5 mass emission stations (located at the mouths of major streams and rivers), which were tested for 82 water quality constituents. These data are presented in *Los Angeles County 1994-2000 Integrated Receiving Water Impacts Report, 2000* and *Los Angeles County 2000-2001 Stormwater Monitoring Report, 2001*.

Stormwater quality for the Newhall Ranch Project was estimated based on the recent EMC data collected by LA County (LA County, 2000). These data were used because of the relatively close location to the project site and because the monitored land uses were representative of the proposed land uses for the Newhall Ranch Project. The monitored land uses stations are listed in Table B-8 with a brief description of the site and when the monitoring data were collected.

Table 1-8: LA County Land Use Monitoring Stations Available for Water Quality Modeling

Station Name	#	Modeled Land Use	Site Description[1]	Years Monitoring Conducted
Santa Monica Pier	S08	Commercial	The monitoring site is located near intersection of Appian Way and Moss Avenue in Santa Monica. The storm drain discharges below the Santa Monica Pier. Drainage area is approximately 81 acres. The Santa Monica Mall and Third St. Promenade dominate the watershed with remaining land uses consisting of office buildings, small shops, restaurants, hotels and high-density apartments.	1995-1999

Station Name	#	Modeled Land Use	Site Description[1]	Years Monitoring Conducted
Sawpit Creek	S11	Open Space (& Parks)	Located in Los Angeles River watershed in City of Monrovia. The monitoring station is Sawpit Creek, downstream of Monrovia Creek. Sawpit Creek is a natural watercourse at this location. Drainage area is approximately 3300 acres.	1995-2001
Project 620	S18	Single Family Residential	Located in the Los Angeles River watershed in the City of Glendale. The monitoring station is at the intersection of Glenwood Road and Cleveland Avenue. Land use is predominantly high-density, single-family residential. Drainage area is approximately 120 acres.	1995-2001
Project 1202	S24	Light Industrial	Located in the Dominguez Channel/Los Angeles Harbor Watershed in the City of Carson. The monitoring station is near the intersection of Wilmington Avenue and 220th Street. The overall watershed land use is predominantly industrial.	1995-2001
Dominguez Channel	S23	Freeway (Roadways)	Located within the Dominguez Channel/Los Angeles Harbor watershed in Lennox, near LAX. The monitoring station is near the intersection of 116th Street and Isis Avenue. Land use is predominantly transportation and includes areas of LAX and Interstate 105.	1995-2001
Project 474	S25	Education (Schools)	Located in Los Angeles River watershed in the Northridge section of the City of Los Angeles. The monitoring station is located along Lindley Avenue, one block south of Nordoff Street. The station monitors runoff from the California State University of Northridge. Drainage area is approximately 262 acres.	1997-2001
Project 404	S26	Multi-Family Residential	Located in Los Angeles River watershed in City of Arcadia. The monitoring station is located along Duarte Road, between Holly Ave and La Cadena Ave. Drainage area is approximately 214 acres.	1997-2001

[1] Los Angeles County 1999-2000 Draft Stormwater Monitoring Report (Los Angeles County, 2000)

1.2.4.2. Ventura County Monitoring Data

As part of its NPDES permit, the Ventura County Flood Control District conducts monitoring to determine the water quality of stormwater runoff from areas with specific land uses. One monitoring station, Wood Road at Revolon Slough (site A-1), drains the approximately 350 acre Oxnard Agricultural Plain, which is comprised almost entirely of agricultural land (primarily row crops), including a small number of farm residences and ancillary farm facilities for equipment maintenance and storage. Data from the Wood Road station was used to estimate pollutant concentrations in stormwater runoff for agricultural land use.

Land use runoff sampling for the Ventura County stormwater monitoring program originally began during the 1992/93 monitoring season, with up to several samples collected at each site during each storm season. For the A-1 site, the period of record begins during the 1996/97 storm season, and continues through the 2003/04 season. All land use monitoring sites are equipped with automated monitoring equipment, including flowmeters (with area-velocity probes and level sensors) and refrigerated auto-samplers which enable the collection of flow-weighted composite samples. Stormwater quality monitoring data for the agricultural land use site was provided by Mark Davis of the Ventura County Watershed Protection District. This information was extracted from their newly-constructed water quality database, which contains monitoring data for their land use, mass emission, and receiving water monitoring sites.

1.2.4.3. Data Analysis for Derivation of Land Use EMCs

The County of Los Angeles Department of Public Works (LADPW) has monitored stormwater runoff quality from various land uses throughout the County on an annual basis beginning in 1995 through 2001. For each year of monitoring several storm event mean concentrations (EMCs) are reported and included in the County's annual water quality report to the Los Angeles Regional Water Quality Control Board. The convention for dealing with the censored data (e.g., data only known to be below the analytical detection limit) is to substitute ½ of the detection limit for all non-detects. L.A. County has followed this convention when providing summary arithmetic statistics of the stormwater monitoring data. This method tends to introduce bias into the estimate of the mean and standard deviation and the summary statistics are not believed to be robust or adequately account for non-detects. To further complicate matters, the detection limit for dissolved copper and total lead has changed during the period stormwater monitoring was conducted by LADPW.

In an effort to provide more reliable and accurate estimates of land use EMCs for the Newhall Ranch Specific Plan water quality modeling, a robust method of estimating descriptive statistics for censored data with multiple detection limits was employed. The plotting position method described in Helsel and Cohn (1988) was used to estimate censored values using the distribution of uncensored values. Descriptive statistics were then estimated using the parametric bootstrap method suggested by Singh, Singh, and Engelhardt (1997).

Example Data Set

To illustrate the statistical methods used to obtain land use EMCs, the LADPW stormwater monitoring data collected for total lead from the transportation land use station is used. The data were collected from 01/1996 to 04/2001. At the beginning of March 1997 the detection limit for total lead changed from 10 to 5 μg/L. Table 1-9 describes the data according to the number of censored and uncensored values in the example data set.

Table 1-9. Number of Censored and Uncensored Data Points in the Total Lead Transportation Land Use Data Set

Total Lead EMC Data for Transportation Land Use	
Uncensored	37
Censored < 10 µg/L	2
Censored < 5 µg/L	38
Total Data Count	77

Prior to applying the plotting position method, it is necessary to check the normality of the data. Figure 1-8 shows histograms and probability plots of the transportation land use total lead data above detection limits in normal and lognormal space. As indicated in the figure, the data tends to follow a lognormal distribution, a finding that is common with many pollutants in stormwater.

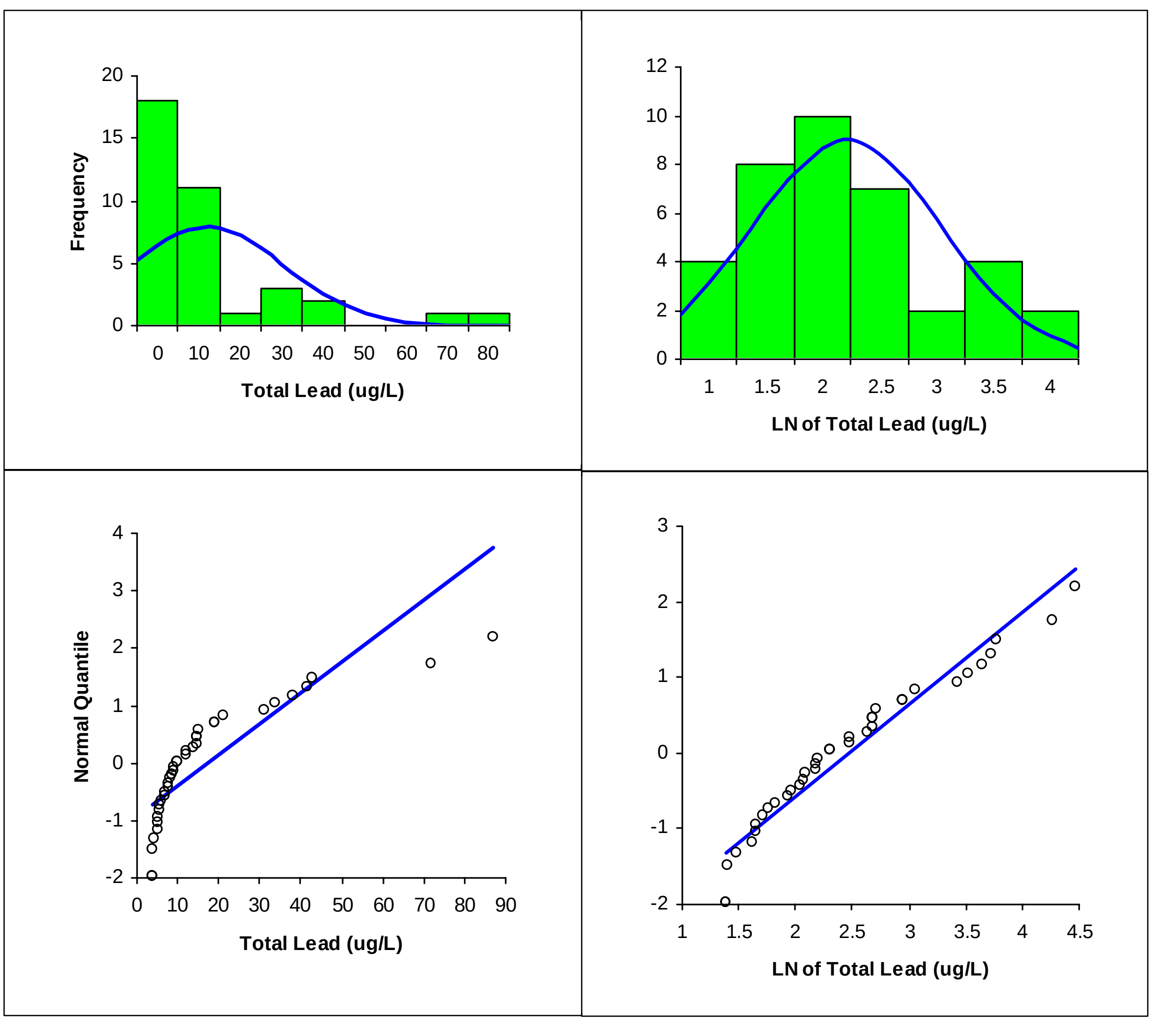

Figure 1-8: Histograms and Probability Plots of Transportation Total Lead Data in Arithmetic and Lognormal Space

To verify the visual check that the data are lognormally distributed, the Shapiro-Wilk goodness-of-fit test was used (Royston, 1992). In this test, if $p > 0.1$, the null hypothesis that the log data follow a normal distribution cannot be rejected. For this example data set, the p-value of the log-transformed uncensored data is 0.293, which indicates that lognormal distribution is a good approximation of the distribution of the data set.

Method for Dealing with Multiple Detection Limits

To account for the multiple detection limits in the censored data sets, a regression on order statistics (ROS) method was employed. ROS is a category of robust methods for estimating descriptive statistics of censored data sets that utilize the normal scores for the order statistics (Shumway et al. 2002). The plotting position method by Hirsch and Stendinger (1987) (summarized by Helsel and Cohn, 1988) was the ROS method used. In this method, plotting positions are based on conditional probabilities and ranks, where the ranks of the censored (below detection) and uncensored data (above detection) related to each detection limit are ranked independently. The method is summarized in the equations below.

After plotting positions for the censored and uncensored values have been calculated, the uncensored values are plotted against the z-statistic corresponding to the plotting position and the best-fit line of the known data points is derived. Using this line and the plotting positions for the uncensored data, the values for the uncensored data are extrapolated. Figure 1-9 illustrates the plotting position method results on the total lead data for transportation land use.

$$pe_j = pe_{j+1} + \frac{A_j}{(A_j + B_j)} \times (1 - pe_{j+1}) \qquad (1)$$

Where:

- A_j = the number of uncensored observations above the j detection limit and below the j +1 detection limit.
- B_j = the number of censored and uncensored observations less than or equal to the j detection limit.
- pe_j = the probability of exceeding the j threshold for j = m, m -1, … 2, 1 where m is the number of thresholds; by convention $pe_{m+1} = 0$.

Equation 2 was used for plotting the uncensored data and equation 3 was used for plotting the censored data; the plotting positions of the data were calculated using the Weibull plotting position formula.

$$p(i) = (1 - pe_j) + \frac{(pe_j - pe_{j+1}) \times r}{(A_j + 1)} \qquad (2)$$

Where:

p(i) = the plotting position of the uncensored i data point.

r = the rank of the i^{th} observation of the A_j observations above the j detection limit.

$$pc(i) = \frac{(1 - pe_j) \times r}{(n_j + 1)} \qquad (3)$$

Where:

pc(i) = the plotting position of the censored i data point.

r = the rank of the i^{th} observation of the n_j censored values below the j detection limit.

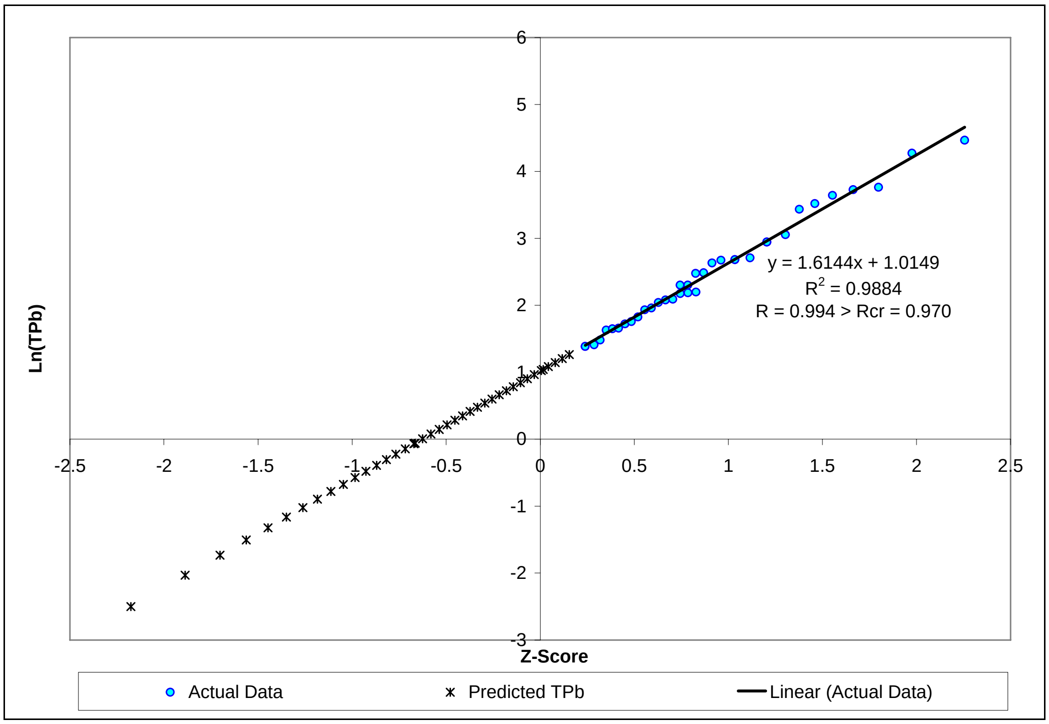

Figure 1-9: Probability Plot of the Uncensored and Predicted (Censored) Total Lead Transportation EMCs

Method for Calculating Descriptive Statistics

After the censored data are estimated (or for datasets without non-detects), descriptive statistics were computed using the bootstrap method (Singh et al. 1997). The bootstrap method samples from the data set with replacement several thousand times and calculates the desired descriptive statistics from the sampled data. The steps of the bootstrap estimation method are described below.

1. Take a sample of size *n* with replacement (the sampled data point remains in the data set for subsequent sampling) from the existing data set (Singh et al. recommends n be the same size as the original data set, this recommendation was followed for the analysis) and compute the descriptive statistic, θ_i, from the sampled data.
2. Repeat Step 1 independently N times (10,000 for this analysis) each time calculating a new estimate for θ_i.
3. Calculate the bootstrap estimate θ_B by averaging the θ_i's for i=1 to N

Fundamentally, the bootstrap procedure is based on the Central Limit Theorem (CLT), which suggests that even when the underlying population distribution is non-normal, averaging produces a distribution more closely approximated with normal distribution than the sampled distribution (Devore 1995). Figure 1-10 compares the total lead data after estimating censored values using the ROS method described prior to applying the bootstrap method with bootstrapped means of the ROS data. Note the bootstrap means are more normally distributed than the original data and the central tendency of the data is centered near 8 ug/L.

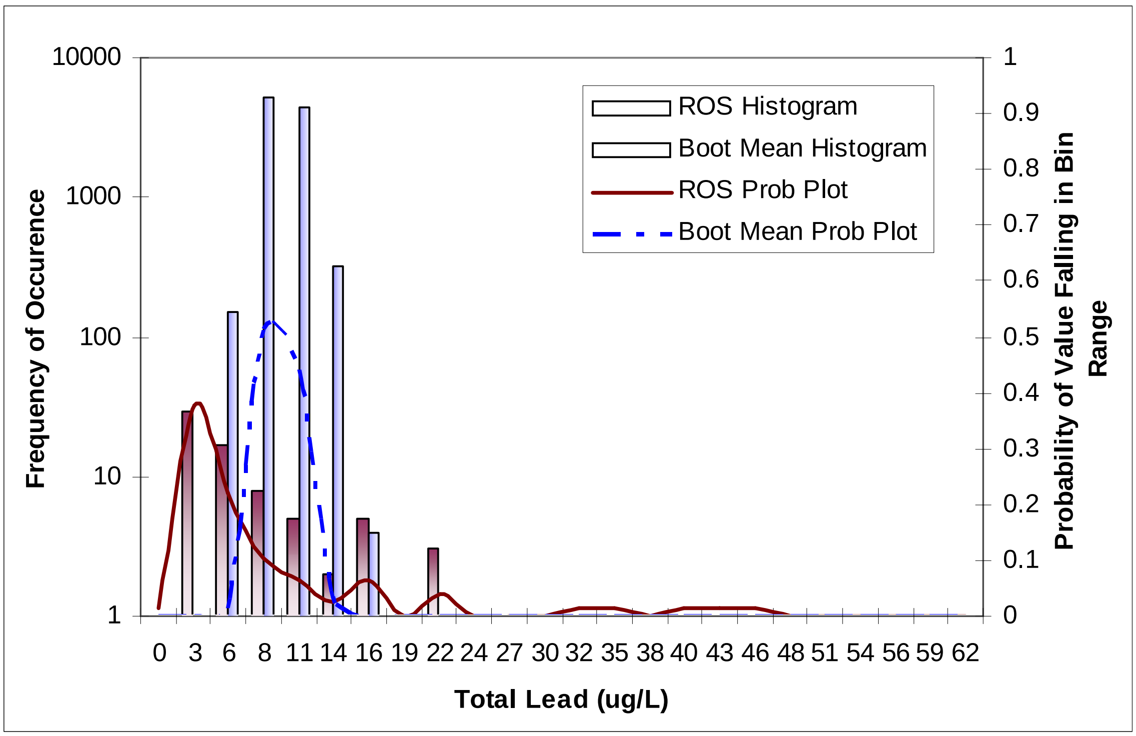

Figure 1-10: Comparison of the Distribution of ROS Method Total Lead Data and the Bootstrap Means of the ROS Data.

The majority of the LADPW stormwater monitoring for the pollutant land use combinations analyzed fit a lognormal distribution. The data that did not statistically fit the lognormal distribution were more closely approximated with a lognormal distribution than a normal distribution. The bootstrap method was applied differently depending on the distributional fit of the data. If the pollutant EMC data for a particular land use fit a lognormal distribution according to the Shapiro-Wilk goodness-of-fit test, the log-transformed data were bootstrapped and an estimate of the mean and standard deviation were obtained in log space and then converted to arithmetic space. The assumption of lognormality was more stringently applied than normal by using an alpha significance value of 0.1. This was done to improve the estimate of the standard deviation when the hypothesis of lognormality is rejected. When analyzing data in log space there is a tendency to overestimate the standard deviation for relatively symmetric data and underestimate the standard deviation for severely skewed data. For datasets that did not fit the lognormal distribution, the raw data were bootstrapped to obtain the mean and standard deviation statistics. Bootstrapping the data in arithmetic space assumes no distribution in those instances when a distribution could not be confirmed through goodness-of-fit testing.

Conclusions

The plotting position method for multiple detection limits has been used in conjunction with the bootstrap procedure for calculating the descriptive statistics used to represent pollutant EMC distributions in the water quality model. If the uncensored data were determined to be lognormally distributed with less than 50% of the data below the detection limit (censored), the bootstrap procedure was coupled with lognormal theory (i.e., data were log transformed prior to the bootstrap analysis). Otherwise, the original data plus the estimates of the censored data were analyzed in arithmetic space to calculate the arithmetic mean and standard deviation. Table 1-10 summarizes the lognormal descriptive statistics, and Table 1-11 summarizes the resulting arithmetic means. The latter data represent the land use specific pollutant EMCs in the Monte Carlo water quality model.

Table 1-10: Lognormal Statistics for Modeling Pollutants Concentrations from Land Uses.

Land Use		TSS	TP	NH3	NO3	NO2	TKN	Diss Cu	Tot Pb	Diss Zn	Cl
	Arithmetic Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	mg/L
Commercial	Mean	3.966	-1.242	-0.832	-0.884	-2.721	0.711	2.210	1.292	4.778	3.043
	St. Dev	0.609	0.680	1.218	0.635	1.060	0.804	0.685	1.389	0.703	1.226
Education	Mean	4.097	-1.375	-1.838	-0.750	-3.127	0.296	2.163	0.777	4.121	2.380
	St. Dev	0.923	0.515	1.111	0.626	1.177	0.604	0.733	0.891	0.531	1.264
Light Industrial	Mean	5.019	-1.328	-1.065	-0.574	-2.650	0.783	2.344	1.994	5.591	2.238
	St. Dev	0.741	0.828	0.957	0.828	0.667	0.694	0.764	1.041	0.769	0.590
Transportation	Mean	3.935	-1.229	-1.271	-0.687	-3.011	0.345	2.806	1.902	4.783	1.261
	St. Dev	0.834	0.992	0.608	0.749	1.056	0.654	1.116	0.631	1.040	0.998
Multi-Family Residential	Mean	3.144	-1.788	-1.208	-0.180	-2.932	0.346	1.768	0.812	3.965	2.124
	St. Dev	0.920	0.728	0.886	0.930	1.102	0.556	0.576	0.985	0.707	1.119
Single Family Residential	Mean	4.178	-1.170	-1.248	-1.219	-3.198	0.734	1.869	1.762	2.392	1.440
	St. Dev	1.026	0.640	0.964	1.274	1.191	0.747	0.783	0.997	1.085	0.570
Agriculture (Ventura County)	Mean	6.754	0.990	0.338	2.519	-2.120	1.948	2.839	3.015	3.252	3.666
	St. Dev	0.551	0.469	0.712	0.460	0.000	0.380	0.536	0.763	0.847	0.689
Vacant / Open Space	Mean	3.342	-3.060	-3.075	-0.033	-3.976	-0.458	-2.573	-1.246	1.293[1]	1.864
	St. Dev	1.859	1.064	0.811	0.548	0.459	0.784	1.505	1.616	1.312	0.226
Golf Course	Mean	4.649*	-0.705*	-1.031*	-0.397*	-3.976+	1.058	-2.573+	-1.246+	1.293+	1.864+
	St. Dev	0	0	0	0	0.459+	0	1.505+	1.616+	1.312+	0.226+

[1] Dissolved zinc for open space was estimated from the total zinc analysis of LADPW monitoring data. Four data points for dissolved and total zinc from the National Stormwater Quality Database gave an average ratio of dissolved to total zinc of 50 percent. For the open space land uses the variation of dissolved zinc was assumed to equal that of total zinc (i.e. same standard deviation) and the lognormal mean was set to give an average concentration of 8.6 ug/L for the open space land use, half of the average total zinc concentration of 17.2 ug/L.

* Developed through literature review of golf course runoff quality.

\+ Used same EMC as vacant/open space to represent golf course runoff quality

Table 1-11: Resulting Arithmetic Means from Lognormal Statistics for Modeling Pollutant Concentrations[1]

Land Use	TSS	TP	NH3	NO3	NO2	TKN	Diss Cu	Tot Pb	Diss Zn	Cl
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	mg/L
Commercial	63.5	0.364	0.913	0.505	0.115	2.81	11.5	9.55	152	44.5
Education	92.1	0.289	0.295	0.575	0.088	1.61	11.4	3.23	70.9	24.0
Light Industrial	151	0.265	0.345	0.563	0.071	2.19	10.4	7.34	268	9.38
Transportation	72.4	0.478	0.338	0.666	0.086	1.75	30.8	8.17	205	5.80
Multi-Family Residential	35.4	0.218	0.442	1.29	0.098	1.65	6.92	3.66	67.7	15.6
Single Family Residential	110	0.381	0.457	0.665	0.083	2.75	8.81	9.57	19.7	4.97
Agriculture (Ventura County)	998	3.00	1.81	13.8	0.120	7.54	19.7	27.3	37.0	49.6
Vacant / Open Space	159	0.083	0.064	1.12	0.021	0.860	0.237	1.06	8.61	6.62
Golf Course	104	0.494	0.357	0.672	0.021	2.88	0.237	1.06	8.61	6.62

[1] Calculated from values provided in Table 1-10: Lognormal Statistics for Modeling Pollutants Concentrations from Land Uses. - all footnote comments from Table 1-10 apply.

1.2.5. Estimate of BMP Performance Parameters

BMP performance is a function of three factors: (1) the fraction of stormwater runoff receiving treatment (often referred to as percent of runoff captured, or simply percent capture); (2) the pollutant removal achieved in the unit by virtue of infiltration and/or evapotranspiration (generically referred to as volume reduction); and (3) the pollutant removal achieved in the treatment unit by virtue of improved water quality. Newhall Ranch has committed to designing stormwater BMPs to capture and treat at least 80 percent of the stormwater runoff volume on an average annual basis.

Capture efficiency calculations used to estimate results for the individual storms and volume reduction estimates are discussed in Section 1.2.5.1. Pollutant removal estimates are described in Section 1.2.5.2.

1.2.5.1. BMP Capture Efficiency

The modeled structural BMPs were analyzed as flow or volume-based. Different methods were used to calculate the capture efficiency of each type of BMP as discussed below.

1.2.5.1.1. Volume-based BMP Capture Efficiency

The volume-based BMP that is included in the Newhall Ranch Project is the extended detention water quality basin. The capture efficiency is calculated by first running the GeoSYNOP program that provides descriptive statistics of storm events based upon analysis of hourly rainfall records. Included in these statistics is the dry time between storms. This information, along with the storm depths and drainage rates of the volume based BMPs, was used to estimate the percent capture of the volume-based BMPs for each storm in the period of record. The percent capture calculations for volume-based BMPs required the following steps.

Step 1 – Estimate Runoff Volumes for Each Storm in the Period of Record Modeled
The runoff volume for each storm in the period of record (538 storms) was calculated for the tributary area draining to each BMP.

Step 2 – Determine the BMP Storage Capacity
Next, the available storage capacity of the BMP was calculated for each storm. If the time from the preceding storm was equal to or larger than the drawdown time of the BMP (48 hours for DEDBs), then the BMP was considered empty at the time of the storm.

If the time between storms was less than the drawdown time, then the capture volume was calculated to account for the size of the previous storm, the drawdown that occurred during the previous storm, and the drawdown during the dry period between storms. This is done in order to account for insufficient time for the BMPs to completely empty before the next storm arrived. If the volume of stormwater runoff to the BMP from the previous storm minus the drawdown that occurred during the previous storm was larger than the BMP volume, then the BMP was assumed to be filled completely at the end of the previous storm and the initial storage capacity (*ISC*) in equation 4 is equal to the volume of drawdown that occurred during the dry period between storms.

If the runoff volume (for a storm occurring less than the drawdown time prior to the storm of interest) was less than the storage capacity of the BMP, then the difference between the storage capacity of the BMP and the volume remaining in the BMP after the previous storm plus the volume of drawdown that occurred during the dry period between storms was considered available to capture runoff from the next storm. This volume is then added to the storage capacity created from outflow from the basin during the time of the storms as shown in equation 4.

$$TC = ISC + [BV \times DD \times T] \qquad (4)$$

Where:

- TC = the treatment capacity (ft^3) of a volume-based BMP available to capture runoff over the duration of a storm
- ISC = the initial storage capacity for storm of interest (ft^3)
- BV = the BMP volume (ft^3)
- DD = the draw down rate of a volume-based BMP in percent per hour (hr^{-1}) [2.08% per hour for a 48 hour draw down time]
- T = the storm duration (hr)

The above equation accounts for storage capacity that is created during emptying of the BMP while a storm occurs. That is, during long duration storms more runoff can be processed through the BMP than for a short storm of comparable rainfall intensities and runoff rates. This method has produced percent capture results that consistently are in close agreement with the overall results from EPA's Stormwater Management Model (SWMM), which are used to verify the results from this method.

Step 3 – Determine BMP Percent Captures for Storms

The storage capacity estimated from step 2 is compared to the runoff volume estimate from step 1. If the storage capacity exceeds the storm runoff volume then the storm is considered to be completely (100%) captured. If the storage capacity is less than the runoff volume, a volume of runoff equal to the storage capacity is considered treated by the BMP. The excess volume is assumed to bypass the BMP and enter the receiving water untreated.

1.2.5.1.2. Flow Based BMP Capture Efficiency

The flow based BMPs (swales) are sized to treat a flow capacity exceeding the LA County SUSMP sizing requirements in order to achieve treatment of approximately 80% of the stormwater runoff. Off-line swales (swales with a diversion structure for flows up to the swale treatment capacity) that provide treatment even when a fraction of the runoff is bypassed achieve higher capture efficiency than in-line swales. The following steps were followed in estimating the percent capture for flow based BMPs.

Step 1 – Estimate the Depth of Runoff Captured on an Hourly Basis

The percent capture estimate for each storm is made through comparison of the hourly rainfall data comprising the storm event to the design rainfall intensity of the flow-based BMP. For off-line BMPs, if the depth of rainfall for a given hour exceeds the design rainfall intensity, then no treatment is credited for the rainfall above the design intensity (0.3 inches per hour). If the design capacity (in inches per hour) of the BMP meets or exceeds the depth of rainfall occurring in a given hour, then all of the resulting runoff during that hour is considered captured by the BMP.

Step 2 – Sum the Depth of Rainfall Capture for Each Storm Event

The depth of rainfall captured for each hour of rainfall during the storm event is then summed to give the total depth of rainfall considered captured by the BMP for the storm of interest.

Step 3 – Calculate the Percent Capture for Each Storm Event

The depth of rainfall captured during a given storm event is divided by the total depth of the storm to give the percent capture for the storm event that is used in the water quality model input.

Note that because flow-based BMPs are designed based on rainfall intensity and because a non-variable runoff coefficient method is used to convert rainfall to runoff over each catchment, the runoff characteristics of the catchment do not need to be known to calculate capture efficiency at the design stage. Rather, capture efficiency is based on a comparison of design rainfall intensity to measured rainfall intensity.

1.2.5.1.3. BMP Volume Reductions

The volume reduction achieved by a BMP is a function of the capture efficiency and the fraction of captured stormwater runoff that is infiltrated, evaporated, or transpired by vegetation.

Data in the International BMP Database have shown that as much as 30 percent of stormwater volume captured by dry extended detention basins and 35 percent captured by swales can be lost to infiltration (Strecker et al., 2004) which indicates that this may be an important mechanism that should be included in the water quality analysis. Evapotranspiration is expected to occur in vegetated basins and swales but is anticipated to be much less significant than infiltration and was not included in the volume reduction estimates.

BMPs specifically designed to infiltrate stormwater runoff (e.g. bioretention) were not included in the modeled stormwater management system for the Newhall Ranch Specific Plan water quality assessment, although bioretention will be included on the project level. Bioretention areas are expected to reduce captured stormwater runoff volumes by 90 percent or more, primarily through infiltration with smaller volume reductions occurring due to evapotranspiration. The large reduction in captured stormwater runoff volumes will not only achieve greater reductions in pollutant loads than water quality basins and swales, but will also provide significant benefits for minimizing potential receiving water impacts due to hydrologic changes (i.e. increased runoff volumes). As mentioned previously, the bioretention BMPs were not simulated in the water quality model as the planning level detail required for incorporating these BMPs into the project areas is largely unavailable at this time. The Newhall Ranch Specific Plan results are therefore conservatively based by modeling DEDBs and swales which have lower volume reductions.

1.2.5.2. BMP Pollutant Removal

Various data sources were examined to estimate the anticipated performance of the treatment BMPs. A comprehensive source of BMP performance information is the American Society of Civil Engineers (ASCE) International Stormwater BMP Database (ASCE, 2001, Strecker et al., 2001). The ASCE BMP database is comprised of carefully examined data from a peer-reviewed collection of studies that have monitored the effectiveness of a variety of BMPs in treating water quality pollutants for a variety of land use types. The mean effluent water quality for treatment BMPs used for modeling purposes was based on values found in the International Stormwater BMP Database (ASCE/EPA, 2004). Recent work in characterizing BMP performance suggests that effluent quality rather than percent removal is more reliable in modeling stormwater treatment (Strecker et al. 2001).

To match site conditions, the BMP database studies were screened to exclude studies where BMP design or function was believed to result in significantly lower performance than the BMP design criteria that will be met for the Newhall Ranch Project BMPs. For example some of the detention basin studies had significantly lower maximum detention times than the 48 hour criteria for the water quality basins. The water quality data for detention basins with a drawdown time of less than 9 hours were excluded from the data set used to predict detention basin performance. Certain studies in the detention basins category were not considered comparable in function to the dry-extended detention basin that will be incorporated into the Newhall Ranch Project treatment system. Detention basins that were listed as either underground vaults or settling chambers were also excluded.

As with the estimation of land use EMCs, final effluent values to be used in modeling analysis were determined using a combination of regression-on-order statistics and the “bootstrap” method (see Section 1.2.4.3).

Once the BMP sites had been screened for design criteria, the normality and lognormality of all BMP effluent sample data sets were tested using the Shapiro-Wilk goodness-of-fit test (Royston 1992). The majority of the pollutant data fit a lognormal distribution. The data that did not statistically fit the lognormal distribution were more closely approximated with a lognormal distribution than a normal distribution. The bootstrap method was applied differently depending on the distributional fit of the data. If the data fit a lognormal distribution, the log-transformed data were bootstrapped and an estimate of the mean and standard deviation were obtained in log space and then converted to arithmetic space. The assumption of lognormality was more stringently applied than normal by using an alpha significance value of 0.1. This was done to improve the estimate of the standard deviation when the assumption of lognormality fails. When analyzing data in log space there is a tendency to overestimate the standard deviation for relatively symmetric data and underestimate the standard deviation for severely skewed data. For datasets that did not fit the lognormal distribution, the raw data were bootstrapped to obtain mean and standard deviation values. Bootstrapping the data in arithmetic space assumes no distribution in those instances when a distribution could not be confirmed through goodness-of-fit testing.

Table 1-12 shows the lognormal effluent quality descriptive statistics and corresponding arithmetic means for detention basins and swales. These values were estimated using the above procedure on the ASCE/USEPA International BMP Database data (ASCE, 2003). Note that sufficient data were not available for nitrite-N or ammonia for detention basins, and removal of these pollutants was not simulated. Chloride removal was not simulated in either of the treatment BMPs.

Table 1-12: Summary of Lognormal Effluent Quality Statistics & Arithmetic Mean Effluent Quality for Modeled BMPs.

	Lognormal Modeling Parameters				Arithmetic Means	
	Detention Basins		Swales		Detention Basins	Swales
Pollutant	Mean	St Dev	Mean	St. Dev		
TSS	3.503	0.709	3.089	0.821	42.7	30.7
Total P	-1.262	0.553	NA	NA	0.330	NA
NH3	NA	NA	NA	NA	NA	NA
NO3	-0.346	0.671	-1.394	1.108	0.886	0.459
NO2	NA	NA	NA	NA	NA	NA
TKN	0.460	0.522	0.336	0.593	1.81	1.67
Dissolved Cu	NA	NA	1.756	0.776	NA	7.82
Total Pb	3.000	0.931	1.402	1.314	31.0	9.64
Dissolved Zn	3.786	0.705	3.231	0.714	56.5	32.6

NA - not available

BMP effectiveness studies in the International BMP database infrequently monitor aluminum therefore insufficient effluent data were available to model the removal effectiveness of treatment control BMPs for this water quality constituent. In order to estimate the reduction in total aluminum load and concentration (dissolved aluminum was assumed to pass through BMPs without removal), TSS removal was used as a surrogate.

Due to lack of aluminum monitoring data, it was necessary to simulate treatment for total aluminum using percent removal rather than the preferred BMP effluent concentration. TSS removal was modeled using BMP effluent concentrations for detention basins and swales and stormwater runoff concentrations for commercial, residential, and transportation land use; the most prevalent land uses in the Newhall Ranch Project. Detention basins and swales were found to remove, on average, 54% and 61% of the total TSS, respectively. The average fraction of total aluminum in dissolved form was 23% when averaging the available stormwater monitoring data from LADPW. The particulate fraction of total aluminum (77%) was multiplied by the percent removal for TSS to derive the reduction in total aluminum for detention basins (42%) and swales (47%).

It is possible that particulate aluminum is not uniformly distributed among the range of particle sizes and that the smaller particles with a higher ratio of surface area have a higher fraction of aluminum sorbed to these particles. However, it is also possible that dissolved aluminum could be sorbed to particulates within the treatment BMP affecting some removal of the dissolved fraction of aluminum. To best account for the variability in particulate and dissolved aluminum, the removal efficiency of total aluminum was modeled assuming no removal of dissolved aluminum and a uniform distribution of particulates for removal of particulate aluminum. The overall effectiveness for total aluminum was about 35% when taking into account the average annual 80% capture efficiency of the treatment BMPs.

1.2.6. Model Parameter Reliability & Assumptions

The input parameters for the water quality model fall into the following five main categories:

- Rainfall data;
- Runoff Coefficients;
- Land Use data;
- Stormwater pollutant EMCs; and
- BMP performance estimates.

Each of the categories of input data is evaluated for accuracy in reflecting the project site conditions:

Rainfall Data: A limited period of record (about 12 years of hourly data) is available from the Castaic Junction gauge monitored by the LADPW. The Castaic Junction gauge is nearer to the project site and consistently measures precipitation amounts lower than recorded at the Newhall gauge. However, the limited period of hourly data collected at the Castaic Gauge is insufficient for water quality modeling and the rainfall data collected at the Newhall gauge was used. The rainfall data from the Newhall gauge are believed to overestimate the average annual rainfall by about 3 inches per year resulting in a conservative estimate of stormwater runoff volumes and changes in average annual volumes resulting from development. The San Fernando gauge which was used to fill in missing periods in the Newhall gauge measures only slightly lower average rainfall depths than the Newhall gauge and the data used from this gauge were corrected to account for this small difference. Thus the use of San Fernando gauge data to fill gaps in the Newhall record results in a more accurate representation of actual rainfall and does not significantly bias estimates of runoff volume or concentration.

Runoff Coefficients: The estimation of runoff coefficients, described in Section B.2.2, is highly dependant on soil properties (i.e. infiltration potential) and less dependent on parameters such as ET rates, slopes, and surface roughness. Soil properties are estimated as accurately as possible from available data such as soil surveys and site specific geomorphology studies. The result is estimates for runoff coefficients that may somewhat overestimate or underestimate stormwater runoff. The net result on the water quality model is that this parameter is not conservatively estimated; however, it is estimated as accurately as the available information permits. When combined with the overestimate of average annual rainfall and land use percent impervious values (discussed below), stormwater runoff volumes are somewhat conservatively predicted.

Land Use Data: Land use data is generally considered a relatively accurately quantified input parameter. The land use data for the developed conditions can be use to classify land use type and compute area. The percent impervious values used in the water quality model for the urban land uses in the developed project condition are based upon the values listed in the LA County Hydrology Manual (2006). The percent impervious values assigned to types of urban land uses may slightly overestimate imperviousness for some land uses because the Manual is intended for drainage and flood control analysis of large storm events. However on a whole the Hydrology Manual values are generally considered to be a fairly accurate quantification of impervious where detailed site designs are not available. The emphasis of modeling efforts described herein is to quantify imperviousness as accurately as possible without intentionally incorporating conservatism.

Stormwater Pollutant EMCs: Stormwater pollutant EMCs are estimated from monitoring data collected by the LADPW from land use characterization stations and generally do not have site design and source control BMPs that will be implemented for the Newhall Ranch Project. Therefore the stormwater pollutant EMCs estimated from the LADPW data are probably slightly conservative compared to the pollutant concentrations in stormwater runoff that will occur from the developed conditions of the project site.

BMP Capture Efficiency & Effluent Concentrations: Stormwater capture efficiency estimates were calculated in Excel spreadsheets and calibrated with continuous simulation to provide results on a storm-by-storm basis for input into the water quality model, to accurately reflect the anticipated performance of the structural stormwater BMPs.

BMP effluent concentrations are based on studies contained in the International BMP database. These studies are screened to remove data for undersized (i.e., inadequate design criteria) BMPs that are likely to have pollutant removal performance substantially less than the BMPs to be constructed for the Newhall Ranch Project. This screening is believed to improve the accuracy of BMP performance estimates; however it is only intended to remove BMPs that are clearly unrepresentative in terms of sizing. The screening process is intended to include BMPs with adequate performance that may not be as well designed or maintained as the structural BMPs that will be part of Newhall Ranch Project. It is anticipated that the BMPs for the Newhall Ranch Project will perform as well, if not slightly better than, the projected performance based on the database. A major issue in the use of the International Database is representativeness for semi-arid climates. In this respect the database contains sites from different climates, but does include a number of sites from semi-arid climates, including data for over 40 sites studied by Caltrans.

Conclusions: The runoff coefficient, land use type and area, land use percent imperviousness and BMP performance model input parameters are thought to be reasonably accurate representations of the site conditions and do not increase the conservativeness of the water quality model. The rainfall data and stormwater pollutant EMC estimates are believed to result in conservative estimates of stormwater runoff volumes, pollutant concentrations and therefore pollutant loads. Overall the predevelopment model input parameters likely result in a slight underestimation of estimated loads and concentrations in the existing condition. The water quality estimates for the developed project condition are also believed to be conservative (i.e., tend to overestimate loads and concentrations) due to pollutant concentration estimates, and BMP performance estimates that in general do not include the benefits of site design or source control BMPs that are planned to be implemented in the Newhall Ranch Project.

1.3. Model Methodology

A Monte Carlo simulation method was used to develop the statistical description for storm water quality. In this approach, the storm water characteristics from a single rainfall event are first estimated. The rainfall depth was determined by randomly sampling from the historical rainfall depth frequency distribution. Similarly, an EMC was determined by randomly sampling from the frequency distribution of EMCs. The rainfall volume and EMC were used to determine runoff volume, pollutant concentration, and pollutant load of the single storm event. BMP volume reduction and performance (effluent quality), determined by randomly sampling from the developed frequency distributions, were used to calculate the pollutant removal resulting from treatment in the BMP system. This procedure was then repeated thousands of times (20,000), recording the volume, EMC and load from each randomly selected storm event, including treatment for the developed project condition. The statistics of these recorded results provide a description of the average characteristics and variability of the volume and water quality of storm water runoff.

- Total Suspended Solids (sediment)
- Total Phosphorus
- Ammonia
- Nitrate
- Nitrite
- Total Nitrogen[1]
- Dissolved Copper
- Total Lead
- Dissolved Zinc
- Chloride

The steps in the Monte Carlo Water Quality Model are as follows:

1. Develop a statistical description of the number of storm events per year, and randomly select a number N_{storms}.
2. Estimate the volume of storm runoff for each land use area from a randomly selected storm event.
3. Randomly select a pollutant concentration in storm runoff for each land-use area and each pollutant.
4. Calculate the total runoff volume, pollutant load, and concentration in runoff from the modeled portion of the project, for both existing and developed conditions.
5. Calculate a total annual pollutant load by repeating steps 2-4 N_{storms} times, where N_{storms} is the number of storms per year, randomly selected in step 1.
6. Repeat steps 1 - 6 a total of 20,000 times for each pollutant modeled, recording the estimated pollutant concentration and annual load for each iteration.
7. Develop a statistical representation (mean annual value) of the recorded storm water pollutant loads and concentrations.

Each of the seven steps is described below.

[1] TKN is modeled, but the results are not reported. Total Nitrogen results are reported from the sum of nitrate, nitrite, and TKN.

1.3.1. Storms & Stormwater Runoff (steps 1 & 2)

Step 1 – Statistical Representation of Number of Storm Events per Year

Number of Storms per Year

The number of storm events per year was calculated for the 35 complete years in the available period of record from 1969 – 2003. The modeled average number of storm events per year (> 0.1 inches) was 15.4, with a standard deviation of 6.2. Figure 1-11 illustrates a frequency histogram of the number of storm events per year at the Newhall gauge. The number of storm events per year was modeled with a normal distribution. In the simulation, the number of storms per year was determined by randomly sampling from the normal distribution and rounding to the nearest whole number, using the equation:

$$N_{storms} = 15.4 + 6.2\ R_N$$

where:

R_N = a standard normal variant with a mean of 0 and a standard deviation of 1.

If the arbitrary number of storms per year was zero or negative, then the normal distribution was re-sampled until a positive number was obtained.

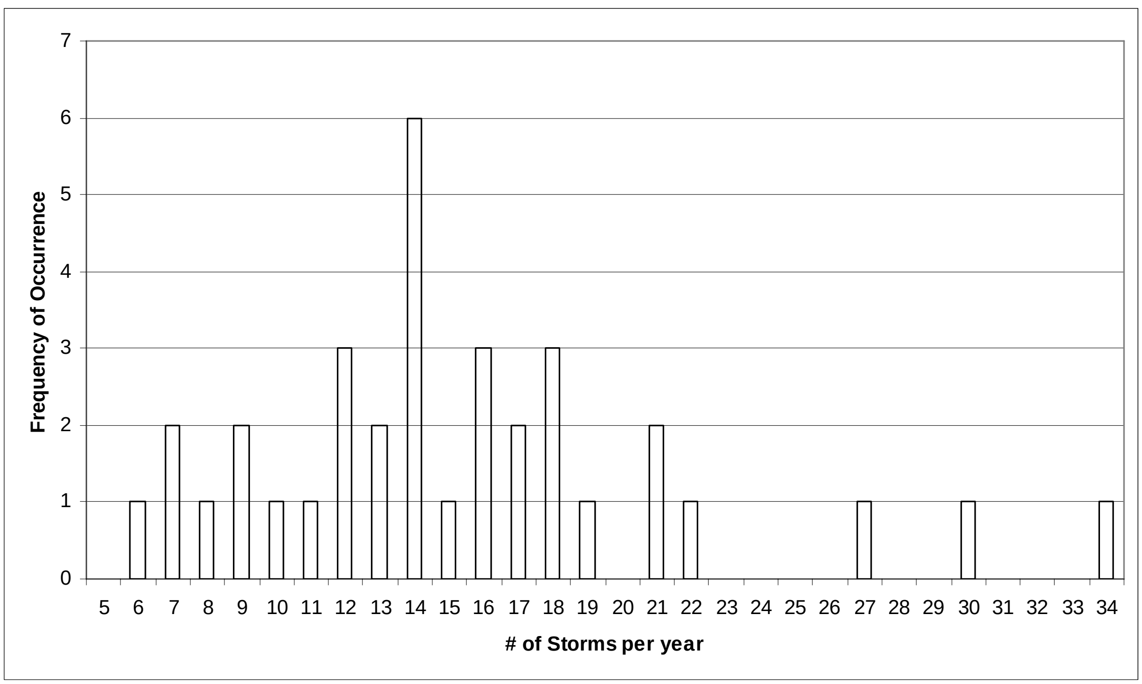

Figure 1-11: Distribution of Storms per Year at the Newhall Gauge

Step 2 – Estimate the Volume of Storm Runoff from a Storm Event.

The runoff volume from each storm was estimated using the following equation:

$$V=R_vPA \tag{5}$$

where:

V = the stormwater runoff volume (ft^3)

P = the rainfall depth of the storm (ft)

A = the drainage area (ft^2)

R_v = the mean volumetric runoff coefficient, a unit-less value that is a function of the imperviousness of the drainage.

For sub-basins that contain multiple land-use types, the total stormwater runoff volume is determined as the sum of runoff from each land-use type:

$$V_{wshed} = \Sigma_{lu} V_{lu} = \Sigma_{lu} (R_{v\,lu} PA_{lu}) \quad (6)$$

where *lu* designates the land-use type. It is assumed that rain falls uniformly over all land-uses in the sub-basin.

The steps used to calculate the volume of runoff from a randomly selected storm event were:

Step 2a Obtain a rainfall depth by randomly sampling from the 538 storm events.
Step 2b For each land-use area calculate a runoff volume using equation (5). The same rainfall depth is applied to each land-use area.
Step 2c Sum the runoff volumes from each land-use area to obtain the total runoff from the watershed for a particular storm event with equation (6).

1.3.2. Pollutant Loads & Concentrations (step 3 & 4)

Step 3 – Estimate a Pollutant Concentration in Storm Runoff from Each Land Use Area

Runoff Concentration
The distribution of land use-based pollutant concentration in storm runoff was developed based on the process described in Section B.2.4.3. For each storm event, stormwater EMCs were sampled randomly for each modeled land use and water quality parameter. The runoff concentration from each land-use area was evaluated with the expression:

$$C_{land-use} = \exp(\mu_{\ln x} + \sigma_{\ln x} R_N) \quad (7)$$

where:

$\mu_{\ln x}$ = the log-normal mean

$\sigma_{\ln x}$ = the log-normal standard deviation

R_N = a standard normal random variable

Step 4 – Calculate the Total Runoff Volume, Pollutant Load, and Pollutant Concentration in a Storm Event

Step 4A - The total runoff volume in the watershed was calculated with equation (6) as discussed in Step 2:

$$V_{wshed} = V_{land-use1} + V_{land-use2} + \ldots + V_{land-usei} \quad (8)$$

where the same randomly selected rainfall event was used to calculate runoff volume in each of the land-use areas.

Step 4B - The total pollutant load from the watershed was calculated by:

$$L_{wshed} = V_{land-use1} C_{land-use1} + \ldots + V_{land-usei} C_{land-usei} \quad (9)$$

where the concentration in each individual land-use area was calculated with equation (7) discussed in step 3.

Step 4C - The average pollutant concentration in runoff from the entire watershed from a single storm event was calculated by dividing the total watershed load (Step 4B) by the total watershed runoff volume (Step 4A):

$$C_{wshed} = L_{wshed} / V_{wshed} \quad (10)$$

Model steps up to 4C (Eq 10) were used in the model calculations for catchments with and without modeled BMPs. The resulting values from Equation 9 and Equation 10 represent the end model output for catchments without modeled BMPs and represent intermediate calculations for catchments with modeled BMPs

Catchments with treatment BMPs used additional calculations to determine the reduction in pollutant load and concentration achieved with treatment BMPs. The fraction of stormwater runoff receiving treatment was calculated for each storm event, using the capture efficiency associated with that event, as described in Section B.2.5. BMP performance was modeled using a randomly selected effluent concentration achieved within the BMP for each water quality pollutant.

Step 4D - The total pollutant load from watersheds with treatment BMPs was calculated by:

$$L_{wshed\_BMPs} = \left[Cap_{\%} \times V_{wshed} \times C_{eff} \times (1 - VR\%)\right] + \left[(1 - Cap_{\%}) \times V_{wshed} \times C_{wshed}\right] \quad (11)$$

where:

$Cap_{\%}$ is the volumetric percent capture of the BMP.

C_{eff} is the randomly determined effluent concentration from the BMP. C_{eff} was determined from sampling from the lognormal distribution described by the parameters contained in Table B-16.

$VR\%$ is the percent reduction in effluent volume achieved by the BMP (see Section B.2.5.1.3).

V_{wshed} and C_{wshed} were calculated per Steps 4A and 4C, respectively

Step 4E - The average pollutant concentration in runoff from the entire watershed with treatment from a single storm event was calculated by dividing the total watershed load with treatment by the total watershed runoff volume less the volume lost in BMPs:

$$C_{wshed\_BMPs} = L_{wshed\_BMPs} / V_{wshed\_BMPs} \qquad (12)$$

where:

$$V_{wshed\_BMPs} = V_{wshed} \times [1 - (Cap_{\%} \times VR\%)] \qquad (13)$$

The results of step 4D (Eq 11) and step 4E (Eq. 12) were used to compute model results for developed conditions with treatment.

Figure 1-12 provides a diagrammatic representation of these water quality calculations.

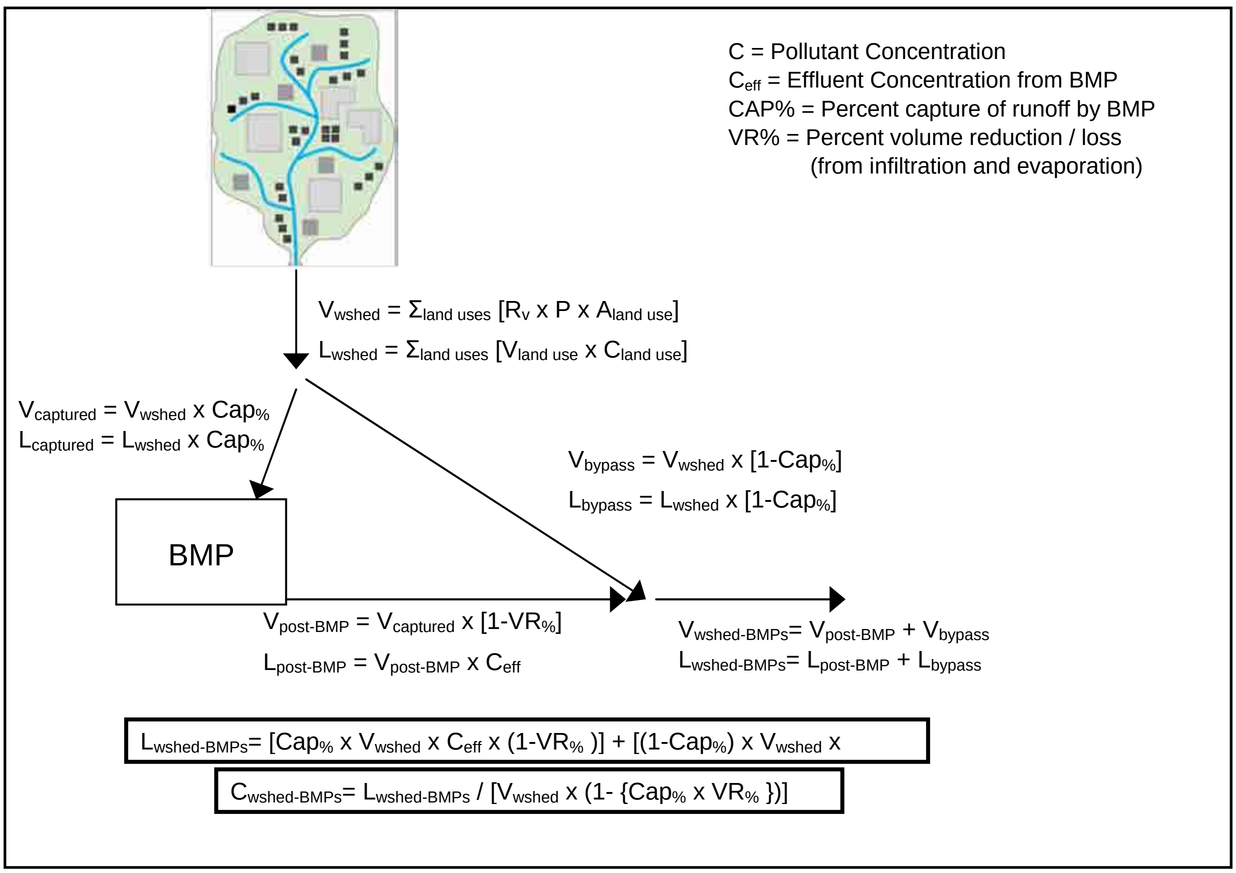

Figure 1-12: Diagrammatic representation of water quality calculations.

1.3.3. Annual Pollutant Loads, Concentrations, and Distributions (steps 5, 6, & 7)

Step 5 – Calculate a Total Annual Pollutant Load
The annual pollutant load is simply the sum of pollutant loads generated from all storms in a given year, based on the random selection described in Step 1. Therefore, steps 2-4 were repeated N_{storms} times (where N_{storms} was randomly selected per step 1), recording the total pollutant load from each randomly selected storm event. The individual storm loads were summed to obtain the total annual pollutant load.

Step 6 & 7 – Determine Distribution of Storm Concentration and Annual Loads
Steps 1-5 were repeated a total of 20,000 times, recording the pollutant concentration and annual load from each iteration. The resultant distributions can be used to present a frequency distribution for pollutant concentrations or loads using statistics calculated from the 20,000 Monte-Carlo iterations.

1.3.4. Model Methodology Assumptions

The following five key assumptions are made for the Monte Carlo water quality modeling methodology:

1. The assumed probability distributions of model parameters;
2. The assumption of independence between model parameters (i.e. no correlation between randomly determined variables);
3. Assigning a Lower Limit to BMP Effluent Concentrations;
4. Limiting pollutant removals to pollutants with data; and
5. Modeling structural BMPs to only remove pollutants and not acting as a source.

The implications of each of these assumptions to the water quality projections are discussed below.

1) Distribution Assumptions: Probability distributions are assumed to represent the number of storms per year, stormwater pollutant concentrations, and BMP effluent concentrations. Observed rainfall data (i.e., storm frequency) and stormwater monitoring data are fit with either a normal or lognormal distribution using standard statistical procedures. The values of storms per year, rainfall depth, runoff pollutant concentration, and BMP effluent concentrations used in given iteration in the Monte Carlo analysis are governed by the selected distributions. Large samples of these estimated variables will approximate the assumed distributions, and will have the same mean and variance that was observed in the rainfall and monitoring data. The following describes the distributions for various input parameters.

Storms per Year: Figure 1-11: Distribution of Storms per Year at the Newhall Gauge shows the number of storms per year occurring at the Newhall rain gauge (augmented with data from the San Fernando gauge). The number of storms occurring per year at the Newhall gauge appears to lie between the normal and lognormal distributions. The normal distribution was used to determine the number of storms per year simulated in the water quality model, as use of the lognormal distribution would overestimate the average annual rainfall, as well as its variability, when the distribution of the data is not heavily skewed. As discussed in Section 1.2.6, use of rainfall data collected at the Newhall gauge already tends to overestimate the average annual rainfall for the Project site. When using the normal distribution to randomly determine the number of storm per year, the resulting average annual rainfall output from the water quality model is typically in the range of 17.9 to 18.0 inches per year. This is in close agreement with the average annual rainfall from runoff producing storms of 17.9 inches determined directly from the rainfall data (see Table 1-1).

Stormwater Pollutant Concentrations: The Shapiro-Wilk Test was used to determine the statistical distribution that best represents the raw stormwater runoff monitoring data collected in Los Angeles and Ventura Counties. In most instances the data were found to be log-normally distributed at a confidence level of 0.10. In some instances, the data were not well fit by either the normal or lognormal distributions, but were found to be more closely approximated by the log-normal distribution. For data sets with greater than 50 percent non-detects or that were not log-normally distributed according to the Shapiro-Wilk test, data were analyzed (ROS and bootstrap) in arithmetic space as to not unreasonably overestimate the standard deviation of the data set. Since stormwater pollutant concentrations, in general, tend to be well approximated by the lognormal distribution (Helsel and Hirsh, 2002), the data sets that did not meet the lognormal criterion are still believed to belong to a log-normally distributed population, but the number of data points is too few to statistically confirm that this is the case. Therefore, simulations of stormwater concentrations in the water quality model were still conducted in lognormal space. This assumption is believed to result in a more accurate prediction than would the application of the normal distribution.

BMP Effluent Concentrations: Goodness-of-fit tests conducted on the raw BMP effluent monitoring data from the International BMP Database with the Shapiro-Wilk Test either resulted in (1) confirmation of the appropriateness of the lognormal distribution for the data; or (2) in the instances when the data did not meet the significance criteria of a p value > 0.1, that the data were more closely approximated with the lognormal distribution than the normal. The use of the lognormal distribution to represent BMP effluent concentrations results in higher average estimates of BMP effluent concentration. This is believed to be a more accurate estimation of BMP performance than use of the normal distribution, and is considered a more conservative assumption (leading if anything to higher than anticipated effluent concentrations).

2) Assumption of No Correlation between Model Parameters: The water quality model randomly samples for stormwater pollutant concentrations independent of the storm depth or antecedent dry period. The validity of this assumption is supported by analyses conducted by Environmental Defense Sciences (2002) who did not find a strong correlation between rainfall volume and event mean concentrations (EMCs) in the LA County data for the education land-use site. Data analyses for the single family residential land use were found to be weakly correlated

(R^2 of 0.6 ± 0.1) for some pollutants with storm depth; however some pollutant showed little correlation between these variables. Where weak correlations were present, stormwater pollutant concentrations decreased with storm size

Correlations between pollutant concentration and antecedent dry period were similarly variable. For the single family land use correlations between pollutant concentration and antecedent dry period were moderately significant for a few pollutants (R^2 of 0.8 ± 0.03), and weak for other pollutants. Correlations between pollutant concentration and antecedent dry period varied widely for the educational and multi-family land uses.

The results of these analyses indicated that no consistent level of correlation was determined between the stormwater EMCs and the rainfall depth or the antecedent dry period where a significant correlation was found to exist; most pollutants and land-uses showed weak correlations or no correlation. On this basis, stormwater pollutant concentrations are sampled independent of storm depth and antecedent dry period in the water quality model.

Effluent concentrations are considered more reliable estimator of treatment performance than percent removal (Strecker et al. 2001). BMP effluent concentrations were sampled independently of stormwater concentrations (i.e. influent concentration to the BMP) in the water quality model. As with the pollutant EMCs, independent sampling of effluent concentrations preserves the mean and standard deviation in the monitoring data.

3) BMP Performance – Irreducible Pollutant Effluent Concentrations: When sampling from the lognormal distribution to estimate BMP performance with an effluent concentration it is possible to select values approaching or equal to zero. While well functioning BMPs are capable of achieving high rates of pollutant removal, it is generally accepted that BMPs cannot completely remove pollutants from the water column. In effect BMPs, at best, can achieve what is called an "irreducible pollutant concentration" (Schueler, 1996). In an effort to prevent overestimating BMP performance in the model, lower limits were set for the effluent concentrations of each modeled pollutant and BMP. The lowest observed effluent value in each pollutant data set was used as the irreducible pollutant effluent concentration in the water quality model.

4) BMP Performance – Limiting Pollutant Removal Estimates to Available Data: Table 1-12: Summary of Lognormal Effluent Quality Statistics & Arithmetic Mean Effluent Quality for Modeled BMPs. presents model parameters for estimating BMP pollutant effluent concentrations. Pollutant removal is only simulated for those pollutants with available data from the International BMP Database. In instances where data is not available for a parameter, no treatment is assumed for that parameter. This does not prevent the model from calculating load reductions of the pollutant as a result of hydrologic source control.

5) BMP Performance – BMPs are not a Source of Pollutants: In instances when the randomly determined BMP effluent concentration exceeds the modeled influent concentration, no pollutant

removal occurs and the effluent concentration is modified to equal the influent concentration. This prevents BMPs from acting as a source of pollutants in the water quality modeling. The commitment to regular and effective maintenance of the stormwater BMPs provides support for this assumption.

Conclusions: The above assumptions are expected to improve the accuracy of the water quality model estimates. The net result for the model outputs are somewhat conservative estimates of pollutant loads and concentrations due to estimation of model input parameters that are not compromised by the model methodology.

1.4. Model Reliability

Factors that affect model reliability include variability in environmental conditions and model error. To account for environmental variability, a statistical modeling approach was used that takes into account the observed variability in precipitation from storm to storm and from year to year. The model also takes into account the observed variability in water quality from storm to storm, and for different types of land uses. One way to express this variability is the coefficient of variation (COV) which is the ratio of the standard deviation of the variable to the mean value. Based on the statistical model, the range of COVs for pollutant loads was from 0.5 to 0.8 on an average annual basis, depending on the pollutant. This variability, or greater, is expected in typical storm water runoff.

Model error relates to the ability of the model to properly simulate the processes that affect storm water runoff, concentrations, and loads. Ideally model error is measured through calibration, but calibration is not feasible when considering a future condition. We are confident that the model is a reasonable reflection of storm water processes because the model relies largely on measured regional data. For example, the runoff water quality data are obtained from a comprehensive monitoring program conducted by LA County that has measured runoff concentrations from a variety of land use catchments and for a statistically reliable number of storm events. In addition parameter estimation is fairly conservative resulting in moderately conservative estimates of pollutant concentrations and loads.

1.5. References

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APPENDIX C

NEWHALL RANCH STORMWATER MONITORING DATA

APPENDIX C

March 6, 2000

Newhall Ranch Monitoring Station	Hardness mg/L	Calcium mg/L	Magnesium mg/L	Potassium mg/L	Sodium mg/L	Alkalinity mg/L	Sulfate mg/L	Chloride mg/L	Nitrate mg/L	E.Coli MPN/100 mL	TDS mg/L
A-Mouth of Potrero	2360	324	378	30	1360	400	3690	780	16.1	8160	7530
B-Mouth of San Martinez	1070	229	122	8	392	210	1520	130	2.8	3090	2690
D-Mouth of Middle Canyon	44	11	4	6	9	30	16	3	12.4	133	160
E-Top of Chiquito Canyon	61	18	4	8	13	40	37	9	2.6	213	150

	Boron mg/L	Copper ug/L	Iron ug/L	Manganese ug/L	Zinc ug/L	Aluminum ug/L	Arsenic ug/L	Barium ug/L	Berylium ug/L	Cadmium ug/L	Chromium ug/L
A-Mouth of Potrero	2.6	20	4770	880	50	4570	5	155	0.6	0.4	7
B-Mouth of San Martinez	0.8	150	51500	4230	300	44000	21	391	7	8.8	47
D-Mouth of Middle Canyon			1290	350	30	2230		136	0.4	0.4	2
E-Top of Chiquito Canyon			11700	970	150	6280	3	210	1.4	1	10

	10 Lead 40 ug/L	Mercury ug/L	Nickel ug/L	Selenium ug/L	Total Coliform MPN/100ml	Fecal Coliform MPN/100ml	TSS mg/L	VS mg/L	pH
A-Mouth of Potrero	8	0.01	22	12	50000	1600	1180	32800	8.2
B-Mouth of San Martinez	47.7	0.06	180	11	160000	1700	28000	40000	8
C-1/2 Mile Upstream of Onion Field					90000	11000			
D-Mouth of Middle Canyon	7.7	6			>160000	>160000	600	4100	7.5
E-Top of Chiquito Canyon	19.1		25		2400	2400	3490	9300	7.1

SS = suspended solids
VS = volatile solids

March 8, 2000

Newhall Ranch Monitoring Station	Hardness mg/L	Calcium mg/L	Magnesium mg/L	Potassium mg/L	Sodium mg/L	Alkalinity mg/L	Sulfate mg/L	Chloride mg/L	Nitrate mg/L	E.Coli MPN/100 mL	TDS mg/L
A-Mouth of Potrero	2090	266	347	39	1470	360	3700	960	18.8	6470	7230
B-Mouth of San Martinez	1340	304	142	10	413	210	1900	120	3.1	2430	2960
C-1/2 Mile Upstream of Onion Field	147	44	9	3	10	80	87	3	1.6	323	190
D-Mouth of Middle Canyon	73	21	5	6	10	40	17	3	18.1	162	160
E-Top of Chiquito Canyon	153	43	11	11	18	70	119	12	2.9	420	260

	Boron mg/L	Copper ug/L	Iron ug/L	Manganese ug/L	Zinc ug/L	Aluminum ug/L	Arsenic ug/L	Barium ug/L	Berylium ug/L	Cadmium ug/L	Chromium ug/L
A-Mouth of Potrero	2.9	10	2460	510	30	1580	5	94.4	0.3	0.2	4
B-Mouth of San Martinez	0.8	200	47500	5210	360	69700	27	573	20	13.6	70
C-1/2 Mile Upstream of Onion Field			44600	6950	330	85100	13	2360	14	2	39
D-Mouth of Middle Canyon			1510	300	30	2300		132	0.5	0.4	2
E-Top of Chiquito Canyon	170	100	30700	2110	300	2360	6	470	4.4	2.7	27

	Lead ug/L	Mercury ug/L	Nickel ug/L	Selenium ug/L	Total Coliform MPN/100ml	Fecal Coliform MPN/100ml	TSS mg/L	VS mg/L	pH	TOC mg/L	Diazinon ug/L
A-Mouth of Potrero	4.2	0.03	15	12	30000	7000	490	850	8.2	21.2	ND
B-Mouth of San Martinez	59.2	0.24	330	11	>160000	205	54200	1840	7.8	11.6	ND
C-1/2 Mile Upstream of Onion Field	95.2	0.45	103	4	160000	1600	36000	1460	8.1	9.4	4
D-Mouth of Middle Canyon	7.6	0.02	6		50000	2400	10700	160	7.9	4	ND
E-Top of Chiquito Canyon	54.5	0.14	64	2	>160000	160000	9800	750	8	15.5	

SS = suspended solids
VS = volatile solids

APPENDIX D

"REVIEW OF BACTERIA DATA FROM SOUTHERN CALIFORNIA WATERSHEDS"

Flow Science Incorporated
723 E. Green St., Pasadena, CA 91101
(626) 304-1134 • FAX (626) 304-9427

REVIEW OF BACTERIA DATA FROM SOUTHERN CALIFORNIA WATERSHEDS

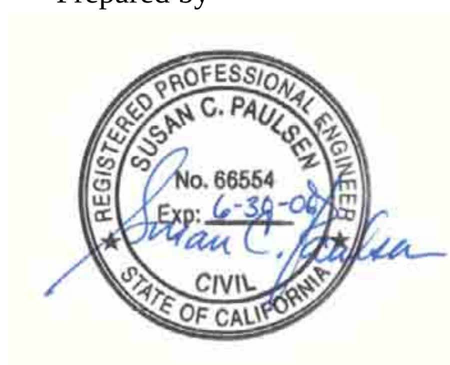
Prepared
for

The Irvine Company
550 Newport Center Drive
Newport Beach, CA 92660

Reviewed By

E. John List, Ph.D., P.E.
Principal Consultant

Prepared by



Susan Paulsen, Ph.D., P.E.
Vice President, Senior Scientist

Alex Anderson
Associate Engineer

FSI 057015
April 2005

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

SUMMARY

Available data from Southern California watersheds demonstrate that both existing and EPA-recommended bacteria water quality criteria are routinely exceeded in fresh water creek and river flows, often by one or more orders of magnitude. Exceedances of criteria occur even for flows from largely natural, undeveloped watersheds with little human influence. Even in urbanized watersheds, there is strong evidence that the predominant source of indicator bacteria may be natural (not anthropogenic) – including, for example, bacteria from wildlife, birds, and regrowth within the environment, including sediments. Both measurement data and numerous literature sources have shown that both wet and dry weather bacteria concentrations frequently exceed objectives in creeks and rivers, and that bacteria concentrations rise dramatically during wet-weather periods.

Data from Orange County coastal watersheds indicate that although bacteria in storm water runoff may be elevated within urban storm drain systems, the level of development within these watersheds has little if any effect on the concentrations of indicator bacteria in the receiving waters. These results are consistent with data from other watersheds within Orange County and in other parts of Southern California. No clear trend is evident in bacteria concentrations over time, with concentrations remaining relatively steady, even in areas where land use characteristics have changed over time. Both the concentrations of bacteria in runoff and the impacts of elevated bacteria concentrations on downstream water quality appear to vary by site and with the size of the contributing stream, and thus are likely a function of the dominant sources of bacteria, local hydrologic conditions and climate, and other site-specific factors.

INTRODUCTION

Flow Science was retained by The Irvine Company to review available data and information on the concentrations of indicator bacteria in storm water and dry weather runoff. The goals of this study were to evaluate variations in the concentrations of bacteria during both wet and dry conditions, variations in bacteria levels with the level of development in a watershed or drainage area, changes in bacteria levels over time or with changes in development or land use areas, and the sources of bacteria in runoff and in receiving waters.

In conducting the analysis, Flow Science utilized water quality criteria and thresholds to evaluate available data. These thresholds were obtained from the Water Quality Control Plan (Basin Plan) for the Santa Ana Region, which contains fecal coliform water quality objectives for inland surface waters that apply to the beneficial uses of water contact recreation (REC-1)[1] and non-water contact recreation (REC-2)[2], from proposed EPA water quality criteria, and from Title 17 "beach posting" thresholds. These thresholds are discussed in greater detail below.

Flow Science evaluated data on bacteria concentrations in Southern California. Data were available for watersheds along the Newport Coast, for inland watersheds, and from Los Angeles County. In addition, Flow Science reviewed literature and studies conducted by others.

BACKGROUND: BACTERIA WATER QUALITY STANDARDS

The Basin Plan bacteria objectives currently contained in the Santa Ana Basin Plan were originally developed by the National Technical Advisory Committee (NTAC) to the Federal Water Pollution Control Administration in 1968.[3] These recommendations were based upon prospective

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[1] See Basin Plan at p. 4-6: "REC-1 Fecal coliform: log mean less than 200 organisms/100 mL based on five or more samples/30 day period, and not more than 10% of the samples exceed 400 organisms/100 mL for any 30-day period."

[2] See Basin Plan at p. 4-6: "REC-2 Fecal coliform: average less than 2000 organisms/100 mL and not more than 10% of samples exceed 4000 organisms/100 mL for any 30-day period."

[3] See *Water Quality Criteria, a Report of the National Technical Advisory Committee to the Secretary of the Interior*, Federal Water Pollution Control Administration: Washington, D.C., April 1, 1968, at p. 8 and p. 12:

"Surface waters should be suitable for use in "secondary contact" recreation – activities not involving significant risks of ingestion – without reference to official designation of recreation as a water use. For this purpose, in addition to aesthetic criteria, surface waters should be maintained in a condition to minimize potential health hazards by utilizing fecal coliform criteria. In the absence of local epidemiological experience, the Subcommittee recommends an average not exceeding 2,000 fecal coliforms per 100 ml and a maximum of 4,000 per 100 ml, except in specified mixing zones adjacent to outfalls."

epidemiological studies conducted by the United States Public Health Service in 1948, 1949, and 1950. These studies found an "epidemiologically detectable health effect" at levels of 2300 to 2400 coliforms per 100 ml at bathing beaches on Lake Michigan (at Chicago) and in the Ohio River. Later work conducted in the mid-1960s showed that approximately 18% of the coliforms present in the mid-1960s at the Ohio location belonged to the fecal coliform subgroup. The recreational contact water quality criteria suggested by the committee were based upon the fraction of coliforms present as fecal coliforms and a factor of safety of two.

The fecal coliform standards recommended in 1968 were adopted by many states and municipalities and remain in use in many locations (including in the Santa Ana Region). Several studies conducted since 1968 have questioned these criteria and recommended use of alternatives.[4] As early as 1972, a Committee formed by the National Academy of Science-National Academy of Engineers noted the deficiencies in the study design and data used to establish the recreational fecal coliform criteria, and stated that it could not recommend a recreational water quality criterion because of a paucity of valid epidemiological data (Committee on Water Quality Criteria, 1972).

In response to these concerns, EPA in 1972 initiated studies at marine and freshwater bathing beaches that were designed to correct the deficiencies in the earlier studies and analyses. These studies were conducted at sites contaminated either with pollution from multiple point sources (usually treated effluents that had been disinfected) or by effluents discharged from single point sources. The studies examined three bacterial indicators of fecal pollution (*E. coli*, enterococci, and fecal coliforms) and found that fecal coliform densities showed "little or no correlation" to gastrointestinal illness rates in swimmers. In contrast, a good correlation was found between swimming-associated gastrointestinal symptoms and either *E. coli* or enterococci in swimming waters (Dufour, 1984). Based on these studies, EPA in 1986 proposed section 304(a) criteria for full body contact recreation based upon *E. coli* and/or enterococci but noted that "it is not until their adoption as part of the State water quality standards that the criteria become regulatory" (USEPA, 1986).

EPA's current recommendations for bacteria water quality objectives (USEPA, 2003) include the use of *E. coli* and/or enterococci as the basis for water quality criteria to protect fresh recreational waters and the use of enterococci as the basis for marine water quality criteria. The EPA recommends that the use of fecal coliform be discontinued for both freshwater and marine

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"Fecal coliforms should be used as the indicator organism for evaluating the microbiological suitability of recreation waters. As determined by multiple-tube fermentation or membrane filter procedures and based on a minimum of not less than five samples taken over not more than a 30-day period, the fecal coliform content of primary contact recreation waters shall not exceed a log mean of 200/100 ml, nor shall more than 10 percent of total samples during any 30-day period exceed 400/100 ml."

[4] For a summary of these studies, see the discussion provided on pages 1-3 of the *Ambient Water Quality Criteria for Bacteria – 1986*, USEPA 440/5-84-001, January 1986.

waters. EPA's recommendations recognize that bacteria concentrations are quite variable and are best characterized in terms of a probability distribution. Because bacteria concentrations tend to follow log-normal distributions, EPA's current recommendations specify that compliance should be based upon geometric means computed with data collected over a long-term (e.g., 30 days, or seasonally) and "upper percentile values," clarifying that compliance should not be determined using "single sample maximum" values. Upper percentile values are calculated bacteria densities that are intended to correspond to a known geometric mean-based risk level, and are intended to be used to interpret any single measurement. EPA recommends that states acquire enough sample data to calculate site-specific upper percentile values to characterize water quality for waters where exposure is greatest (e.g., bathing beaches). EPA's recommended water quality criteria for freshwater and marine waters are presented in Tables 1 and 2.

Table 1. Water quality criteria for bacteria recommended by EPA for fresh recreational waters

Risk level[a] [% of swimmers]	Geometric mean density [per 100 ml]	Upper Percentile Value Allowable Density [per 100 ml]			
		75th percentile	82nd percentile	90th percentile	95th percentile
Enterococci criteria					
0.8	33	62	79	107	151
0.9	42	79	100	137	193
1.0	54	101	128	175	247
E. coli criteria					
0.8	126	236	299	409	576
0.9	161	301	382	523	736
1.0	206	385	489	668	940

a) The risk level corresponds to the anticipated excess illness rate. For example, a risk level of 0.8% is believed to correspond to an illness rate of 8 gastrointestinal illnesses per 1,000 swimmers in excess of background illness rates.

Table 2. Water quality criteria for enterococci recommended by EPA for marine recreational waters

Risk level[a] [% of swimmers]	Geometric mean density [per 100 ml]	Upper Percentile Value Allowable Density [per 100 ml]			
		75th percentile	82nd percentile	90th percentile	95th percentile
0.8	4	13	20	35	63
0.9	5	16	24	42	76
1.0	6	19	29	50	91
1.1	8	23	35	61	110
1.2	9	28	42	73	133
1.3	11	34	51	89	161
1.4	14	41	62	107	195
1.5	17	49	75	130	235
1.6	20	60	91	157	284
1.7	24	72	109	189	344
1.8	29	87	132	229	415
1.9	35	105	160	276	502

a) The risk level corresponds to the anticipated excess illness rate. For example, a risk level of 0.8% is believed to correspond to an illness rate of 8 gastrointestinal illnesses per 1,000 swimmers in excess of background illness rates.

The Santa Ana Region currently continues to utilize fecal coliform bacteria to assess water quality applicable to recreational beneficial uses. However, the Santa Ana Regional Board is currently conducting a triennial review of its Basin Plan, and is including an evaluation of recreational beneficial use designations and water quality objectives as part of the Basin Plan update process. We currently anticipate that the Santa Ana Regional Board will likely update fresh water bacteria water quality objectives; updated objectives may be consistent with the recommendations contained in EPA's November 2003 Implementation Guidance (see Tables 1 and 2).

ADDITIONAL GUIDELINES FOR BACTERIA

Although not enforceable as water quality objectives, Orange County beaches and bays are "posted" and access may be restricted when exceedances of certain bacteria levels are observed. The "posting" levels are described in Title 17 of the California Code of Regulations, Section 7958 (Bacteriological Standards):

The minimum protective bacteriological standards for waters adjacent to public beaches and public water-contact sports areas shall be as follows:

(1) Based on a single sample, the density of bacteria in water from each sampling station at a public beach or public water contact sports area shall not exceed:

(A) 1,000 total coliform bacteria per 100 milliliters, if the ratio of fecal/total coliform

bacteria exceeds 0.1; or
(B) 10,000 total coliform bacteria per 100 milliliters; or
(C) 400 fecal coliform bacteria per 100 milliliters; or
(D) 104 enterococcus bacteria per 100 milliliters.

(2) Based on the mean of the logarithms of the results of at least five weekly samples during any 30-day sampling period, the density of bacteria in water from any sampling station at a public beach or public water contact sports area, shall not exceed:
(A) 1,000 total coliform bacteria per 100 milliliters; or
(B) 200 fecal coliform bacteria per 100 milliliters; or
(C) 35 enterococcus bacteria per 100 milliliters.

COMPARISON LEVELS USED IN THIS REPORT

Flow Science used the following numeric values in analyzing available bacteria data:

Fecal Coliform (from existing Santa Ana Basin Plan water quality standards and Title 17 beach "posting" requirements):

- Single Sample: 400 MPN (or CFU)/100mL[5].
- Geometric Mean: 200 MPN (or CFU)/100mL.

Enterococci (from EPA-recommended criteria):

- Single Sample: 247 MPN (or CFU)/100mL.
- Geometric Mean: 54 MPN (or CFU)/100mL.

Total Coliform (from Title 17 beach "posting" requirements):

- Single Sample: 10,000 MPN (or CFU)/100mL.
- Geometric mean: 1,000 MPN (or CFU)/100mL.

Enterococci criteria used by Flow Science in this report correspond to a proposed 1.0% acceptable risk level, 95th percentile, while fecal and total coliform criteria correspond to beach posting levels. Of course, the beach "posting" requirements apply at the beach, not in upstream freshwater flows, but the numeric values provide a useful threshold value against which data can be compared.

[5] Basin Plan specifies no more than 10% of single samples to exceed this value

MONITORING DATA AND RESULTS

Flow Science examined data on bacteria concentrations from a variety of sources in the Santa Ana Region, including streams in coastal watersheds, the Santa Ana River, and inland streams. Data sources included:

- Bacteria concentrations in stream flows from Orange County coastal watersheds
- Bacteria concentrations in freshwater bodies in the Santa Ana region
- Bacteria concentration in runoff samples collected by the Los Angeles County Department of Public Works

Data from each of these sources are examined in greater detail below.

Review of Data from Orange County Coastal Watersheds

Flow Science has reviewed data from Orange County samples collected between 1986 through 2004.[6] Figures for Orange County coastal watersheds are shown in Appendix A; watersheds and data collection locations are shown in Figures A1- 2. Figures A3, A4, and A5 present long-term geometric mean concentrations, calculated as the geometric mean concentration of all available samples (including both wet and dry weather samples) for the period of record, of enterococci, fecal coliforms, and total coliforms, respectively. As shown in Figure A3, long-term geometric mean concentrations of enterococci exceed EPA's proposed freshwater enterococci water quality criteria in all the coastal creeks for which data were available. Similarly, long-term geometric mean concentrations of fecal coliform in most Newport Coast creeks exceed existing Santa Ana Basin Plan REC-1 fecal coliform water quality criteria. Figures A6, A7, and A8 present long-term geometric mean concentrations of enterococci, fecal coliform, and total coliforms plotted against the percent of development within each watershed. There is no apparent correlation for any of the three indicator bacteria presented in these figures with amount of the watershed that has been developed. Note that Figures A6 through A8 utilize the current (2005) level of development for each watershed.[7]

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[6] Data were obtained from http://www.ocbeachinfo.com/downloads/data/index.htm on February 11 and March 22, 2005. For enterococci, data were available from March 30, 1999, through December 21, 2004. For fecal coliform and total coliform, data were available from January 7, 1986, through December 21, 2004. No data were available for *E. coli*.

[7] The area of watershed that was developed was initially established by PBS&J in 1999 (PBS&J, 1999). These values have been subsequently updated based on information received from The Irvine Company in 2005. Two watersheds experienced significant development between 1999 and 2005: the Crystal Cove Creek watershed increased from ~5% to ~70% developed, and the Muddy Creek watershed increased from ~1% to ~60% developed. The level of development within the other coastal watersheds remained approximately constant.

To facilitate analysis, individual samples were segregated as follows: wet-weather[8], summer dry-weather[9], and winter dry-weather.[10] As shown in Figure A9, wet weather samples exceed single sample threshold values most frequently, regardless of which indicator bacteria are sampled (72%, 61%, and 39% of wet-weather enterococci, fecal coliform, and total coliform samples, respectively, exceed single sample thresholds). Summer dry weather samples exceed thresholds less frequently than wet-weather samples, and winter-dry weather samples exceed thresholds least frequently. The single sample thresholds used to calculate the percent of samples in exceedance are 247, 400, and 10,000 MPN/100mL for enterococci, fecal coliform, and total coliform, respectively.

Figures A10 through A53 present the following information for each site: a) a time-series scatter plot of single sample concentrations of enterococci, fecal coliform, and total coliform for the wet and dry weather data, b) wet and dry weather cumulative distribution functions for each bacteria, and c) the percentage of individual samples that exceed corresponding thresholds in each month. From this analysis, the following conclusions may be reached:

1. Lowest geometric mean concentrations of each of the three bacteria (enterococci, fecal coliform, and total coliform) occurred at the Pelican Hill Waterfall station (watershed 95% developed, primarily golf course), and highest geometric mean concentrations of each bacteria occurred at the Emerald Bay Drain station (watershed 3% developed). In the Muddy Creek watershed, which experienced substantial development between 1999 and 2005 (see footnote 7), enterococci concentrations appear to have decreased as the watershed became more developed. Trends were less evident for fecal and total coliform levels. Similar patterns emerged in data from the Crystal Cove Creek watershed, the other watershed that experienced significant development between 1999 and 2005. Enterococci and fecal coliform concentrations appear to have decreased, while any trends in the total coliform record are unclear. These results indicate that bacteria concentrations in creeks may decline as the level of development increases, and bacteria concentrations in runoff from developed watersheds may be lower than runoff from creeks in less developed coastal areas.

2. No relationship was found between the percentage of the watershed developed and the long-term geometric mean bacteria concentrations (see Figures A6, A7 and A8).

3. The time series plots indicate that concentrations of indicator bacteria are not increasing over time. By visual inspection, bacteria concentrations may be

[8] "Wet-weather" samples are those samples that were collected within two days of a rainfall event greater than or equal to 0.1 inches as measured by the Newport Beach Harbor Station.

[9] "Summer dry-weather" samples are defined as samples collected from April-November, but not within two days of rainfall greater than or equal to 0.1 inches as measured by the Newport Beach Harbor Station.

[10] "Winter dry-weather" samples are defined as samples collected from December-March, but not within two days of rainfall greater than or equal to 0.1 inches as measured by the Newport Beach Harbor Station.

decreasing over the data record in five catchments (Pelican Point Creek, Muddy Creek, Emerald Bay Drain, El Morro Creek upstream station, and Crystal Cove Creek). At the remaining six stations, no apparent long-term trend in bacteria concentration is observed. Very little if any correlation is evident between long-term trends and percentage of watershed developed, as the apparent slight decrease in bacteria concentrations was observed in watersheds that range from 1-95% developed.

4. Although Figure A9 shows that taken as a whole, wet-weather samples have higher concentrations than dry-weather samples, data from some locations show the opposite trend. At Pelican Point Creek (95% developed), dry weather concentrations for enterococci and fecal coliform are higher than wet weather concentrations. At the Emerald Bay Drain (3% developed), fecal and total coliform dry weather concentrations are significantly greater than wet weather concentrations. At El Morro Creek (1% developed), Broadway Creek (25% developed), and Crystal Cove Creek upstream station (70% developed) there is no significant difference (by visual inspection of Figures A34-36, A50-52, and A38-40, respectively) between wet and dry weather bacteria concentration distributions.

5. The general observation that winter dry-weather samples on average contain fewer bacteria than summer dry-weather samples is evident in many of the scatter plots. Figures A10, A34, A38, A42, and A46 (presenting data from Pelican Point Creek, El Morro Creek, Crystal Cove Creek upstream, Crystal Cove Creek, and Buck Gully) illustrate this behavior most clearly.

These results are consistent with the results from an earlier study (PBS&J, 1999) in which long-term geometric mean concentrations of bacteriological data from November 1996-October 1999 were evaluated.

Bacteria Concentrations in Inland Waters in the Santa Ana Region

As part of the activities conducted by the Stormwater Quality Standards Task Force, CDM has compiled bacteriological data from several agencies within the Santa Ana Region (CDM, 2005). The CDM study included data collected and compiled by Orange County, the Regional Water Quality Control Board (Region 8), the Santa Ana Watershed Project Authority, the County of San Bernardino, the County of Riverside, the United States Environmental Protection Agency (EPA), the United States Geological Survey, and Orange County Coastkeeper. Select figures produced by CDM in this study are shown in Appendix B. CDM performed an overview analysis of all bacteria data collected, and reached the following broad-based and general conclusions:

1. Concentrations of indicator bacteria in samples collected from inland water bodies very frequently exceed existing Basin Plan fecal coliform water quality objectives and EPA-proposed *E. coli* criteria.

2. Bacteria concentrations in samples obtained from upstream, largely undisturbed areas are typically lower than those in samples from downstream areas affected by urbanized land uses. Concentrations in upstream samples are more frequently below water quality objectives and proposed criteria than downstream samples.

3. Winter dry-weather samples are more likely to meet objectives than summer dry-weather samples, consistent with results from the Orange County coastal watersheds.

CDM also conducted a detailed analysis of six sites[11] for which long-term data records were available. These six sites exhibited varying degrees of urbanization and channel modification. A map showing the locations of these six sites is shown in Appendix B as Figure B1. Detailed results from these stations are reproduced in Appendix B as Figures B2 through B13. Land use distributions for the areas tributary to the study sites are shown in Table 3.

Table 3. Approximate land use distributions in the watersheds of CDM's six detailed study sites

Site	% Vacant	% Residential	% Commercial	% Industrial	% Other
Chino Cr.[a]	3.2	61.3	16.7	9.7	9.1
Santa Ana Delhi Channel	0.9	52.4	26.0	9.2	11.5
Temescal Cr.	67.3	16.2	2.4	3.4	10.7
Santa Ana R. at Imperial Highway[b]	-	-	-	-	-
Santa Ana R. at MWD Crossing[c]	-	-	-	-	-
Icehouse Canyon Creek	100	0	0	0	0

a) Chino Creek land use data are for portion of watershed downstream of San Antonio Dam.
b) CDM concluded that any potential relationship between land use and bacteria concentrations in this reach of the Santa Ana River is likely masked by the interception of flows by Prado Dam; consequently, no data land use data were available in the CDM report for this site.
c) CDM did not include land use statistics for this station in its report. The report states that land use is "diverse…a combination of commercial, residential, industrial, and agricultural lands. The upper part of the watershed includes natural undeveloped lands…Residential land is dispersed throughout the contributing area."

11 The six sites examined by CDM include: Chino Creek at Schaeffer Avenue, the Santa Ana Delhi Channel, Temescal Creek at Lincoln Avenue, the Santa Ana River at Imperial Highway, the Santa Ana River at the Metropolitan Water District crossing, and Icehouse Canyon Creek in the Angeles National Forest.

By examining these sites in detail, CDM found the following:

1. In streams where flow rate data are available, high bacteria counts are in many cases but not always associated with high flow events (presumably caused by rainfall). Bacteria concentrations in samples collected from Chino Creek at Schaeffer Avenue (Figure B2) and the Santa Ana Delhi Channel (Figure B3) are frequently elevated and do not exhibit any apparent correlation with flow rate in the channel. In Temescal Creek (Figure B4) and the Santa Ana River at the MWD crossing (Figure B5), the data are widely scattered and patterns are difficult to detect. In the Santa Ana River at Imperial Highway (Figures B6-7), data show that bacteria levels are elevated during high flow events and the levels remain elevated for 1-2 days after the high flow has receded.

2. Bacteria concentrations appear to be decreasing over time at three locations (Chino Creek at Schaeffer Ave. (data record 2002-2004), Santa Ana River at MWD Crossing (data record 1984-2004), and Santa Ana River at Imperial Highway (data record 1981-2004)). At the other three locations, no long-term trends are apparent.

3. All sites except Icehouse Canyon Creek have regularly exceeded current or proposed water quality objectives. As mentioned previously, concentrations at the two Santa Ana River sites have shown a decreasing trend, and since 1998 most samples have been at or below objective levels. Icehouse Canyon Creek, at elevation 5,100 feet in the Angeles National Forest, has only one sample (of 40 total samples; a fecal coliform measurement of 9,400 MPN/100mL) in the data record that does not comply with existing or anticipated water quality objectives, indicating that runoff from remote, undeveloped, forested catchments at higher elevations may have significantly lower bacteria levels than runoff from lower elevation watersheds, including undeveloped watersheds at lower elevations. Figures B8-13 show, for each of the six sites, the percent of months in which single sample thresholds are exceeded when samples are classified as summer dry, winter dry, or wet-weather.

Los Angeles County Monitoring Data

Los Angeles County has prepared an Integrated Receiving Water Impacts Report (Los Angeles County, 2001), which includes bacteria concentrations measured in runoff collected downstream of catchments that exhibited primarily single land use types. Los Angeles County data for indicator bacteria for several major land use types are shown in Table 4 (adapted from Table 4-12 of the L.A. County report).

Table 4. Bacteria concentration means, medians and coefficients of variation (C.V.) from Los Angeles County Land Use Sites

	Total Coliform			Fecal Coliform			Enterococcus		
Land Use Type	**Mean**	**Median**	**CV**[a]	**Mean**	**Median**	**CV**[a]	**Mean**	**Median**	**CV**[a]
Commercial	1,140,000	1,250,000	0.71	528,750	90,000	1.35	86,250	40,000	1.18
Vacant	9,187	2,200	1.25	1,397	500	2.60	679	500	0.98
High density S.F. residential	1,366,667	1,600,000	0.30	933,333	900,000	0.70	610,000	140,000	1.41
Transportation	692,500	600,000	0.82	328,750	205,000	1.22	32,000	32,000	0.65
Light industry	454,000	160,000	1.42	338,220	30,000	2.09	98,200	130,000	0.73

a) "CV" refers to "Coefficient of Variation", calculated by dividing the standard deviation by the mean.

The data shown in Table 4 demonstrate that significantly lower bacteria concentrations were observed in runoff from vacant land areas than in other land use types. These data were collected by Los Angeles County in Sawpit Creek, downstream of Monrovia Creek, in the City of Monrovia; this catchment is in the San Gabriel Mountains in a very steep, sparsely vegetated area far from the ocean. Low concentrations of indicator bacteria from the Sawpit Creek watershed are consistent with low concentrations in samples collected from Icehouse Canyon Creek, both mountainous, high elevation watersheds. These results differ from observations from the Orange County coastal watersheds, which indicate no relationship between percentage development in a watershed and bacteria concentrations. The differences are most likely due to differences in catchment characteristics, local climate, the numbers and types of wildlife present, or to other factors. In any case, both the mean and median concentrations observed for each Los Angeles County land use type exceeded applicable water quality thresholds.

Los Angeles County also measured bacteria concentrations in several "mass emission" stations. These stations were sited to capture runoff from major Los Angeles County watersheds that generally have heterogeneous land use, with the objective of estimating pollutant loads to the ocean and of identifying long-term trends in pollutant concentrations, where possible. The mass emission stations include Malibu Creek (watershed 6% impervious; measurement station near Malibu Canyon Road), Ballona Creek (watershed 45% impervious; measurement station between Sawtelle Boulevard and Sepulveda Boulevard in Los Angeles), the Los Angeles River (watershed 35% impervious; measurement station between Willow Street and Wardlow Road in Long Beach), and the San Gabriel River (watershed 30% impervious; measurement station below the San Gabriel River Parkway in Pico Rivera).

In addition to the land use data reported in Table 4, Los Angeles County reached a number of conclusions using data collected at these mass emission stations. The following conclusions are cited directly from the Los Angeles County report (2001):

- The Malibu Creek station appears to have consistently lower [bacteria] counts than other mass emission stations.

- Every wet weather mass emission bacteria sample taken exceeded the public health criteria for indicator bacteria. All of the dry weather bacteria samples taken for the low flow diversion projects exceeded the public health criteria. Most of the dry weather mass emission bacteria samples taken exceeded the public health criteria. Wet weather flows contained bacteria densities at much higher levels (three to four orders of magnitude) than dry weather flows.

- Except for 1996-97, densities observed during the first storm of each rainy season were not necessarily higher than during consecutive storm events, suggesting that there was no consistent "first-flush" effect in these watersheds. Peak densities were observed at different times each year. In 1995-96, the peak density at all four mass emission stations and one land use station coincided with the peak storm of the season.

- Except for somewhat lower [bacteria] densities at Malibu Creek, there was no seasonal or regional consistency in cell densities. There was a very wide range of densities for all stations.

Consistent with data from Orange County coastal watersheds, the Los Angeles County data show that samples collected during wet-weather exhibit significantly higher bacteria concentrations than samples collected during dry weather.

ADDITIONAL DATA ON SOURCES AND CONCENTRATIONS OF BACTERIA IN RUNOFF

Numerous additional studies and data reports have shown a correlation between elevated bacteria concentrations and rainfall events in Southern California. This correlation is evident in data collected from a variety of environments. For example, elevated concentrations of indicator bacteria have been observed during wet weather conditions at Huntington Beach (Boehm et al.,2002; Kim et al., 2004; Reeves et al., 2004), and northern Orange County and Santa Cruz County (Dwight et al., 2004).

Several studies also indicate that runoff from undeveloped watersheds contains bacteria concentrations that exceed relevant water quality standards. For example, storm water runoff from the head of the Rose Creek watershed in the San Diego Region contains levels of indicator bacteria well in excess of water quality objectives, even though this area is non-urban, contains no sewer lines or lift stations, and is restricted from public access (Schiff and Kinney, 2001). Moore (2001) found that concentrations of indicator bacteria in San Juan Creek sampling stations reflecting rural land uses exceeded water quality criteria, and that rainfall events resulted in higher bacteria concentrations at both rural and urban sites than dry weather. (Moore (2001) also found that storm drains can be major sources of dry weather bacteria pollution.)

The level or type of development is not necessarily indicative of bacteria levels in runoff, or of the presence of human-derived bacteria. In Mission Bay, a highly urbanized watershed, extensive efforts have been made to eliminate human sources of bacteria by repairing the sanitary sewer system and diverting dry weather flows to a local waste water treatment plant. Source tracking studies suggest that human sources contribute a minor fraction of the total fecal inputs to the Bay, and yet violations of water quality standards continue to occur (see Colford et al., 2005, and references therein). Pednekar et al. (2005) also found that changes in land use associated with the development of agricultural lands[12] within watersheds tributary to Newport Bay did not have a significant impact on bacteria loads, stating "The storm loading rate of coliform…appears to be unaffected by the dramatic shift away from agricultural land-use."

A number of studies have indicated that runoff from urban areas may not be the sole or even the primary source of elevated bacteria concentrations in receiving waters, but that such elevated levels may be caused by non-human sources, such as terrestrial wildlife and birds or even local sediments. Studies conducted at Huntington Beach have indicated that there may be many sources of indicator bacteria to the surf zone, including urban runoff, flow from adjacent wetlands, birds, and sediments (Grant et al., 2001). A recent study by Noblet et al. (2004) indicates that birds may be the source of high concentrations of indicator bacteria at the mouth of the Santa Ana River and in the nearby surf zone, and suggested that local sediments may be the source of fecal steroids, indicating the presence of fecal-associated material in the sediments. Another study by the Los Angeles Regional Water Quality Control Board (2004) erected a bird exclusion structure on Cabrillo Beach, and found that bacteria levels below the structure were reduced up to 60% compared to levels measured outside the structure, while exceedances of water quality standards were reduced by 65% below the structure. The Los Angeles Regional Board also reported that "high bacterial densities may be largely from the beach itself."

Other studies have provided additional evidence that the bacteria found in creeks may result from natural, not urban, sources. Orange County recently studied the efficacy of several best management practices (BMPs) for reducing bacteria concentrations in Aliso Creek, Orange County, California. Results of this study have been summarized by GeoSyntec (2005) (attached as Appendix C). The BMPs that were evaluated include 1) a multimedia filtration and UV sterilization system, and 2) wetland ponds. The study, which was conducted during dry weather, found that both BMPs greatly reduced concentrations of indicator bacteria[13], but that bacteria levels rebounded within a short distance downstream of the BMPs. In the case of the filtration/sterilization, the geometric mean concentration of fecal coliform increased from 317 cfu/100mL at the outlet of the BMP to

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[12] Tributary creeks to Newport Bay studied by Pednekar et al. include the San Diego Creek (SDC) and the Santa Ana Delhi Channel (SAD). The SDC watershed remained between 52-60% developed over the study period. Agricultural land-use decreased from 34% to 2%, while commercial land-use increased from 1% to 10%, industrial land-use from 2% to 20%, and residential land-use from 11% to 25%. The SAD watershed remained between 88-92% developed over the study period. Agricultural and residential land-use decreased while commercial land-use increased from 3% to 15% and industrial land-use increased from 19% to 33%.

[13] In comparing influent and effluent, multimedia filtration/UV sterilization resulted in a 99.6% reduction in fecal coliform concentration; wetland ponds achieved a 90-99% reduction in fecal coliform concentrations.

2575 cfu/100mL in a natural channel at a distance of 35 feet downstream of the BMP. In the case of the wetland ponds, effluent was routed through a pipe approximately 200 feet long to the monitoring station, which recorded concentrations approximately two times greater than what could be accounted for based on mass-balance calculations. However, uncertainty in flow measurements, data variability, and the fact that ~37% of the flow is not intercepted by the wetlands indicate that regrowth is not the only possible explanation for the unexpectedly high bacteria concentrations at the pipe outlet.

The link between bacteria concentrations in rivers and streams and downstream water quality, including surf zone water quality, has been examined by a number of authors in addition to those cited above. PBS&J (1999) found that even though Newport coastal creek waters contained high concentrations of indicator bacteria, it did not appear that these waters had a significant impact on bacteria concentrations in the surf zone. Ahn et al. (2005) found that while storm water runoff from the Santa Ana River may lead to "very poor" surf zone water quality, the impact on the surf zone was generally confined to <5 km around the river outlet. Pednekar et al. (2005) studied bacteria concentrations in Newport Bay, California, and found that approximately 70% of the variability in the coliform record could be attributed to rainfall, implying that storm water runoff from the surrounding watershed is a primary source of coliform in Newport Bay. A difference in scale may account for the different conclusions reached by different studies – the Ahn et al. and Pednekar et al. studies found significant impacts on surf zone water quality by examining large creeks and rivers, while PBS&J's conclusion that creek water quality does not significantly affect surf zone water quality is based on a study of small to medium sized creeks – and clearly highlights the need for site-specific evaluations of bacterial water quality.

Presumably, the source of bacteria affects its pathogenicity and risk to human health, but data on human health risks from non-human source bacteria are scarce. Some studies (see, e.g., Schroeder et al., 2002) call into question whether the presence or concentration of indicator bacteria in urban runoff has any relationship with the possible presence of human pathogens. Schroeder et al. sampled paved and grass areas of parks, roofs, residential lawns, ponds, storm drains and similar surfaces to characterize the microbial community that may be present in urban water. Each sample was tested for indicator organisms (coliforms, fecal coliforms, *E. coli*, and enterococci), viruses (adenovirus, enterovirus, hepatitis A virus, and rotavirus), bacteria (enterohemorrhagic Escherichia coli, enterotoxigenic Escherichia coli, Shigella, Salmonella, and Staphylococcus aureus), and protozoa (Giardia lamblia and Cryptosporidium parvum). The study states found that although pathogens can be found in urban drainage, "there does not appear to be a relationship between the presence of pathogens and the concentration or presence of indicator organisms." Of particular note, a recent epidemiological study of health risks due to swimming in Mission Bay (Colford et al., 2005), where concentrations of indicator bacteria are believed to be predominantly from non-human sources, concluded that the risks of swimming-related illness were uncorrelated with exceedances of state water quality thresholds or with levels of indicator bacteria.

In conclusion, the available data from Southern California indicate that bacteria concentrations are often elevated in runoff from both urban and undeveloped watersheds, particularly during wet weather conditions. The level of development appears to have little effect on bacteria concentrations in storm flows. There is no clear trend in bacteria concentrations over time, with concentrations remaining relatively steady, even in areas where land use characteristics have changed over time. Available data also indicate that multiple sources may contribute to high concentrations of indicator bacteria, including natural sources such as wildlife, birds, and sediments. Regrowth within the environment also occurs, resulting in elevated bacteria concentrations even downstream of the point where relatively bacteria-free flows enter natural channels or man-made conveyances. Finally, the impact of high bacteria concentrations on downstream water quality appears to vary by location and conditions.

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APPENDIX A

DATA FROM ORANGE COUNTY COASTAL CREEKS

Figure A 1: Location of coastal catchments and surf zone areas along the Newport Coast.

Figure A12: Additional detail on the catchment areas (information collated from the PBS&J report, 1999 and The Irvine Company, 2005)

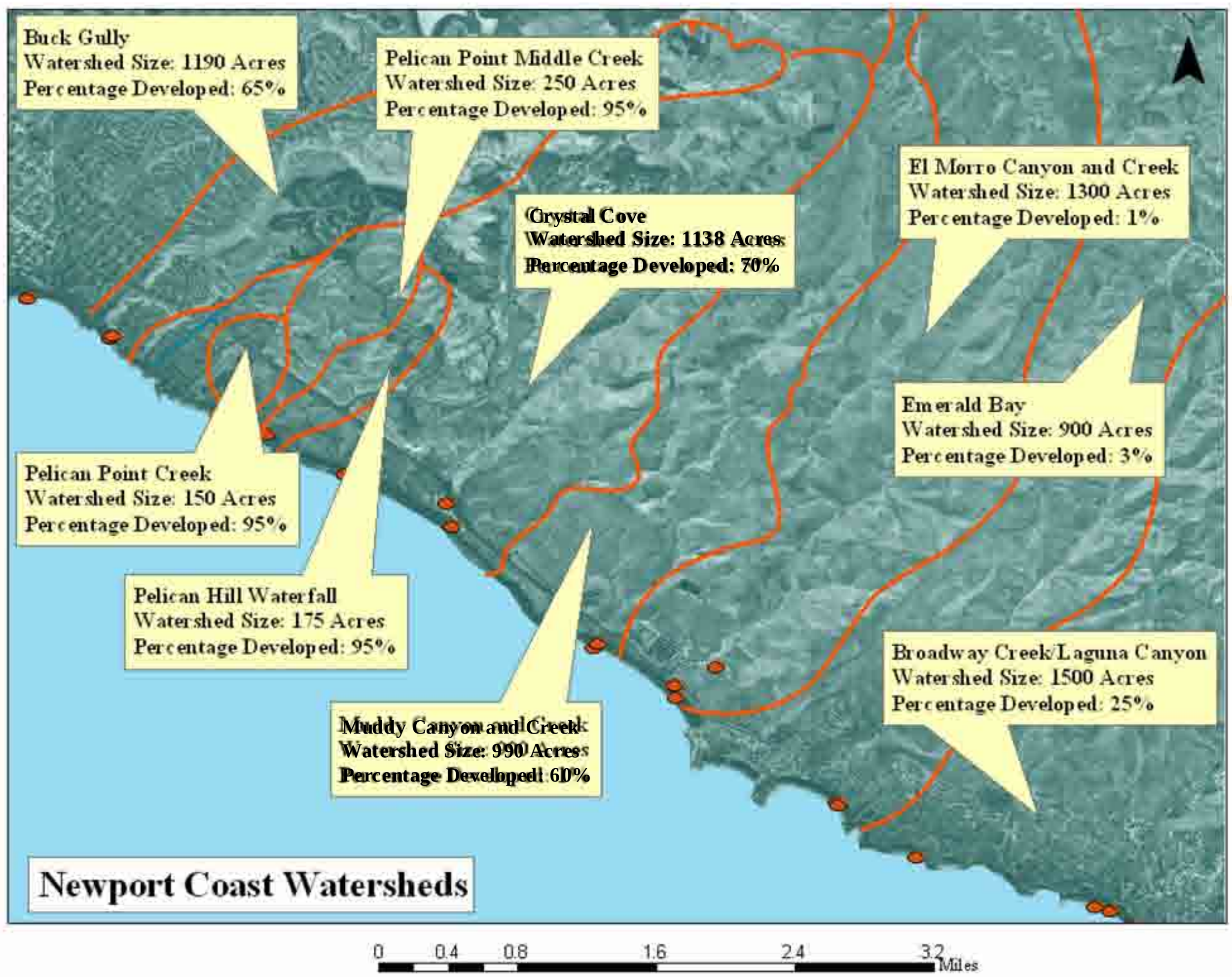


Figure A 3: Long-term geometric mean concentration for enterococci (data from 3/30/99 to 12/21/04). Dashed line represents EPA's suggested 30-day geometric mean water quality criterion for enterococci corresponding to a 1.0% risk level.

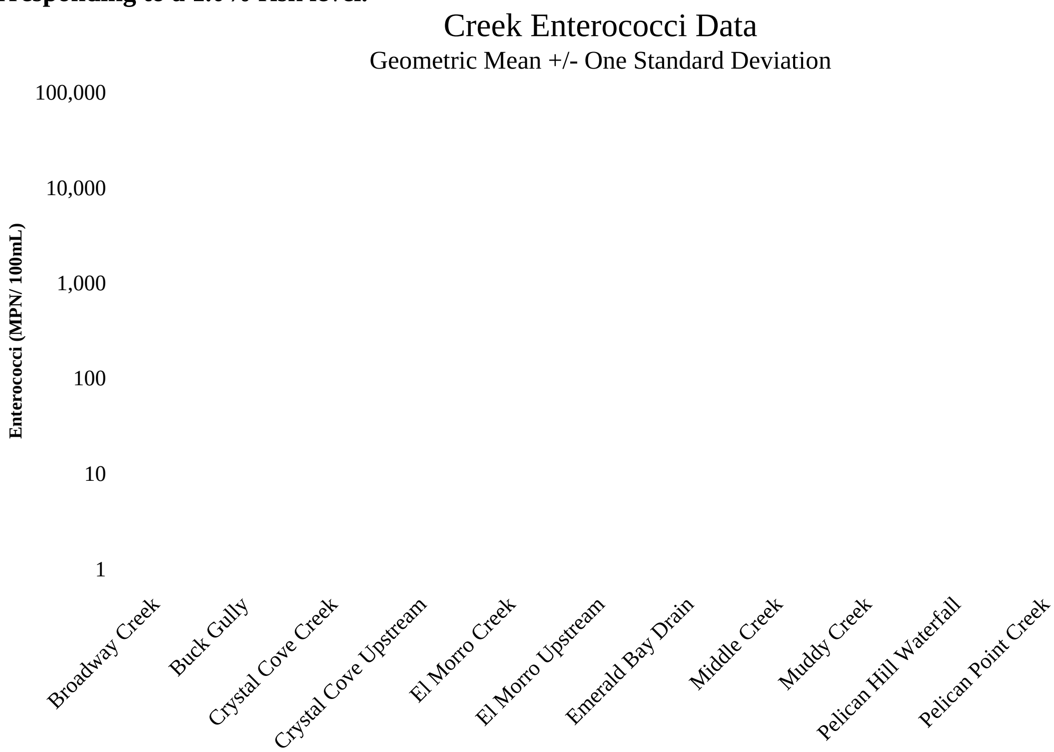


Figure A 4: Long-term geometric mean fecal coliform concentrations (data from 1/7/86 to 12/21/04). Dashed line corresponds to the current Santa Ana Basin Plan water quality criterion for 30-day log mean (geometric mean) fecal coliform concentrations.

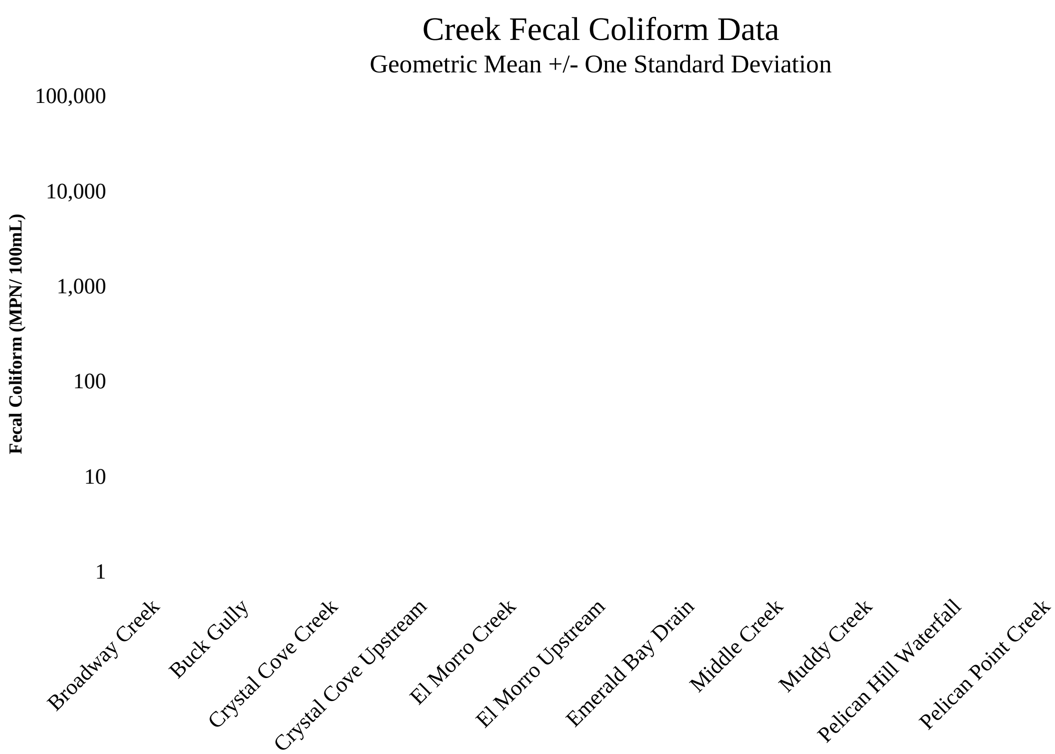


Figure A 5: Long-term geometric mean concentrations for total coliform (data from 1/7/86 to 12/21/04)

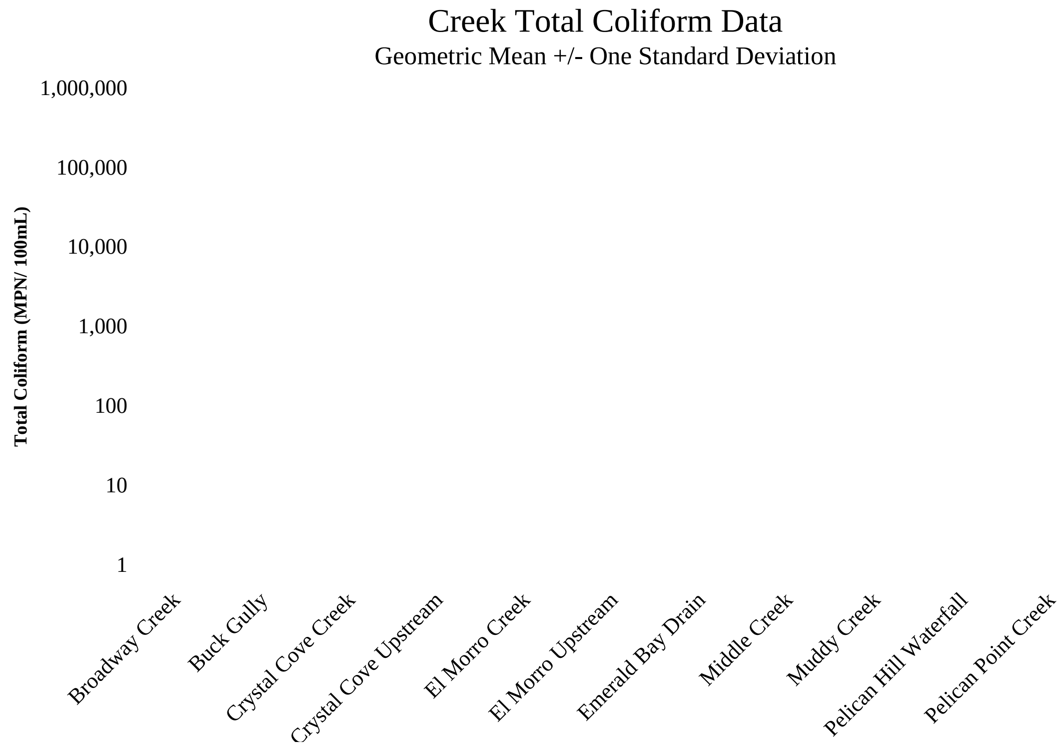


Figure A 6: Relationship between % developed and the long-term geometric mean enterococci concentration (data from 3/30/99 to 12/21/04). Dashed line represents EPA's suggested 30-day geometric mean water quality criterion for enterococci corresponding to a 1.0% risk level.

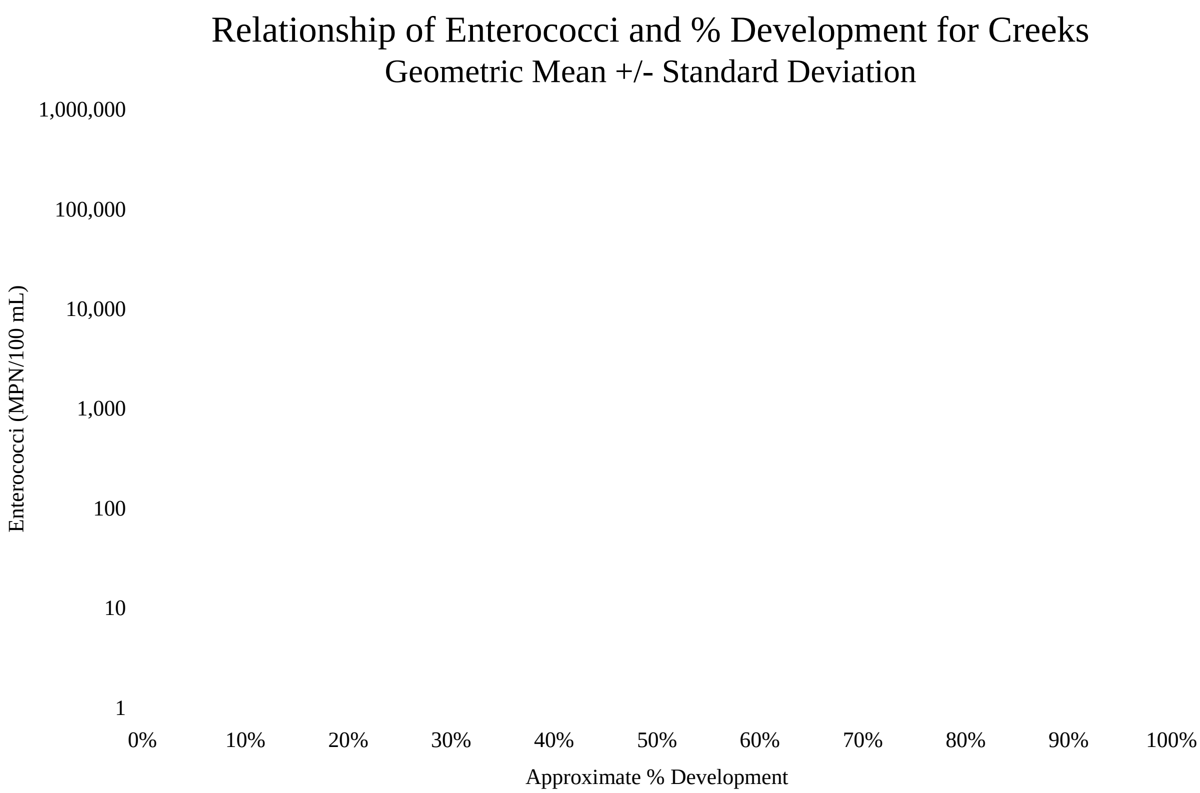


Figure A 7: Relationship between % developed and the long-term geometric mean fecal coliform concentration (data from 1/7/86 to 12/21/04). Dashed line corresponds to the current Santa Ana Basin Plan water quality criterion for 30-day log mean (geometric mean) fecal coliform concentrations.

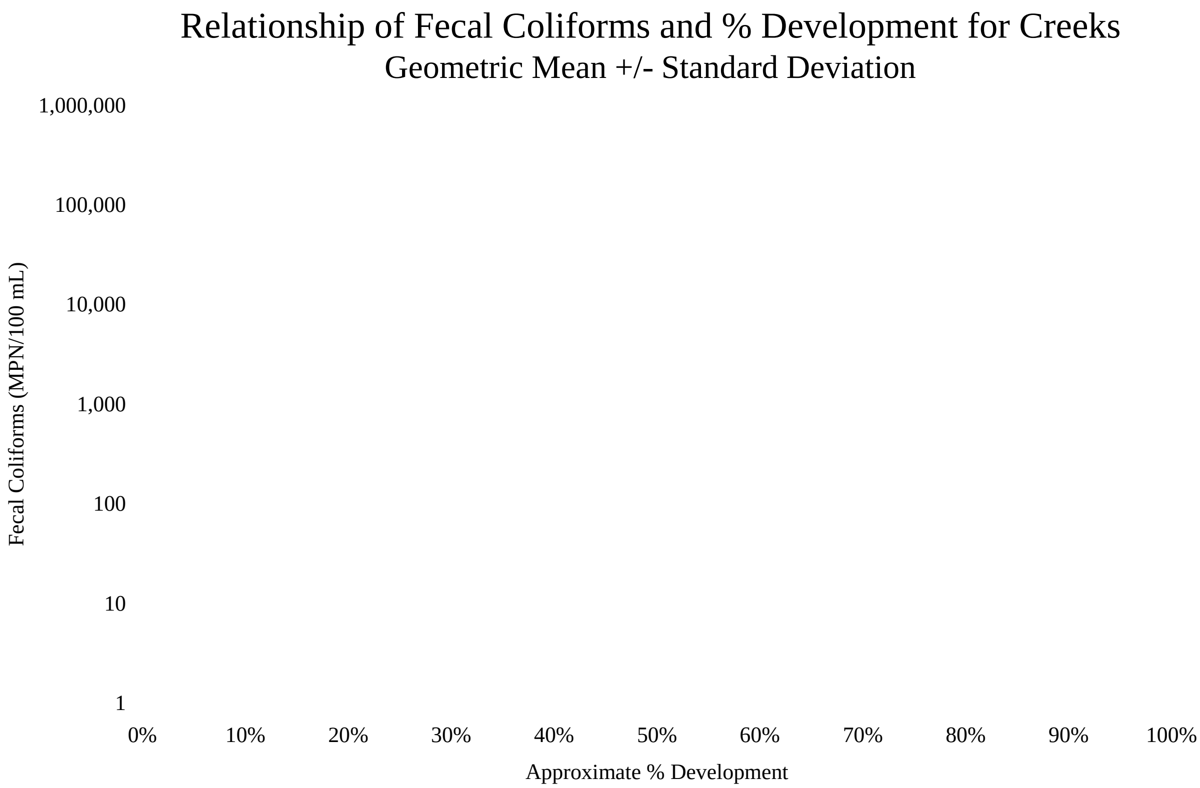


Figure A 8: Relationship between % developed and the long-term geometric mean total coliform concentration (data from 1/7/86 to 12/21/04).

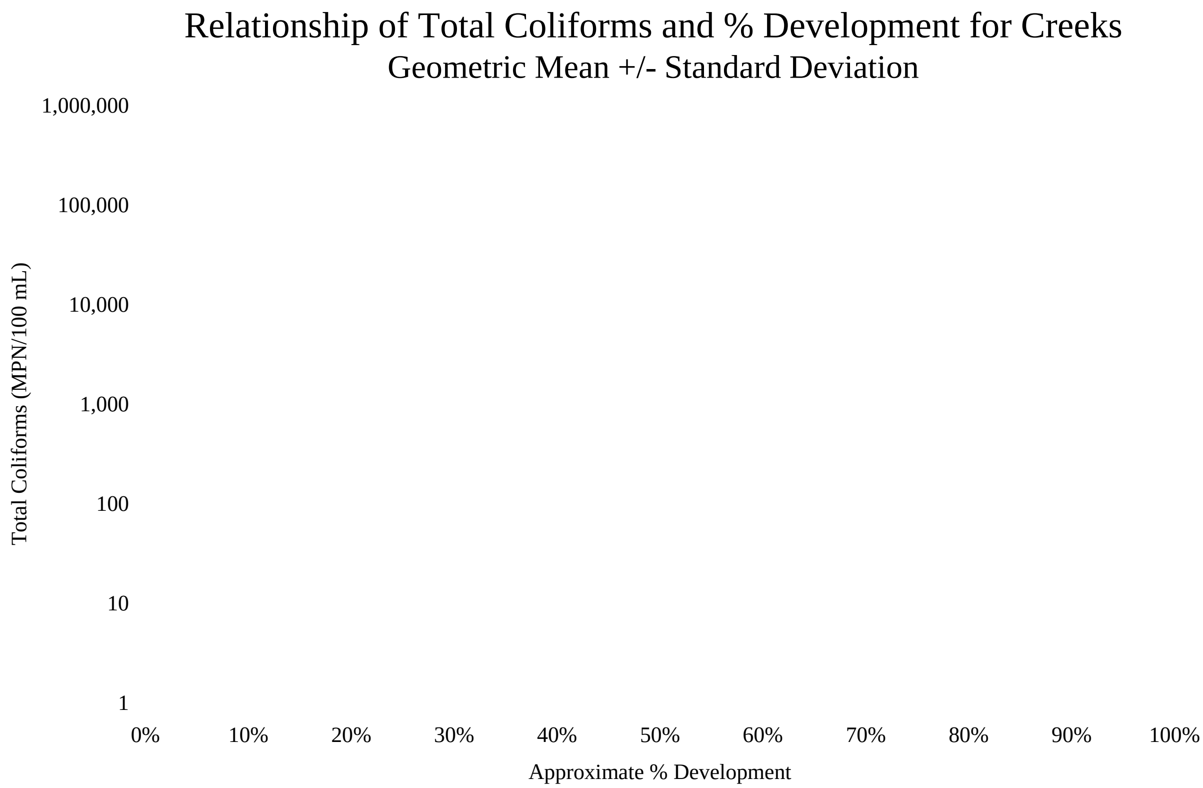


Figure A 9: Percent of samples in exceedance of thresholds by weather type (data from 1/7/86 to 12/21/04 for total and fecal coliform and from 3/30/1999 to 12/21/04 for enterococci). "Wet" data are those within two days of rainfall totaling 0.1" or greater at Newport Harbor. "Summer Dry" samples were collected from April-November, but not within two days of 0.1" or more of rain. "Winter Dry" samples were collected from December-March, but not within two days of 0.1" or more of rain. Threshold values against which data were compared are 247, 400, and 10,000 MPN/100mL, for enterococci, fecal coliform, and total coliform, respectively.

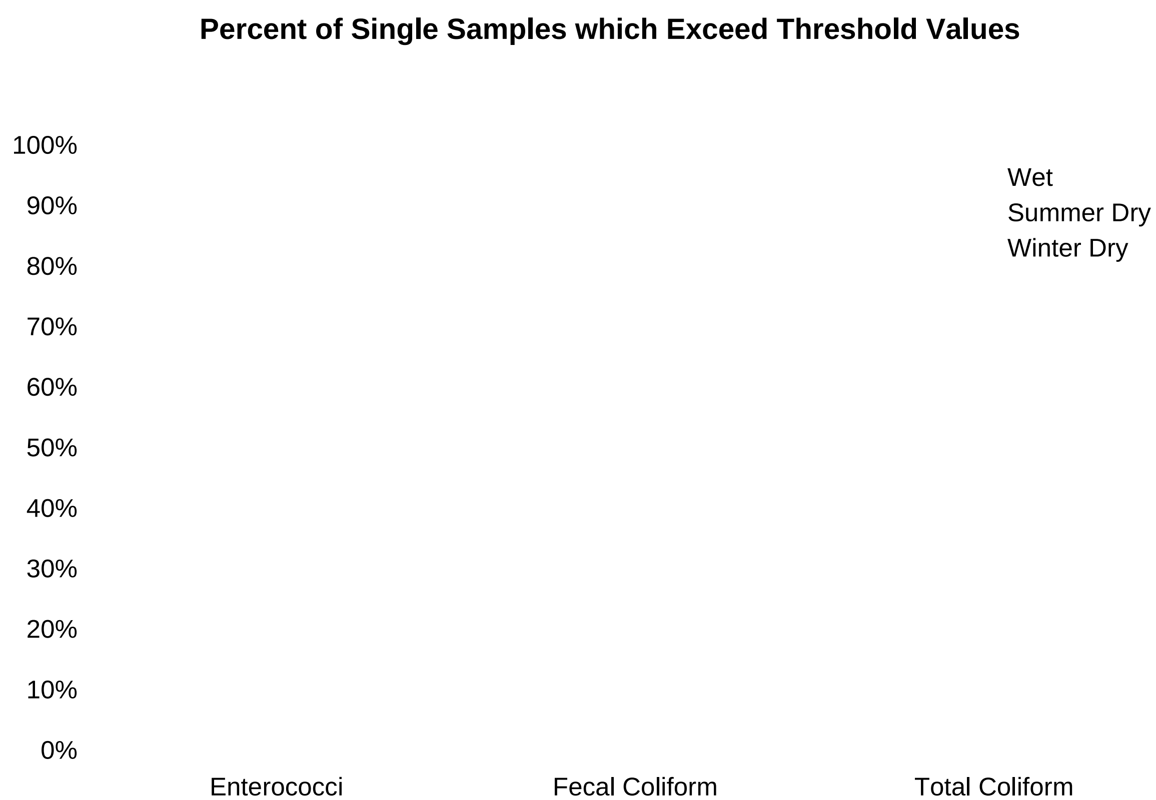


Figure A 10: Pelican Point Creek enterococci data and corresponding cumulative frequency distribution

Pelican Point Creek Enterococci Records, n=287

Dry
Wet
Enterococci 1% Risk 95th Percentile

MPN/100mL

100,000
10,000
1,000
100
10
1

1/1/99 1/1/00 12/31/00 12/31/01 12/31/02 12/31/03 12/30/04

Date

dry
wet
Enterococci 1% Risk 95th Percentile

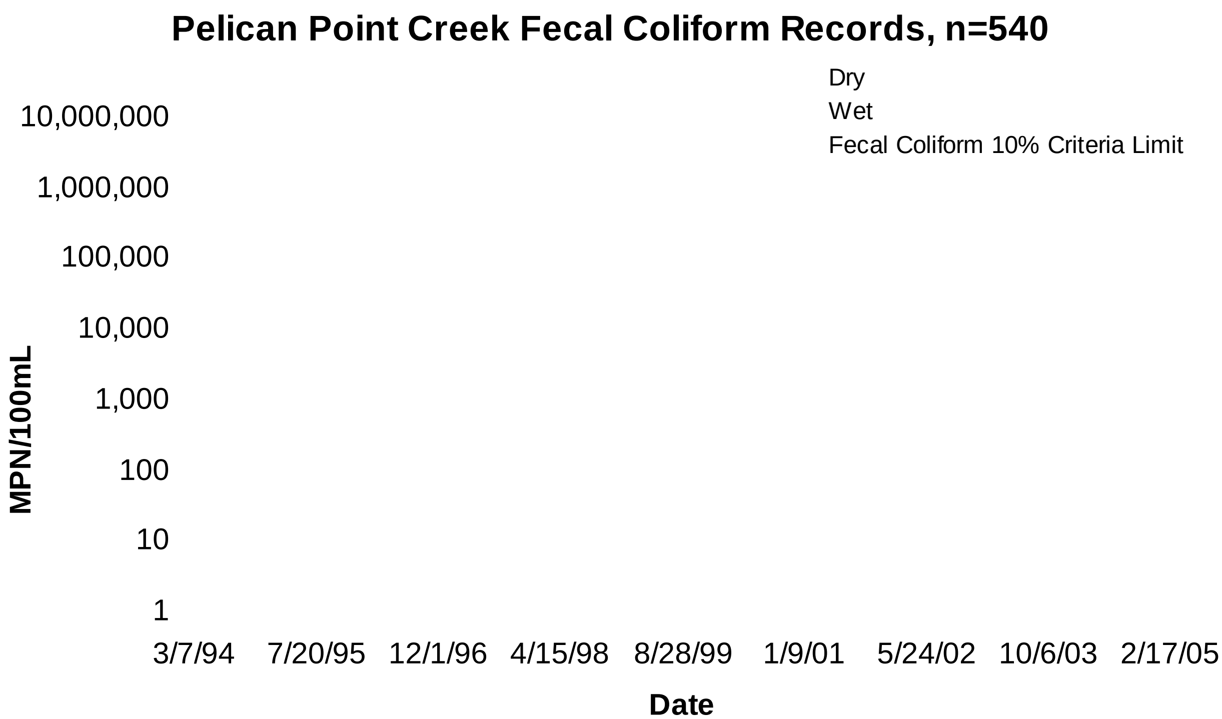
Percent of samples below value

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

1 10 100 1000 10000 100000

MPN/100 mL

Figure A 11: Pelican Point Creek fecal coliform data and corresponding cumulative frequency distribution



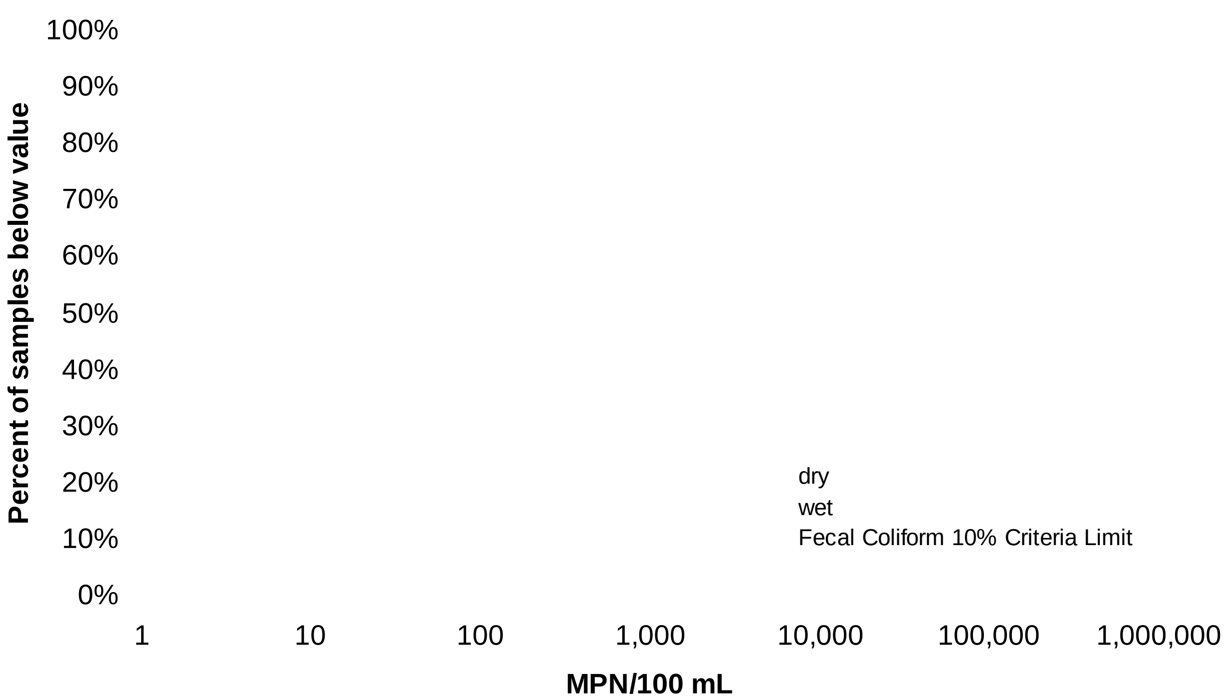
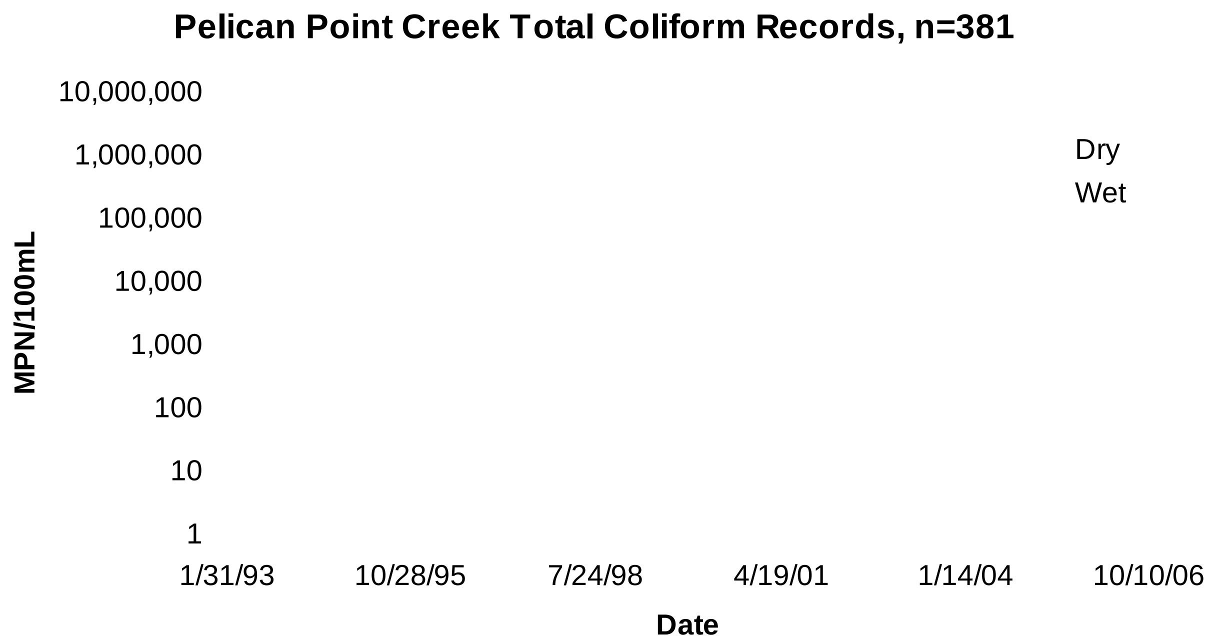


Figure A 12: Pelican Point Creek total coliform data and corresponding cumulative frequency distribution



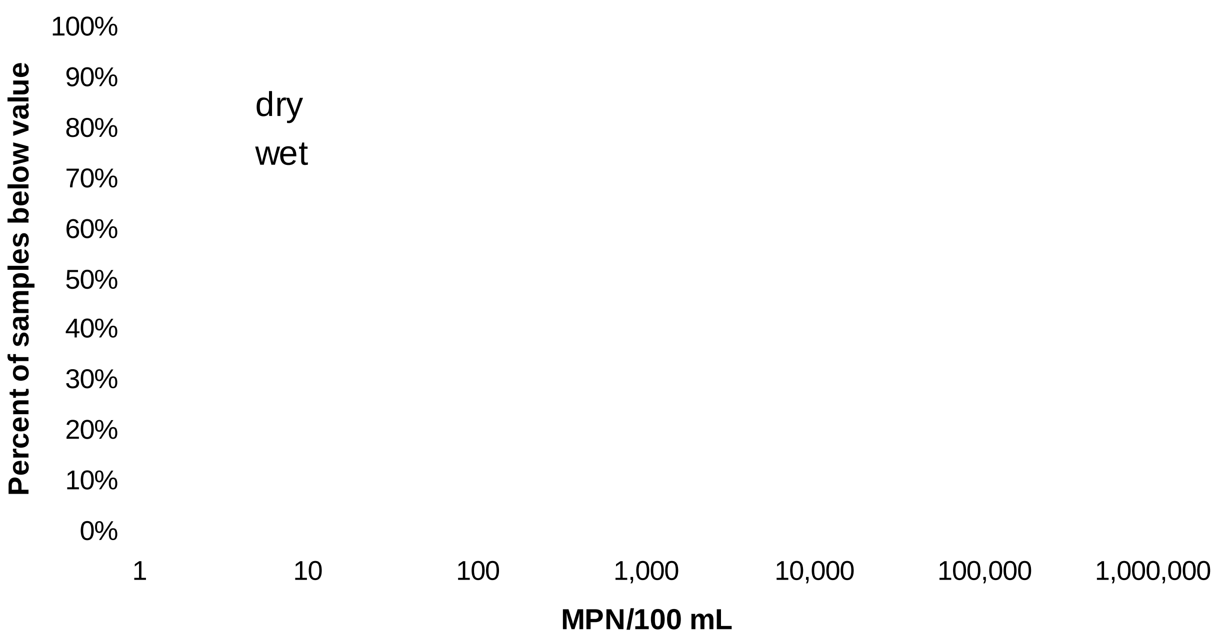


Figure A 13: Percentage of samples from Pelican Point Creek which exceed thresholds, by month

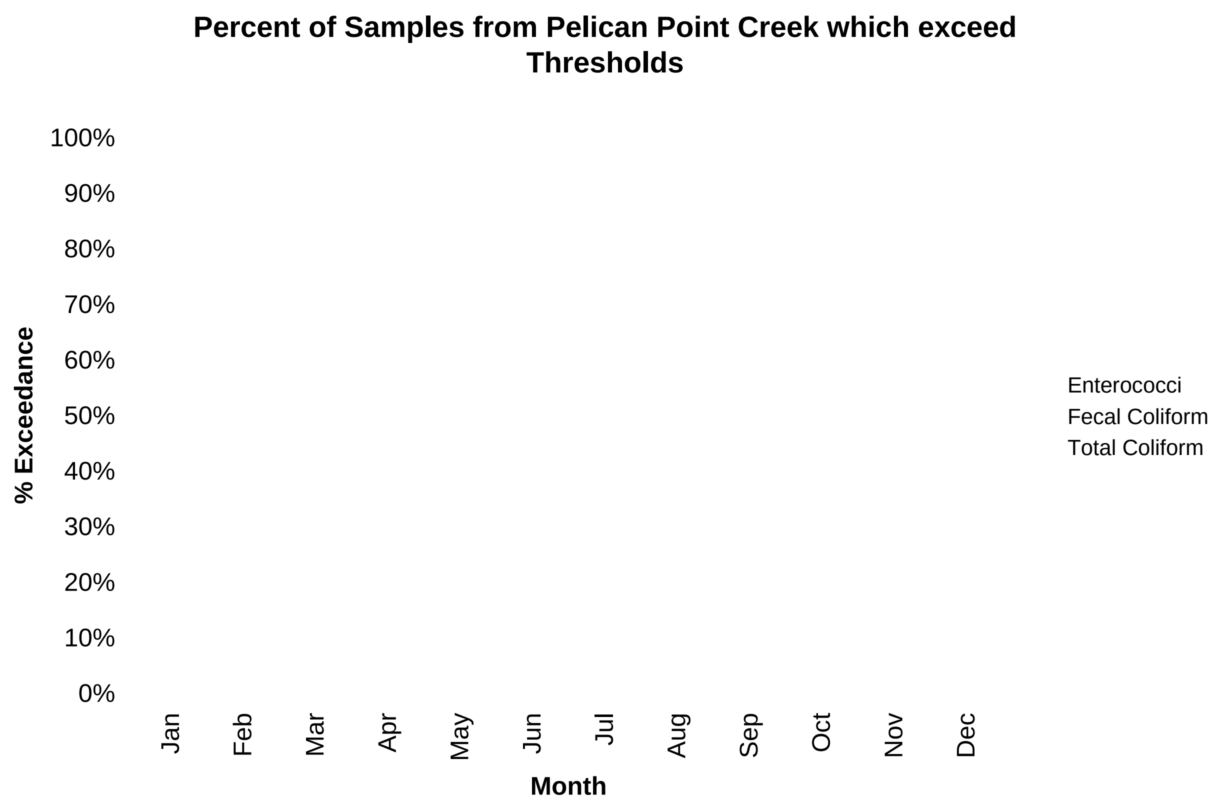


Figure A 14: Pelican Hill Waterfall enterococci data and corresponding cumulative frequency distribution

Pelican Hill Waterfall Enterococci Records, n=289

Dry
Wet
Enterococci 1% Risk 95th Percentile

MPN/100mL

100,000
10,000
1,000
100
10
1

2/9/99 6/23/00 11/5/01 3/20/03 8/1/04

Date

Percent of samples below value

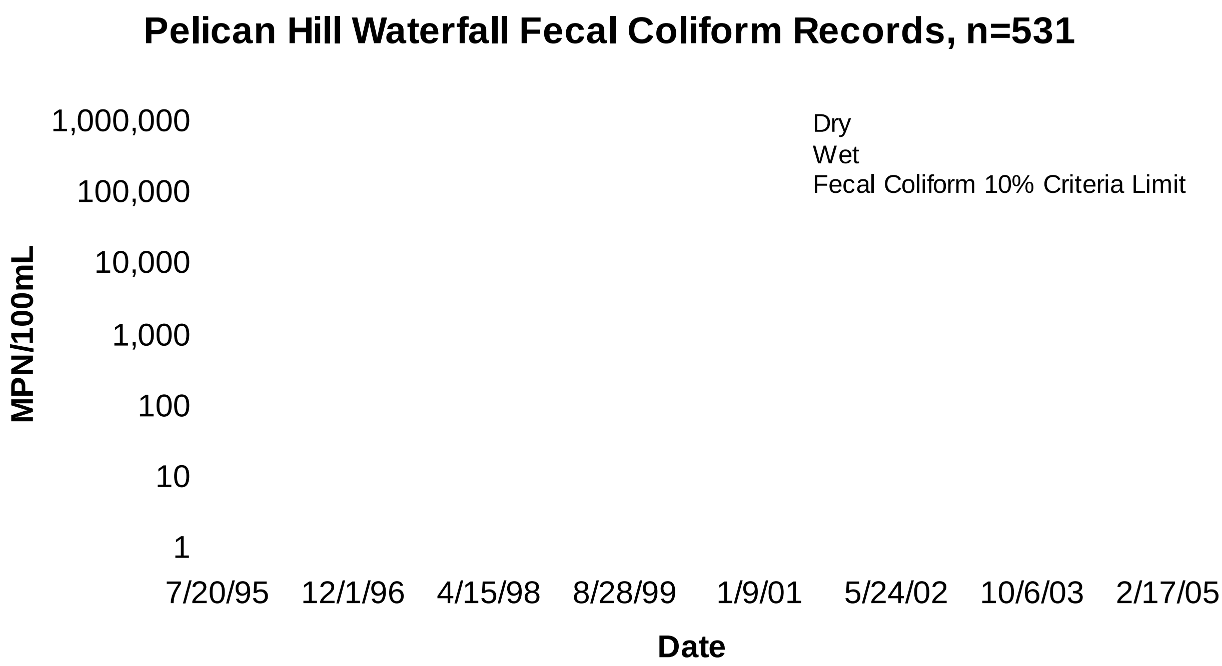
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

dry
wet
Enterococci 1% Risk 95th Percentile

1 10 100 1,000 10,000 100,000

MPN/100 mL

Figure A 15: Pelican Hill Waterfall fecal coliform data and corresponding cumulative frequency distribution



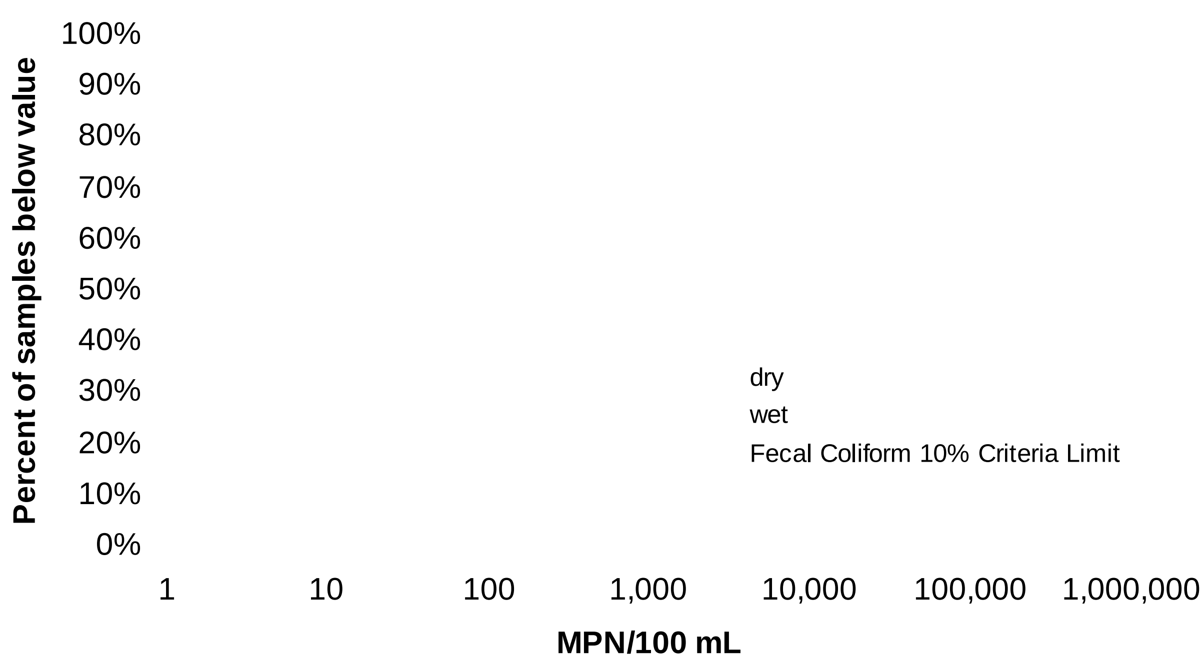
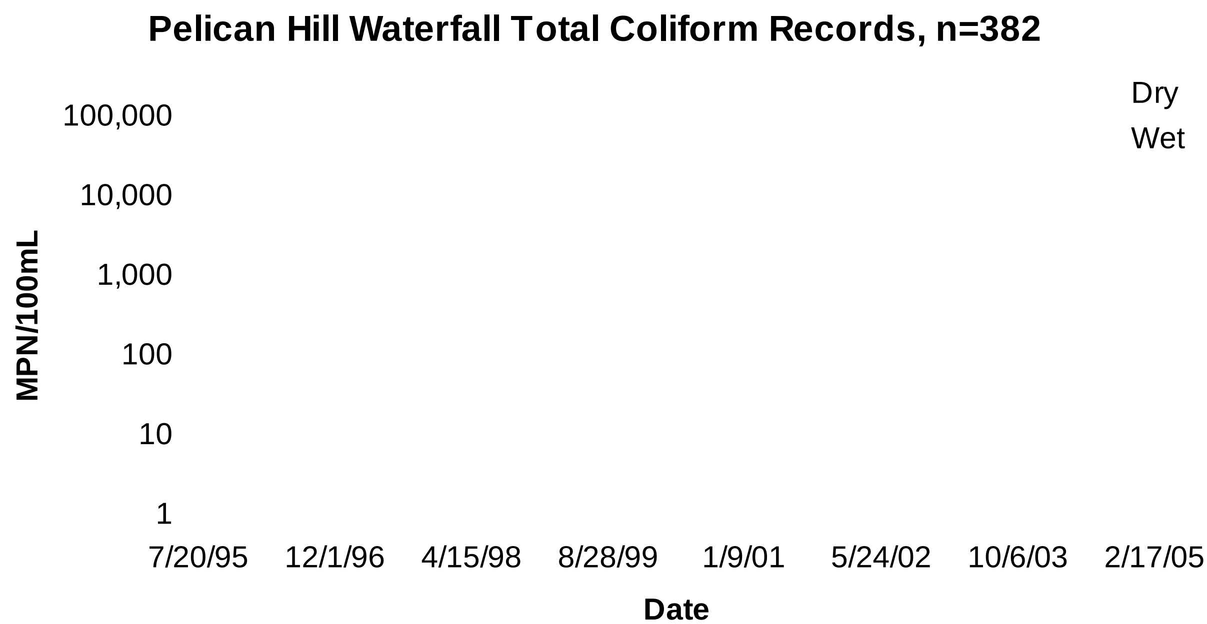


Figure A 16: Pelican Hill Waterfall total coliform data and corresponding cumulative frequency distribution



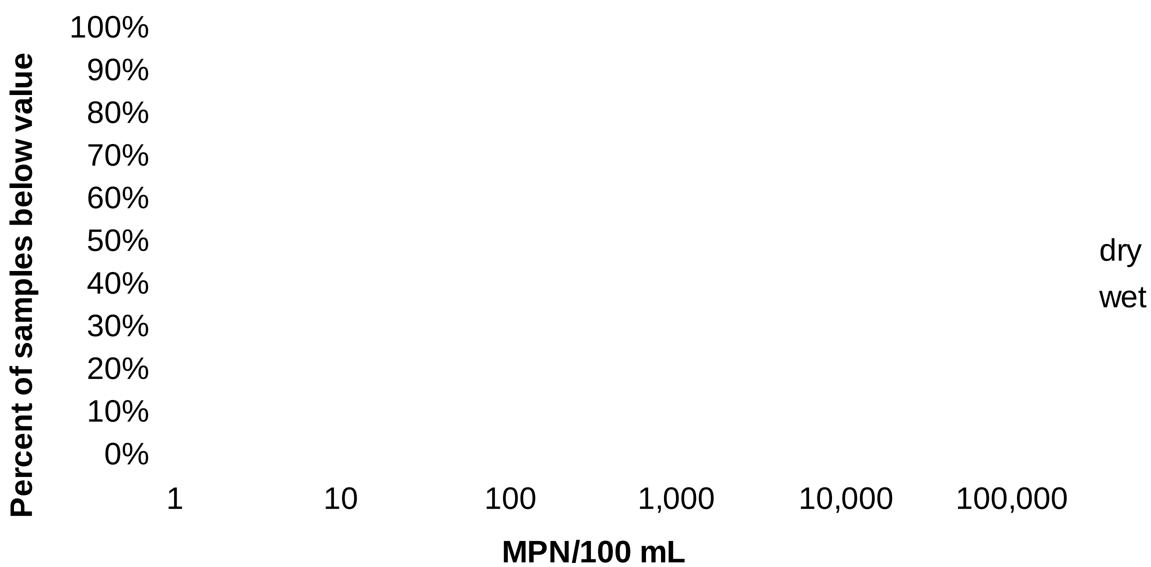


Figure A 17: Percentage of samples from Pelican Hill Waterfall which exceed thresholds, by month

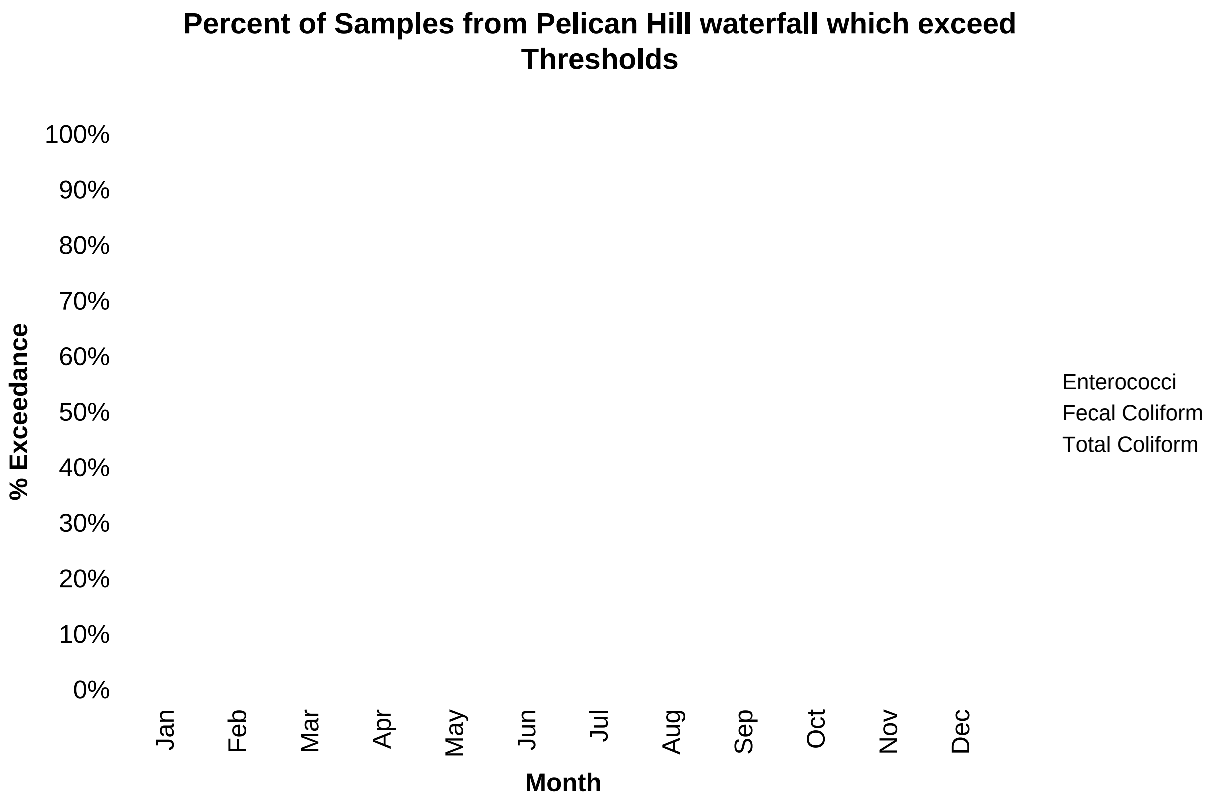
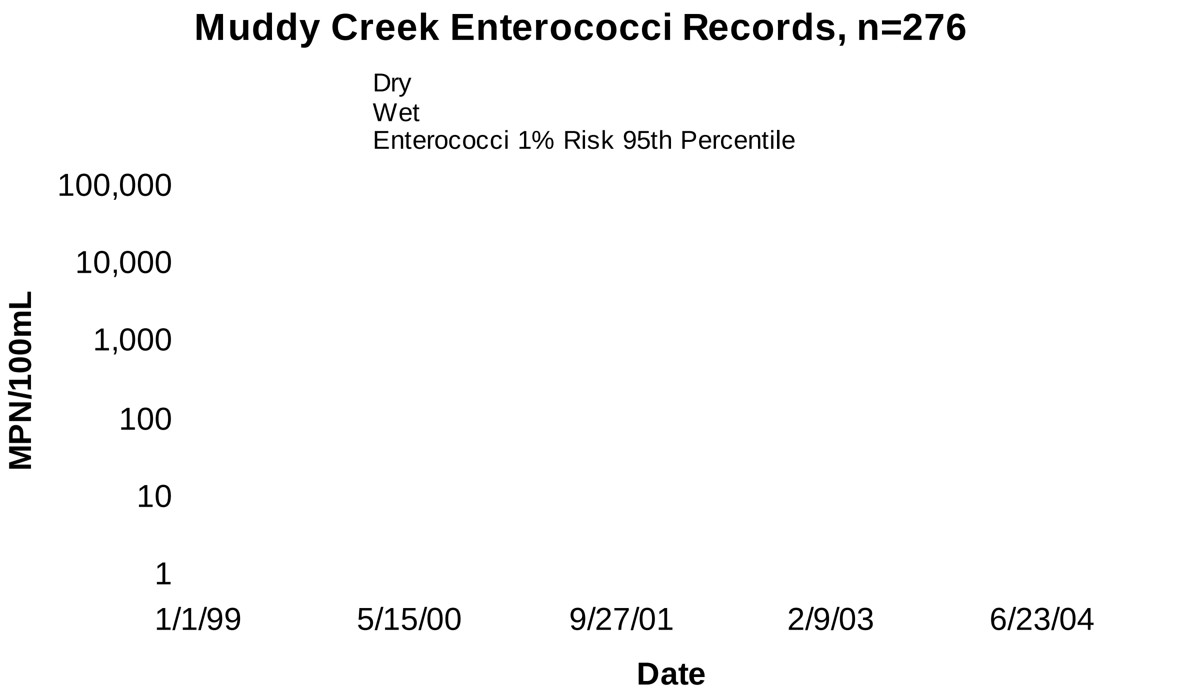


Figure A 18: Muddy Creek enterococci data and corresponding cumulative frequency distribution



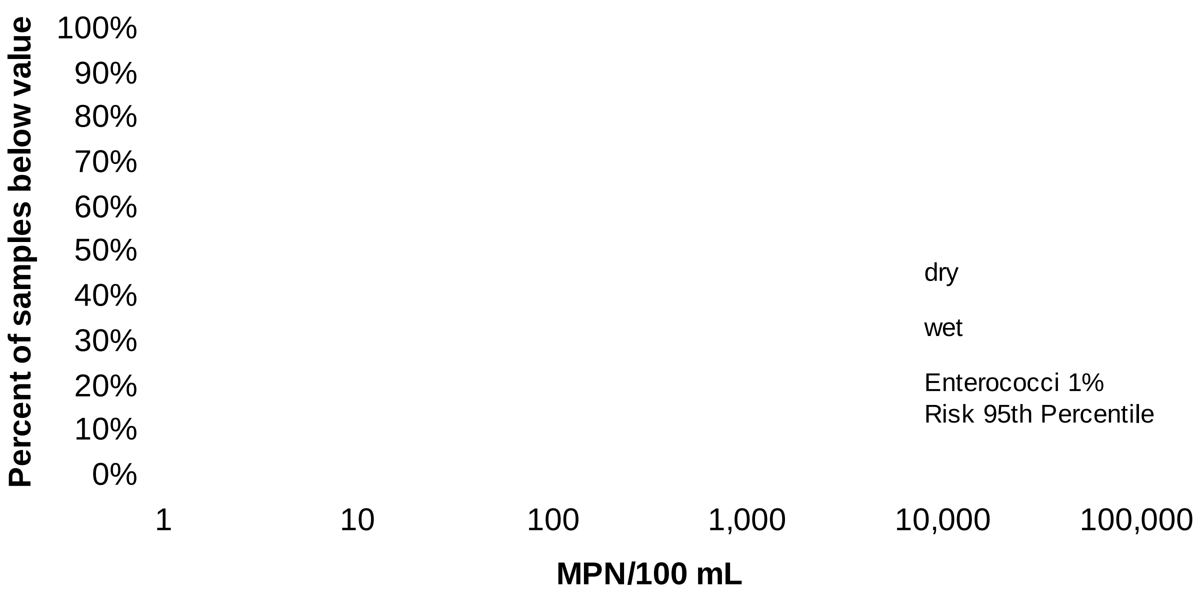
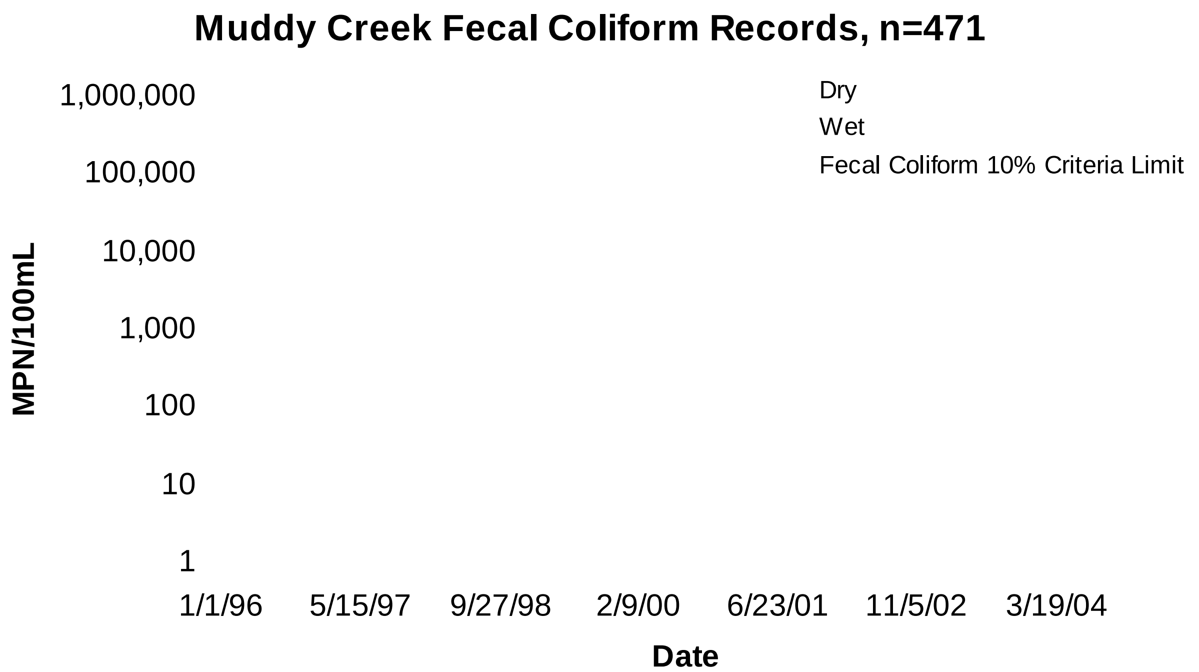


Figure A 19: Muddy Creek fecal coliform data and corresponding cumulative frequency distribution



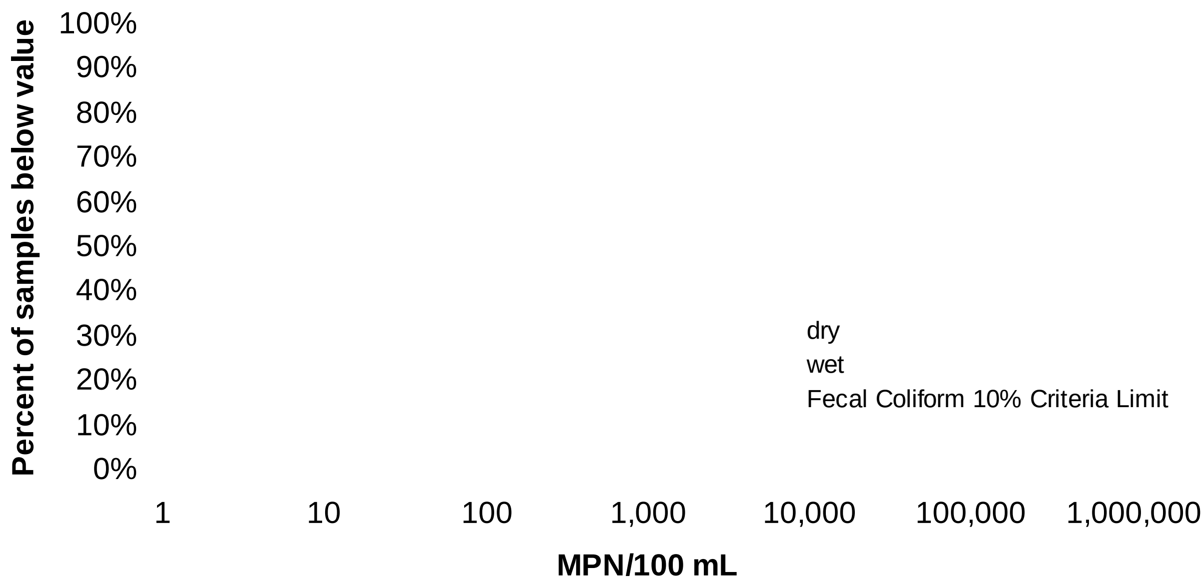
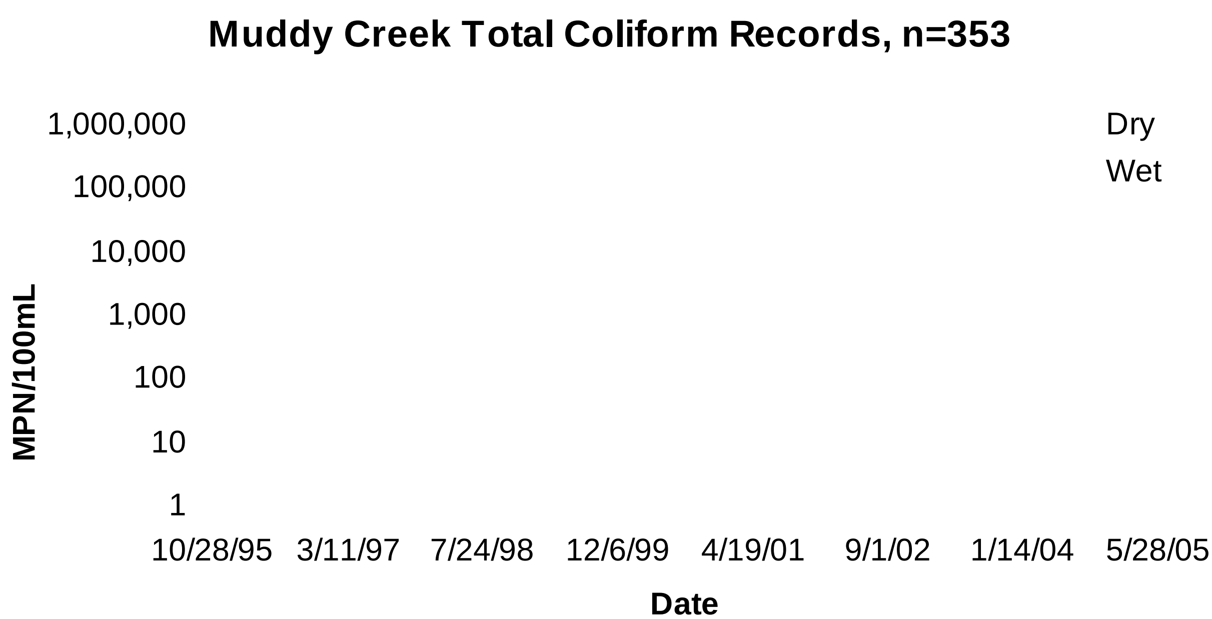


Figure A 20: Muddy Creek total coliform data and corresponding cumulative frequency distribution



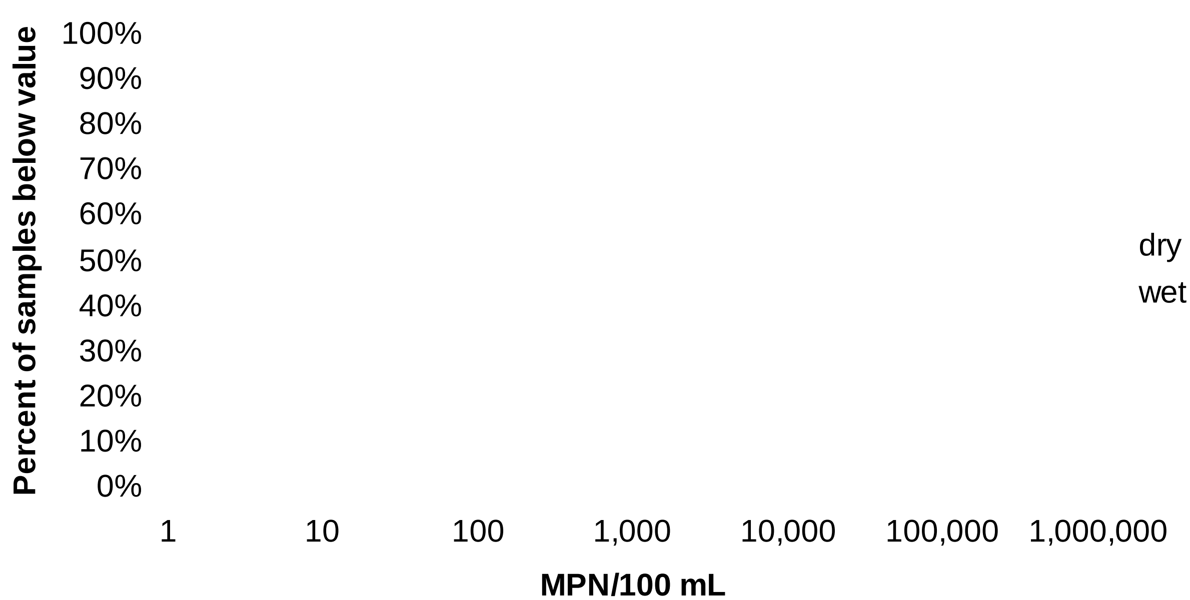


Figure A 21: Percentage of samples from Muddy Creek which exceed thresholds, by month

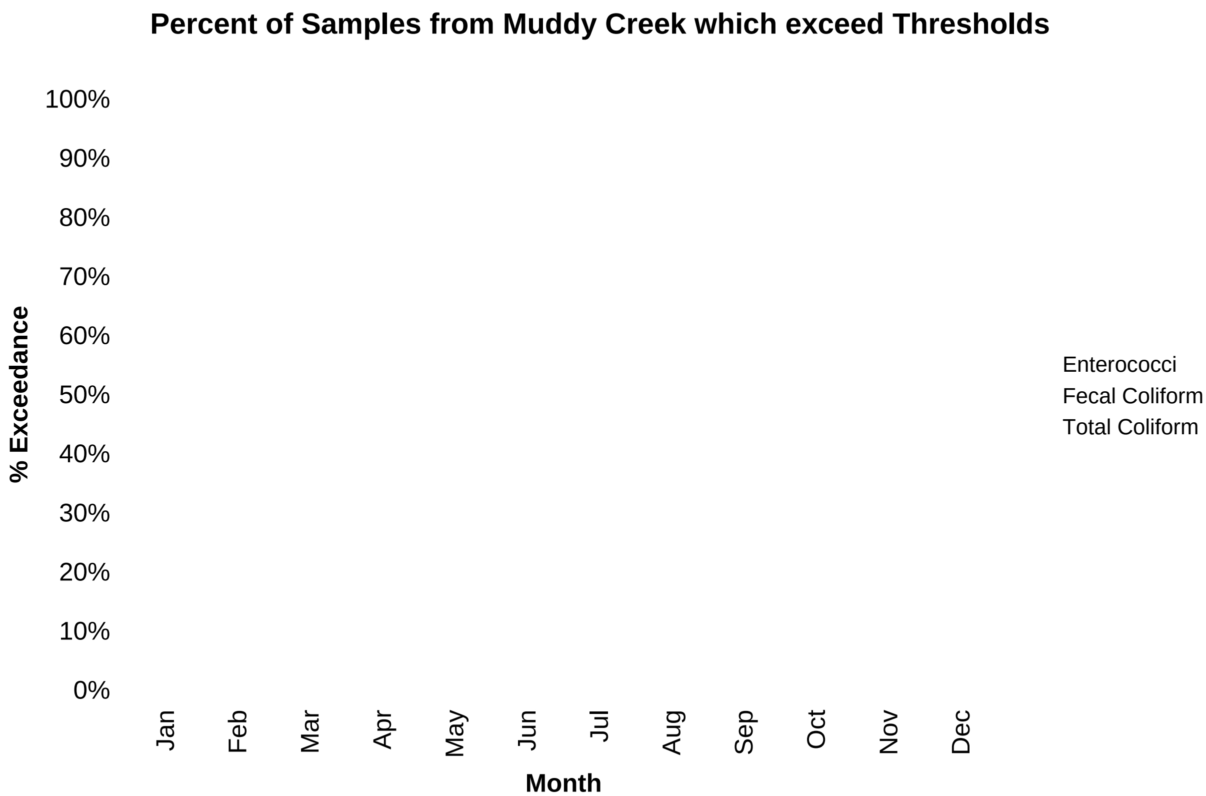
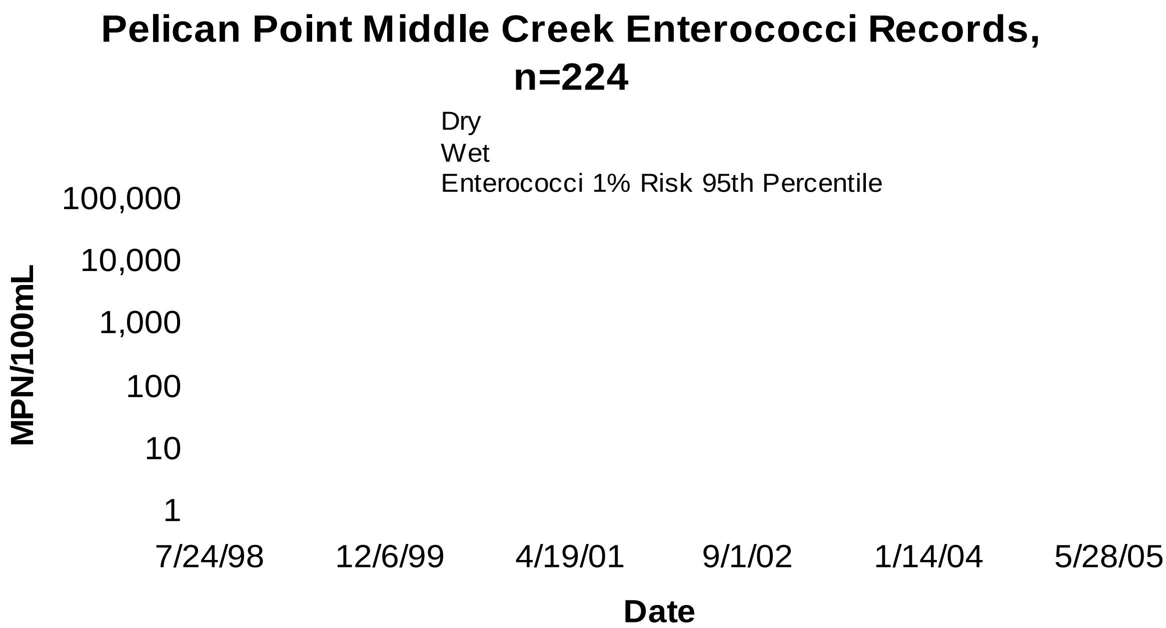


Figure A 22: Pelican Point Middle Creek enterococci data and corresponding cumulative frequency distribution



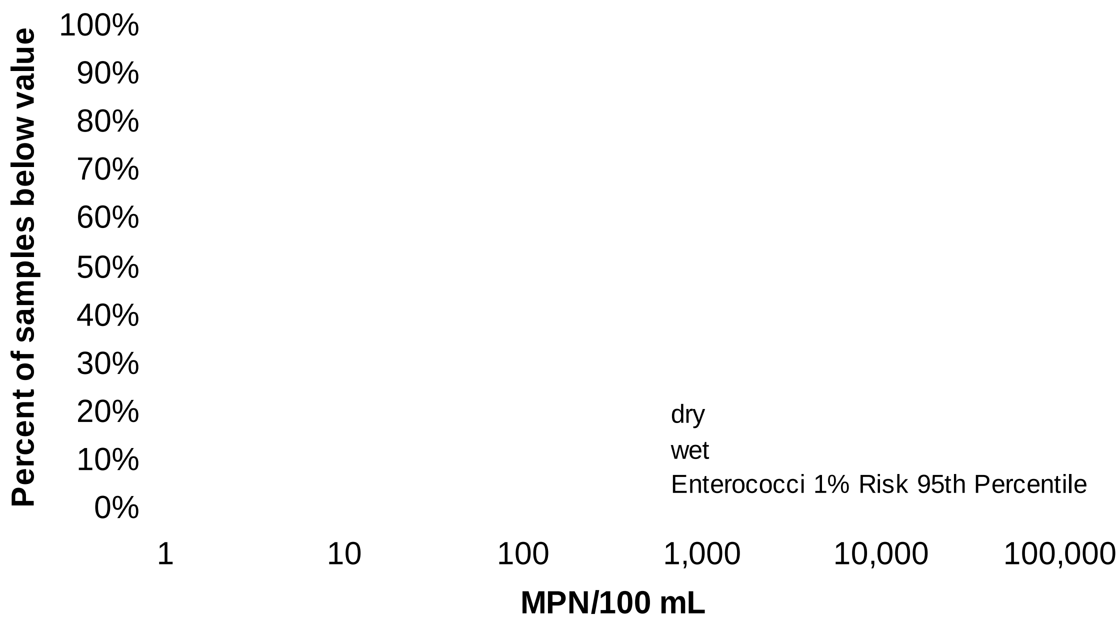
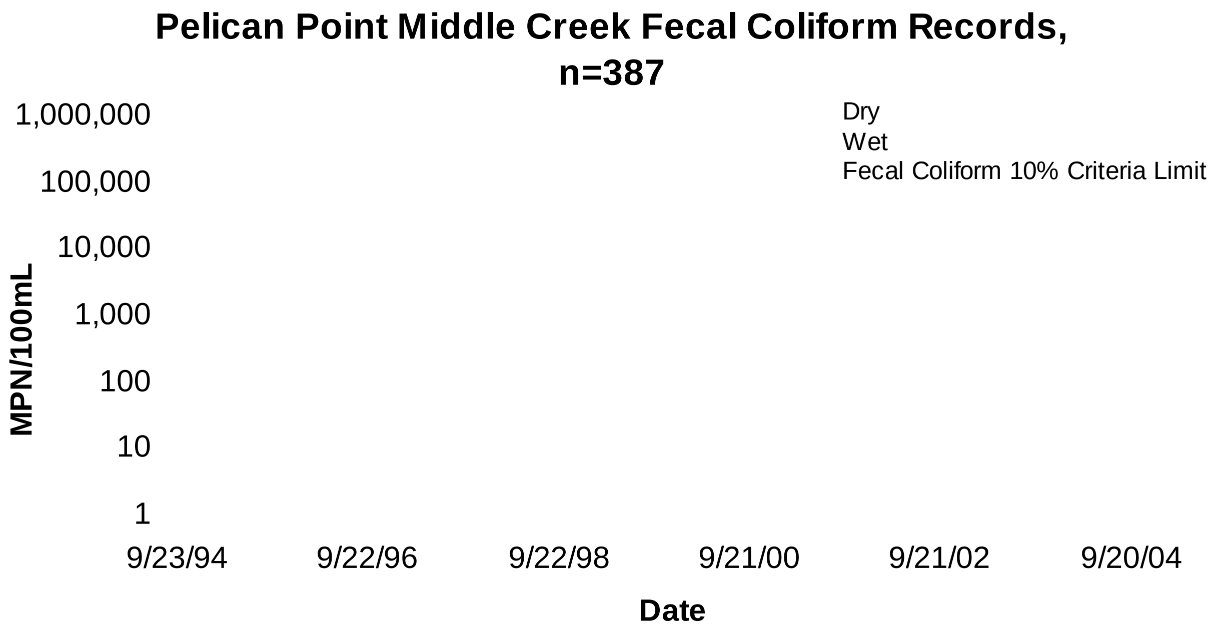


Figure A 23: Pelican Point Middle Creek fecal coliform data and corresponding cumulative frequency distribution



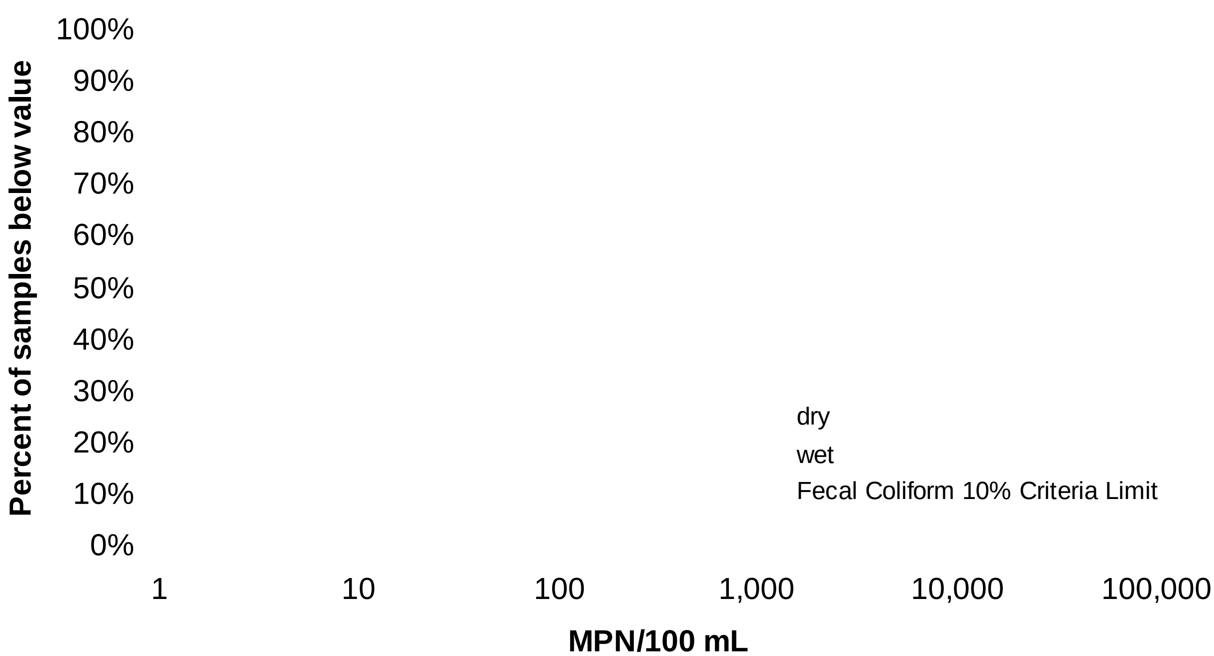
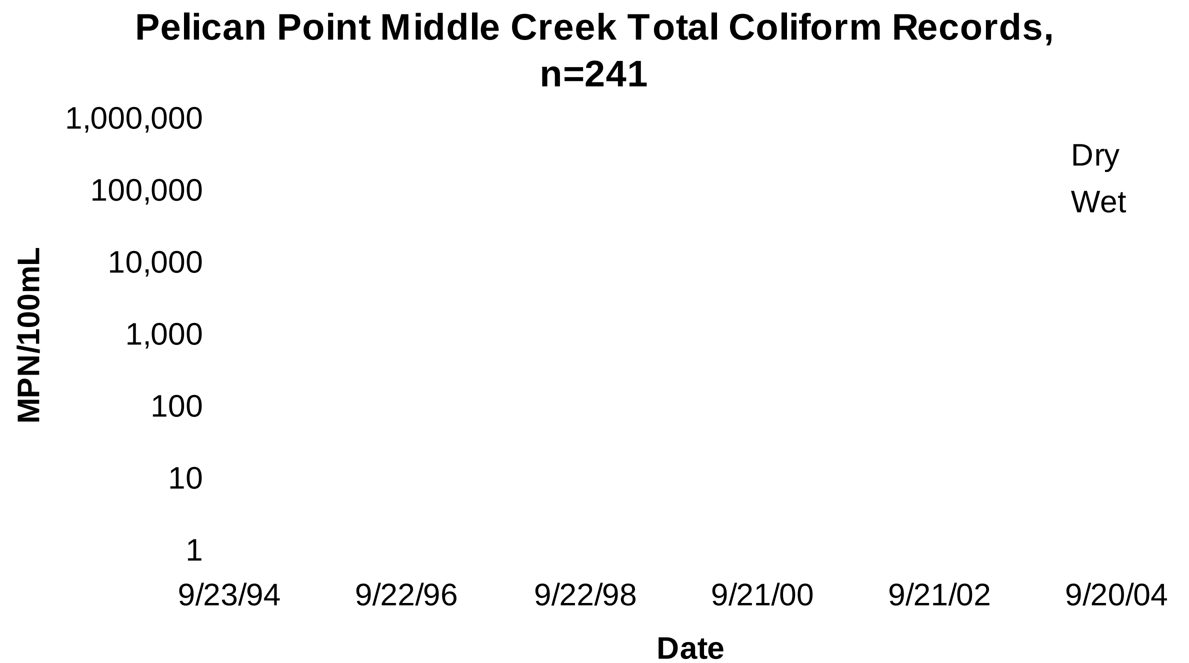


Figure A 24: Pelican Point Middle Creek total coliform data and corresponding cumulative frequency distribution



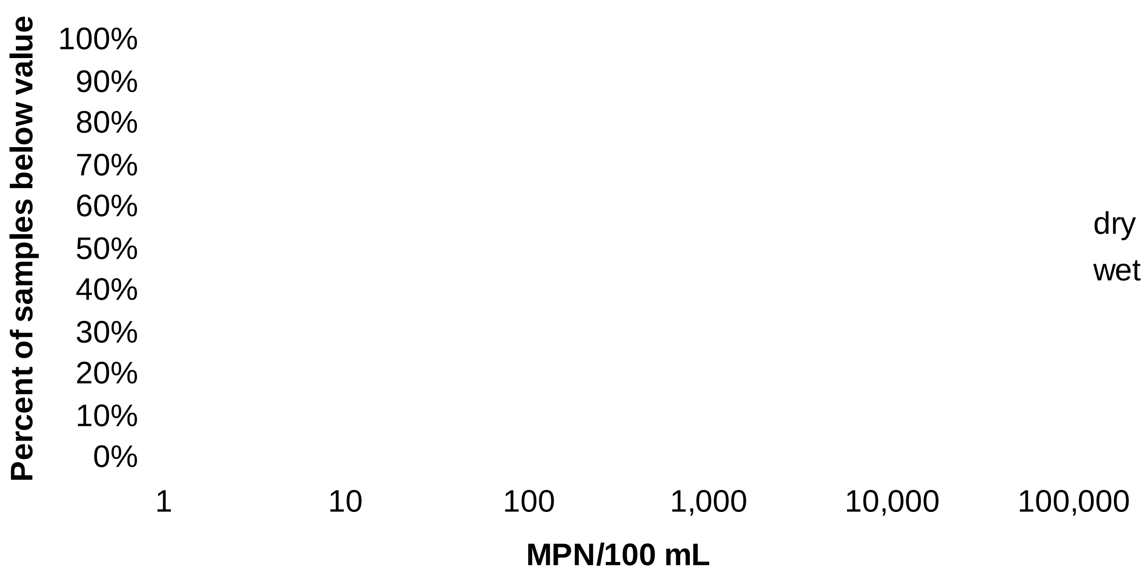


Figure A 25: Percentage of samples from Pelican Point Middle Creek which exceed thresholds, by month

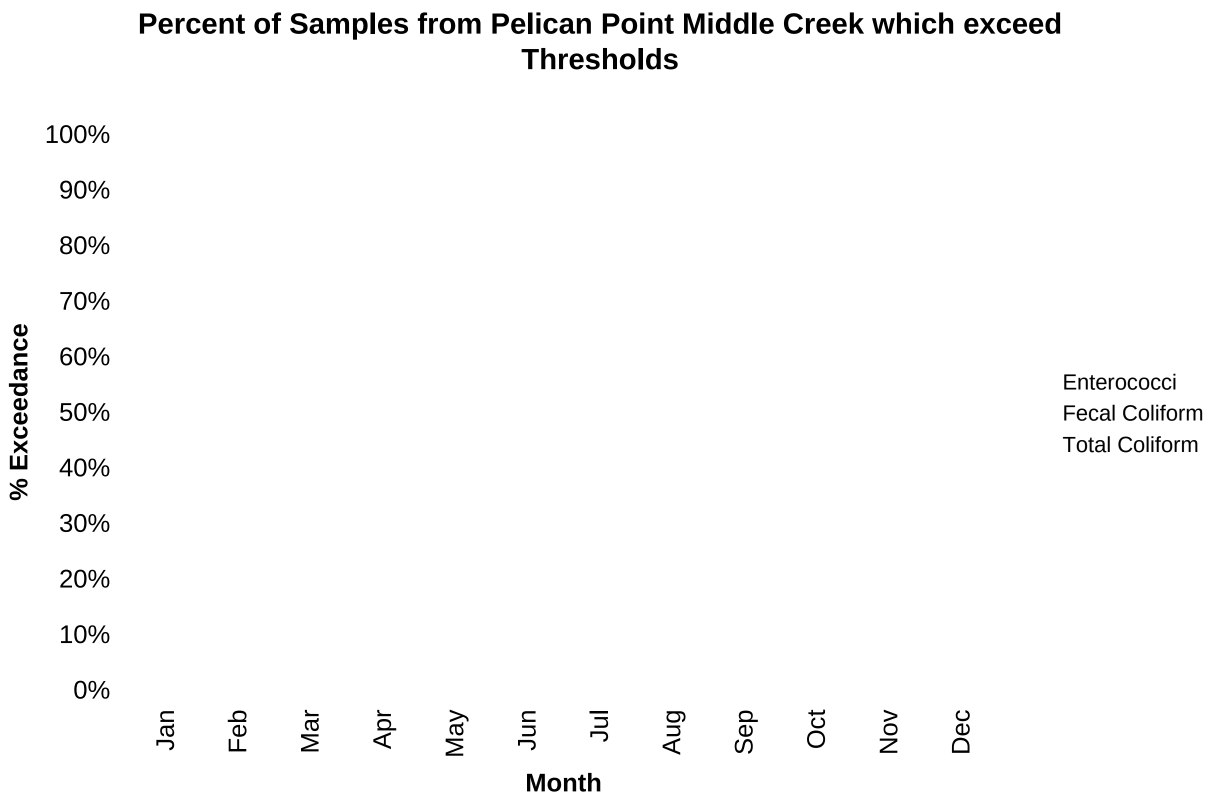
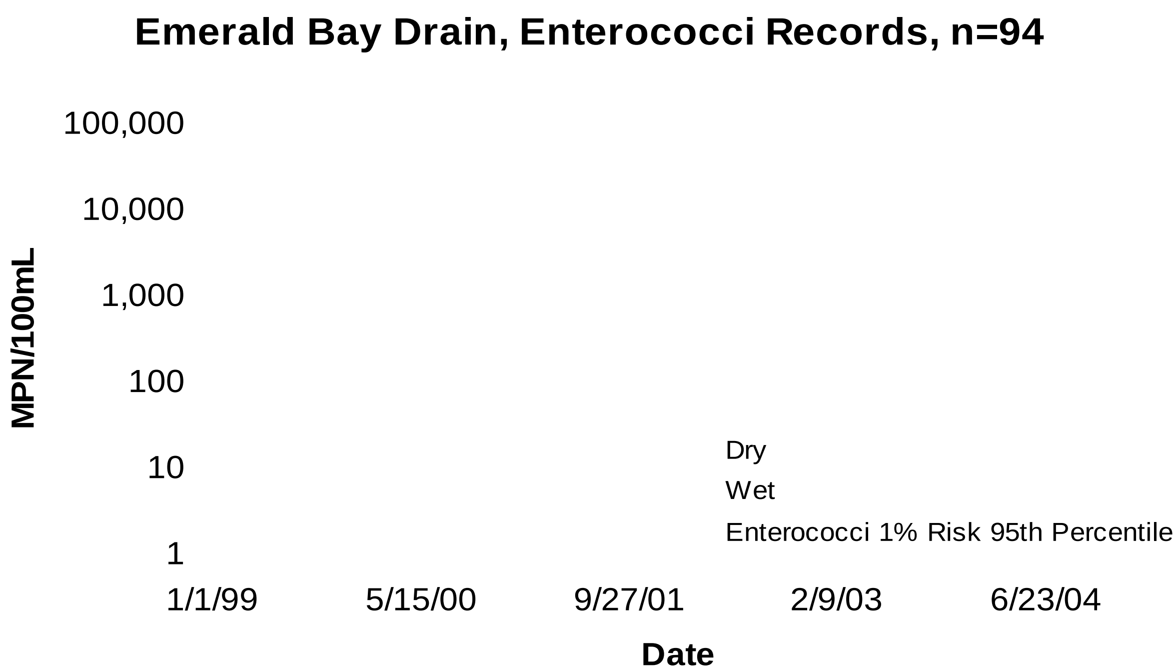


Figure A 26: Emerald Bay Drain enterococci data and corresponding cumulative frequency distribution



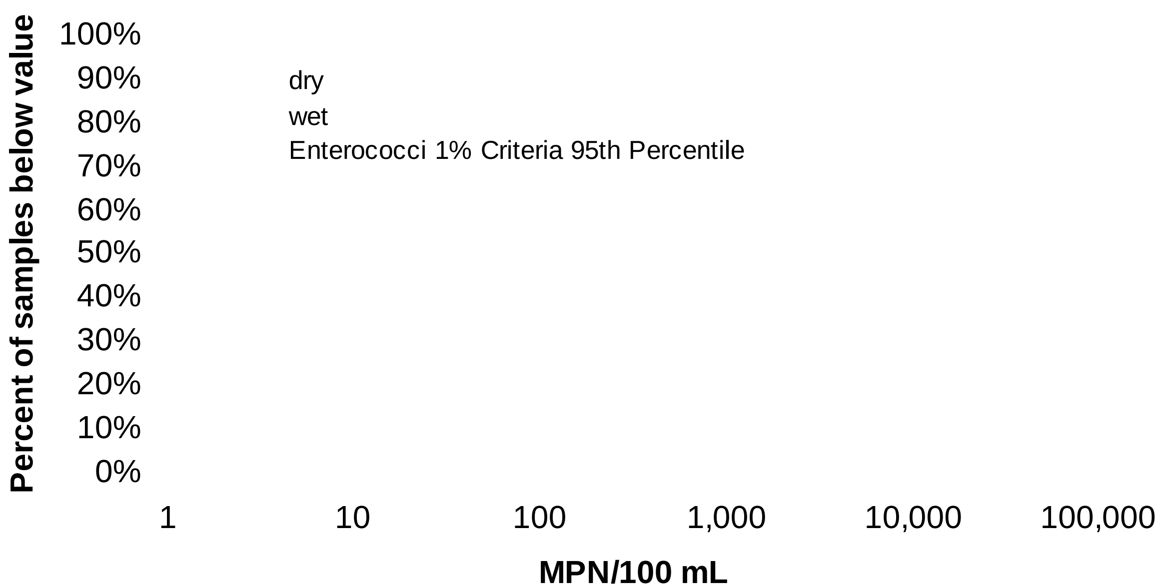
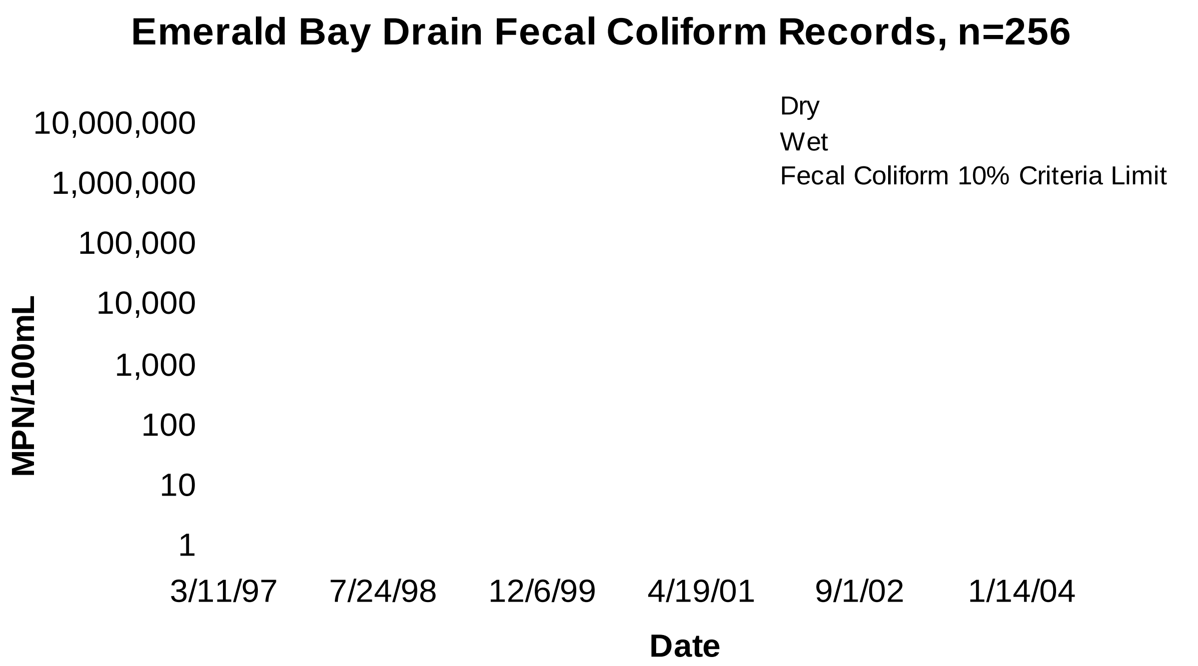


Figure A 27: Emerald Bay Drain fecal coliform data and corresponding cumulative frequency distribution



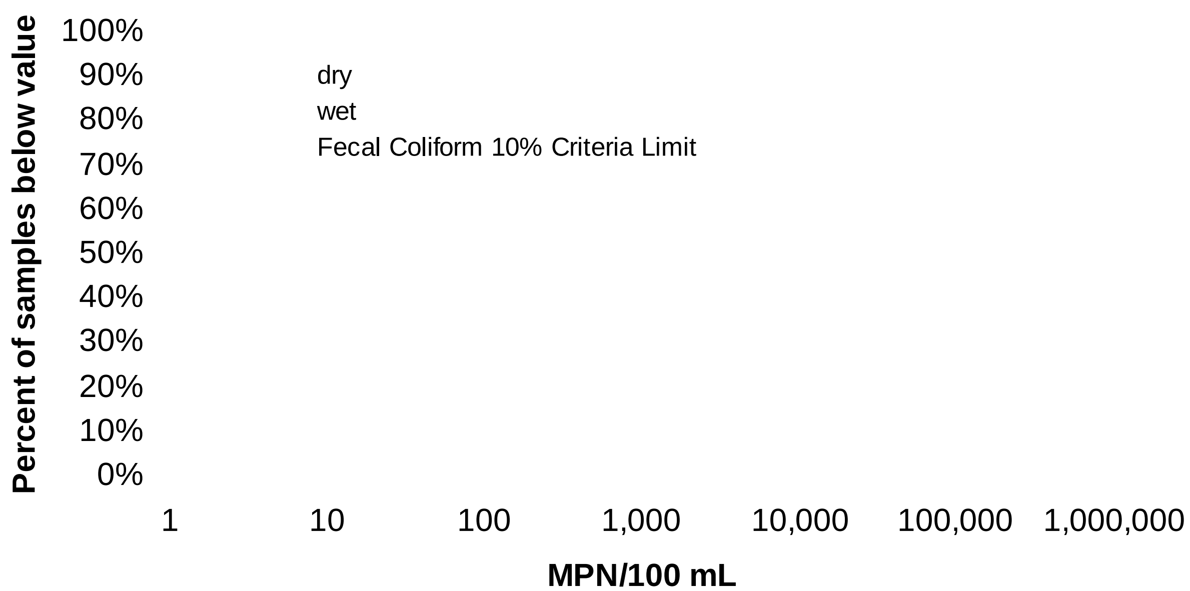
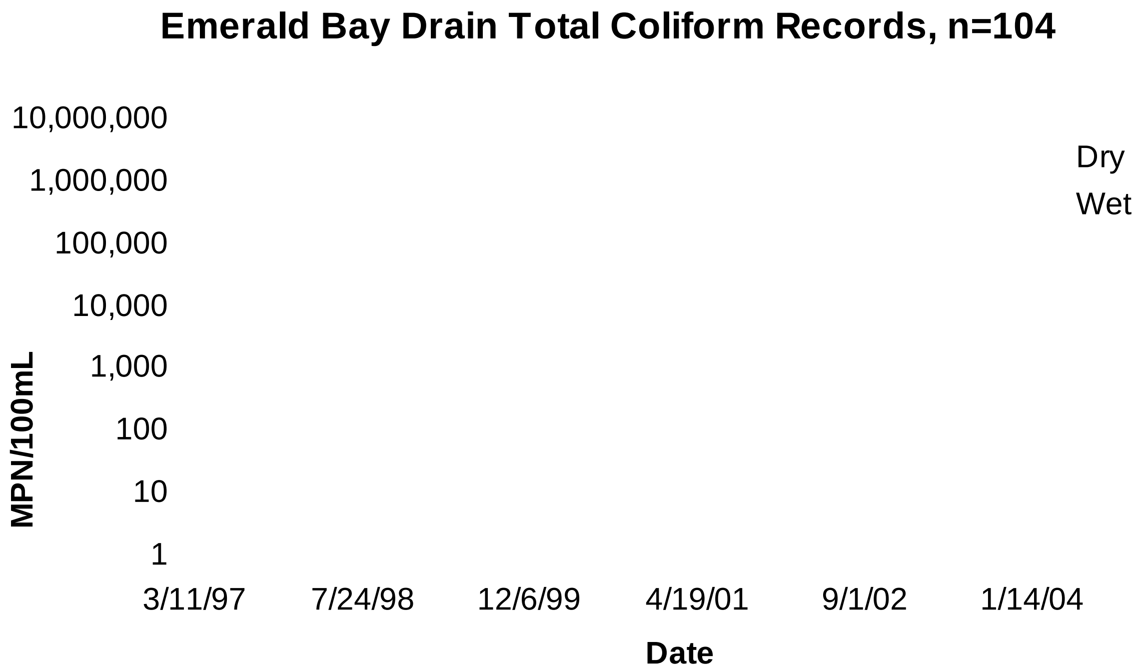


Figure A 28: Emerald Bay Drain total coliform data and corresponding cumulative frequency distribution



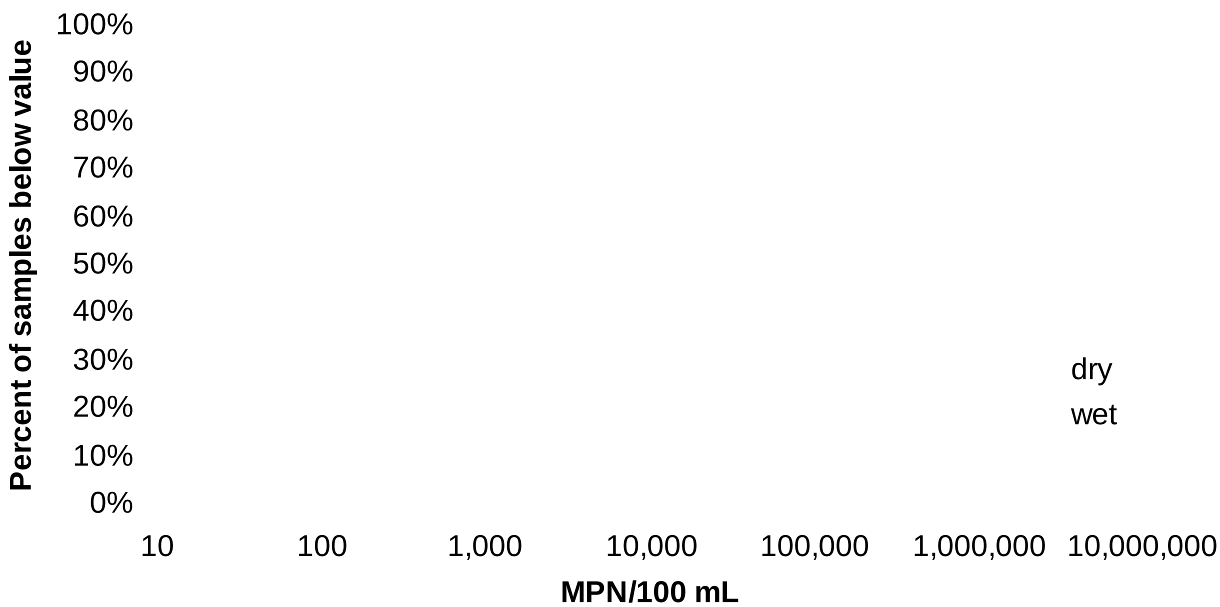


Figure A 29: Percentage of samples from the Emerald Bay Drain which exceed thresholds, by month

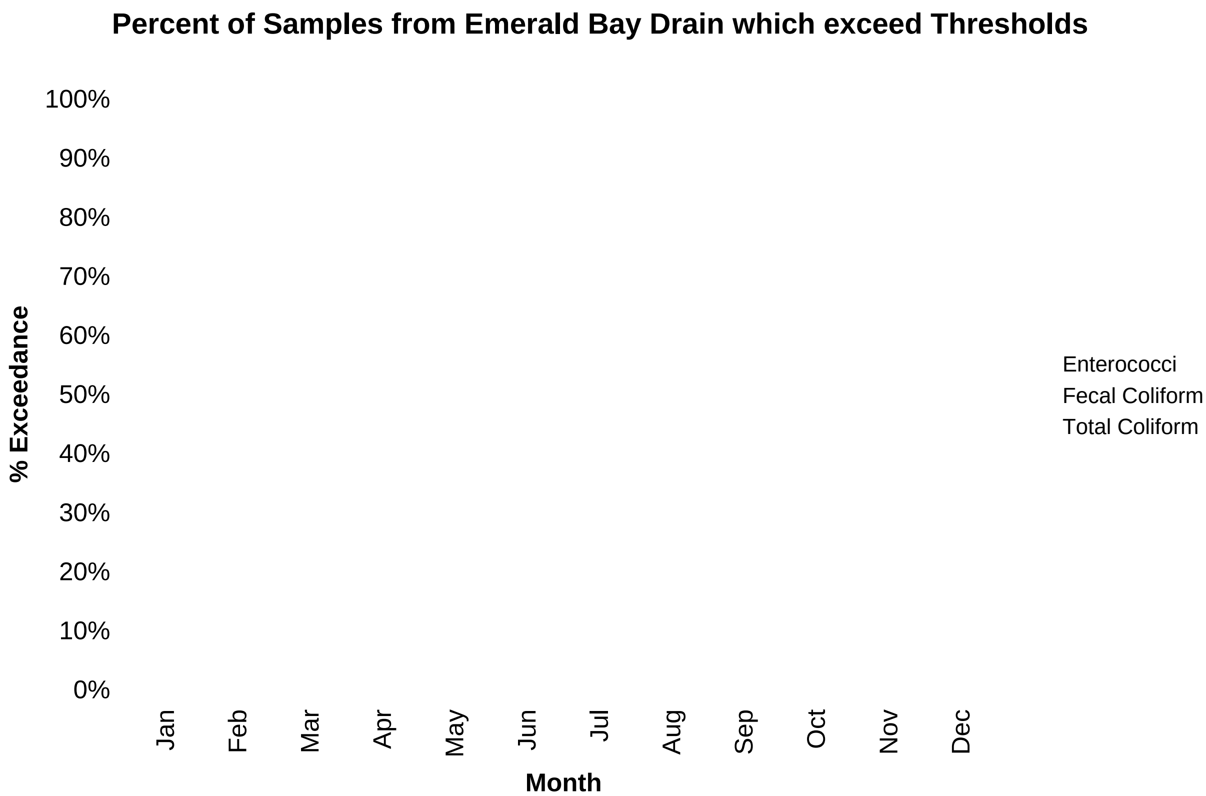
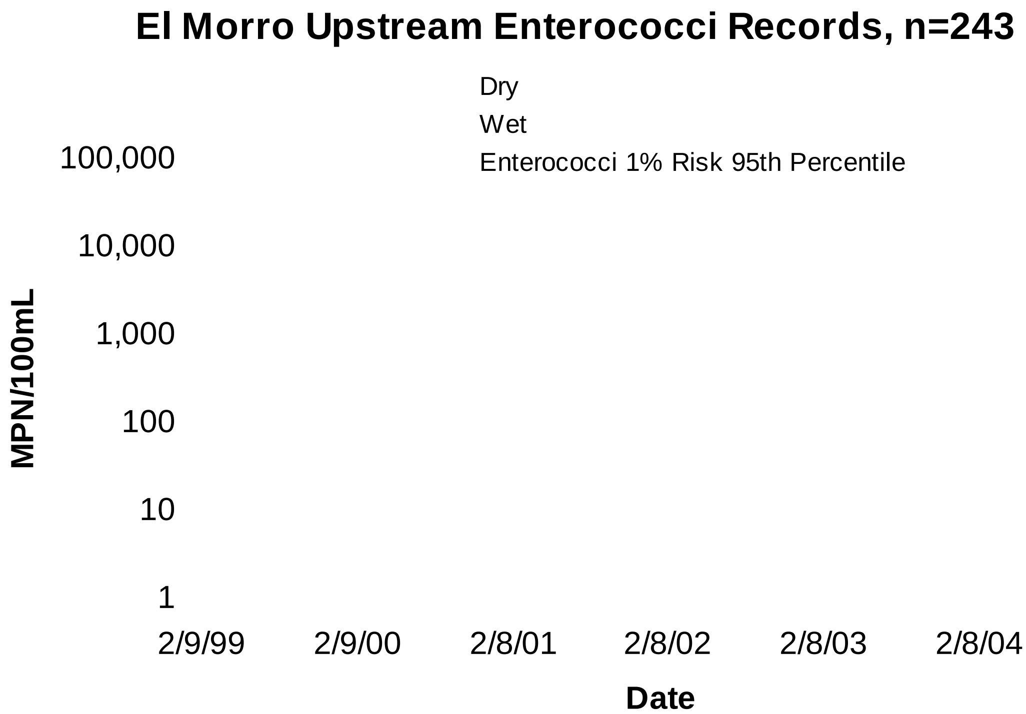


Figure A 30: El Morro Creek Upstream enterococci data and corresponding cumulative frequency distribution



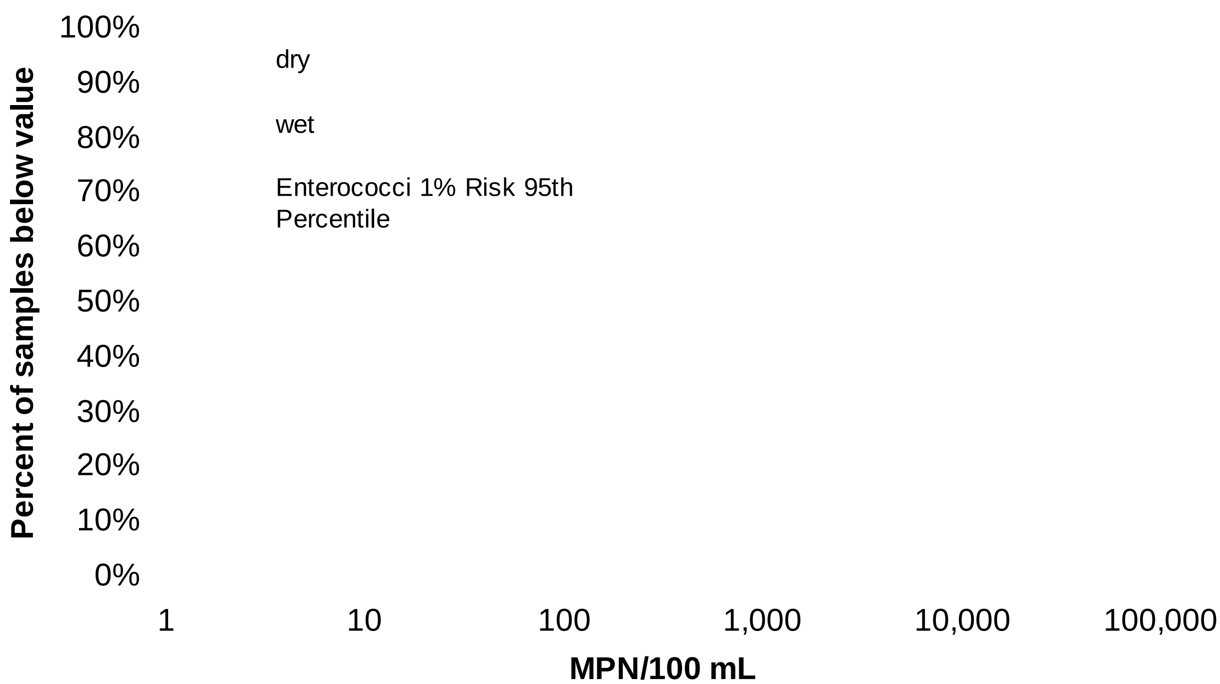
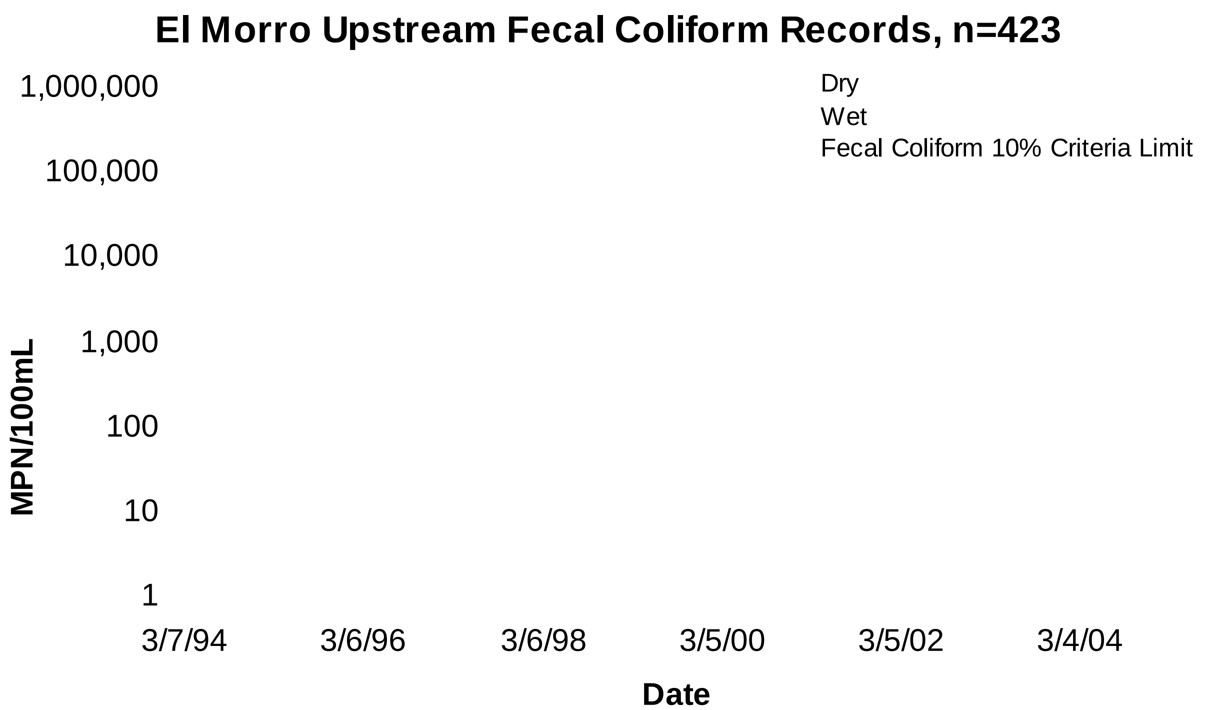


Figure A 31: El Morro Creek Upstream fecal coliform data and corresponding cumulative frequency distribution



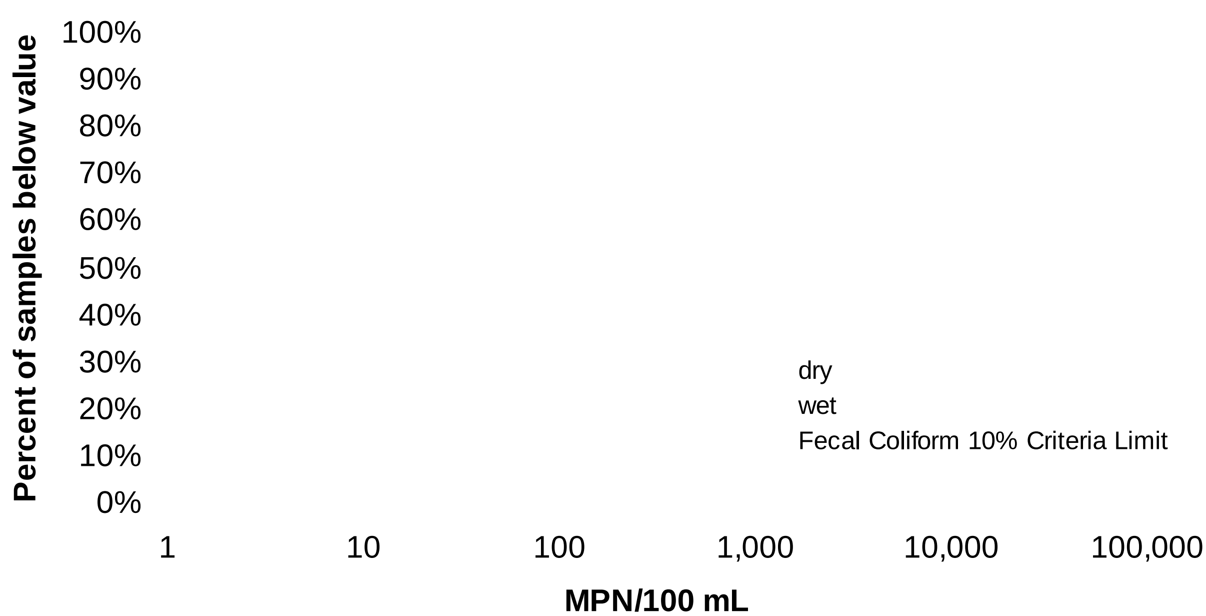
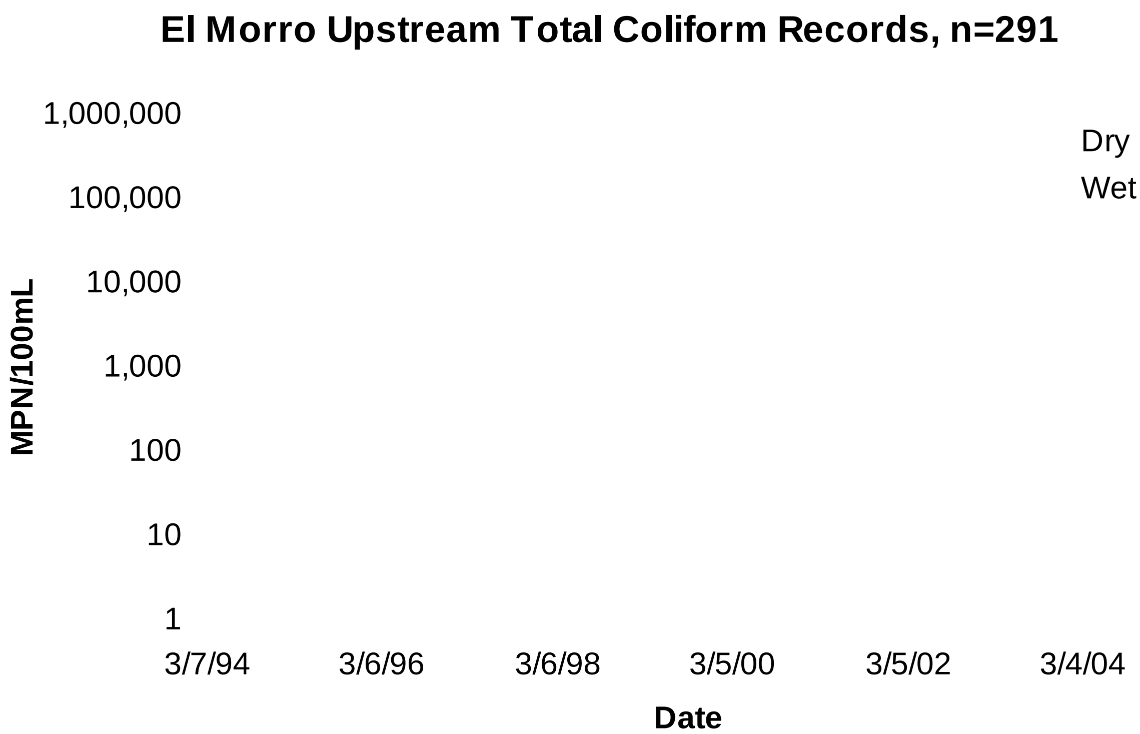


Figure A 32: El Morro Creek Upstream total coliform data and corresponding cumulative frequency distribution



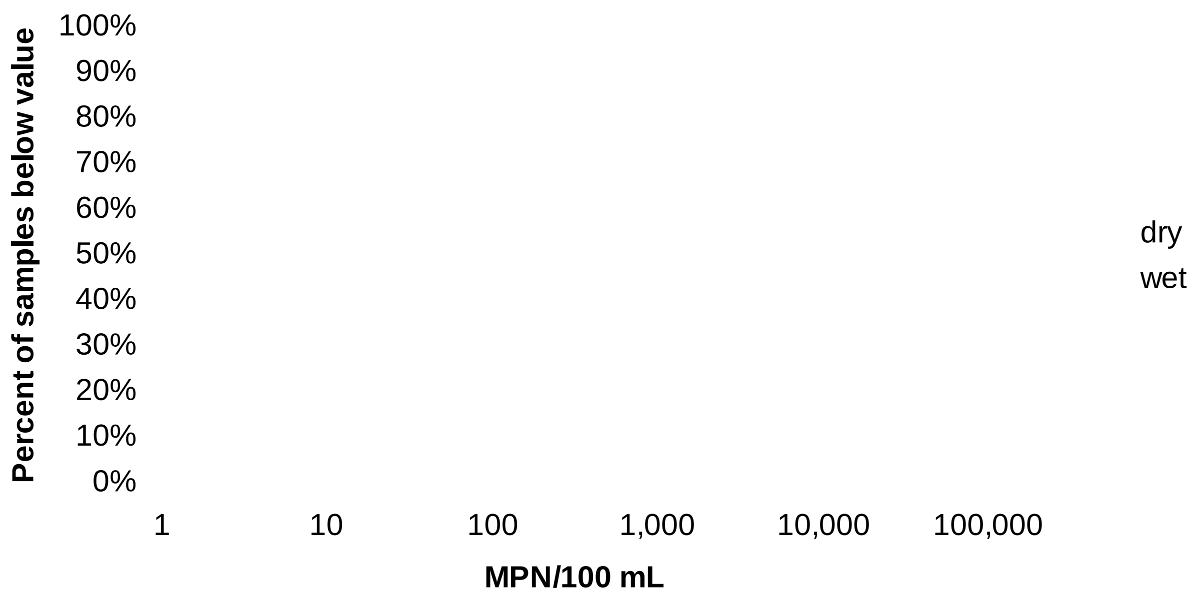


Figure A 33: Percentage of samples from El Morro Creek Upstream which exceed thresholds, by month

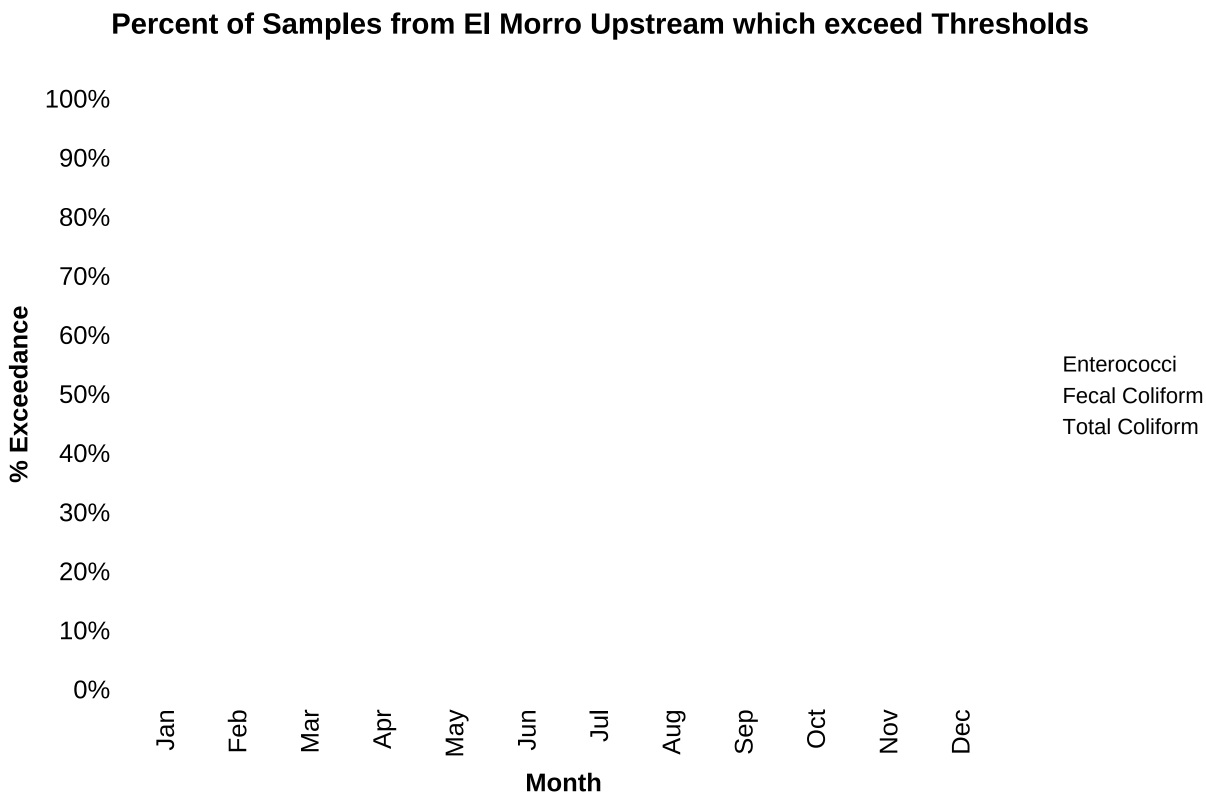
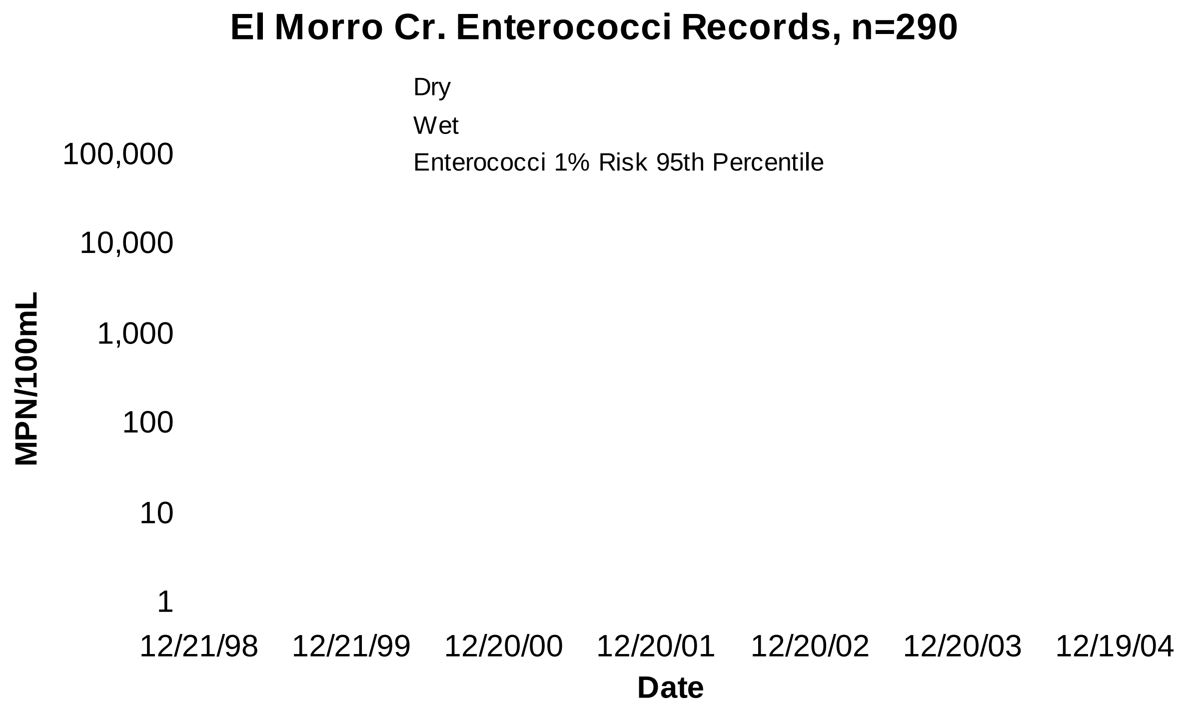


Figure A 34: El Morro Creek enterococci data and corresponding cumulative frequency distribution



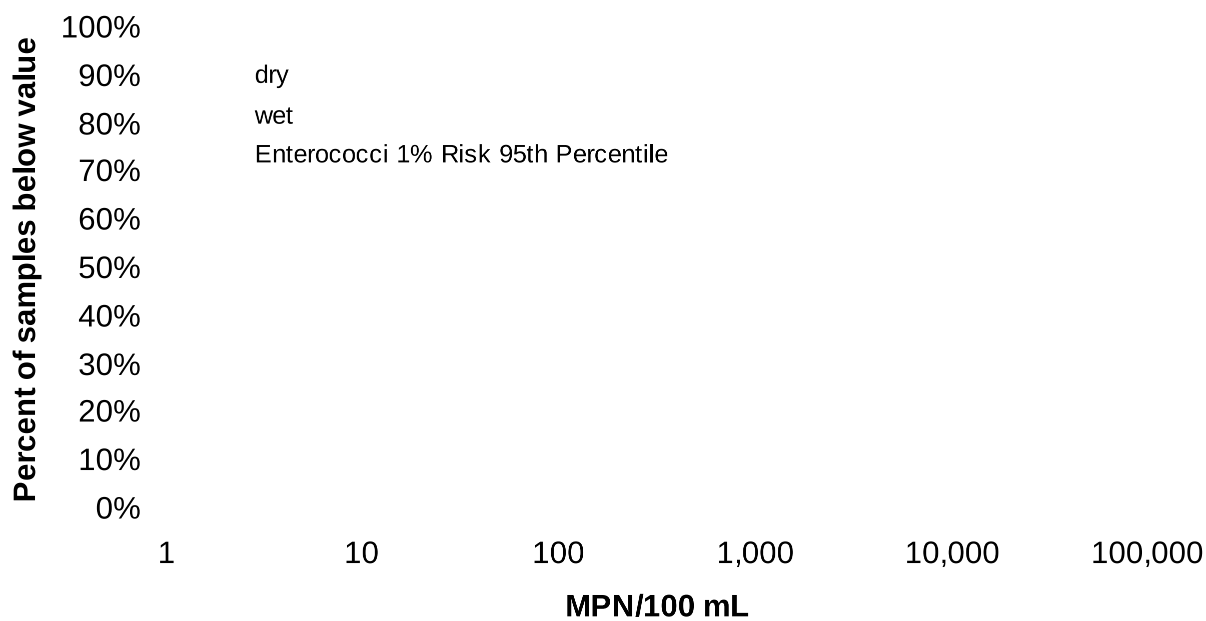
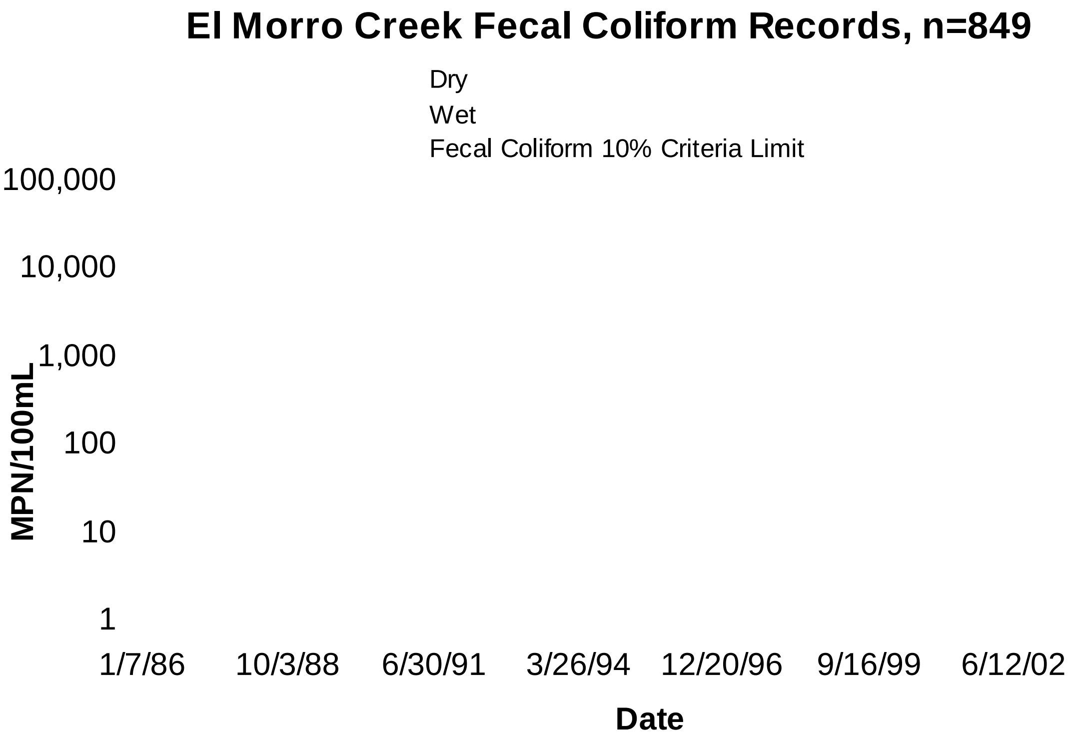


Figure A 35: El Morro Creek fecal coliform data and corresponding cumulative frequency distribution



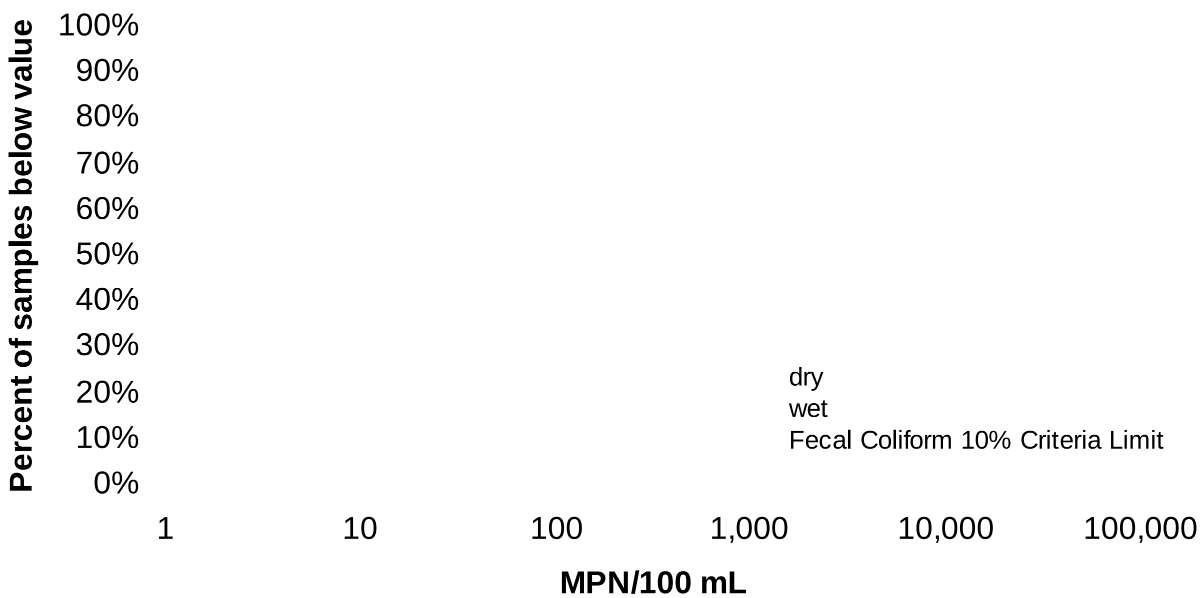


Figure A 36: El Morro Creek total coliform data and corresponding cumulative frequency distribution

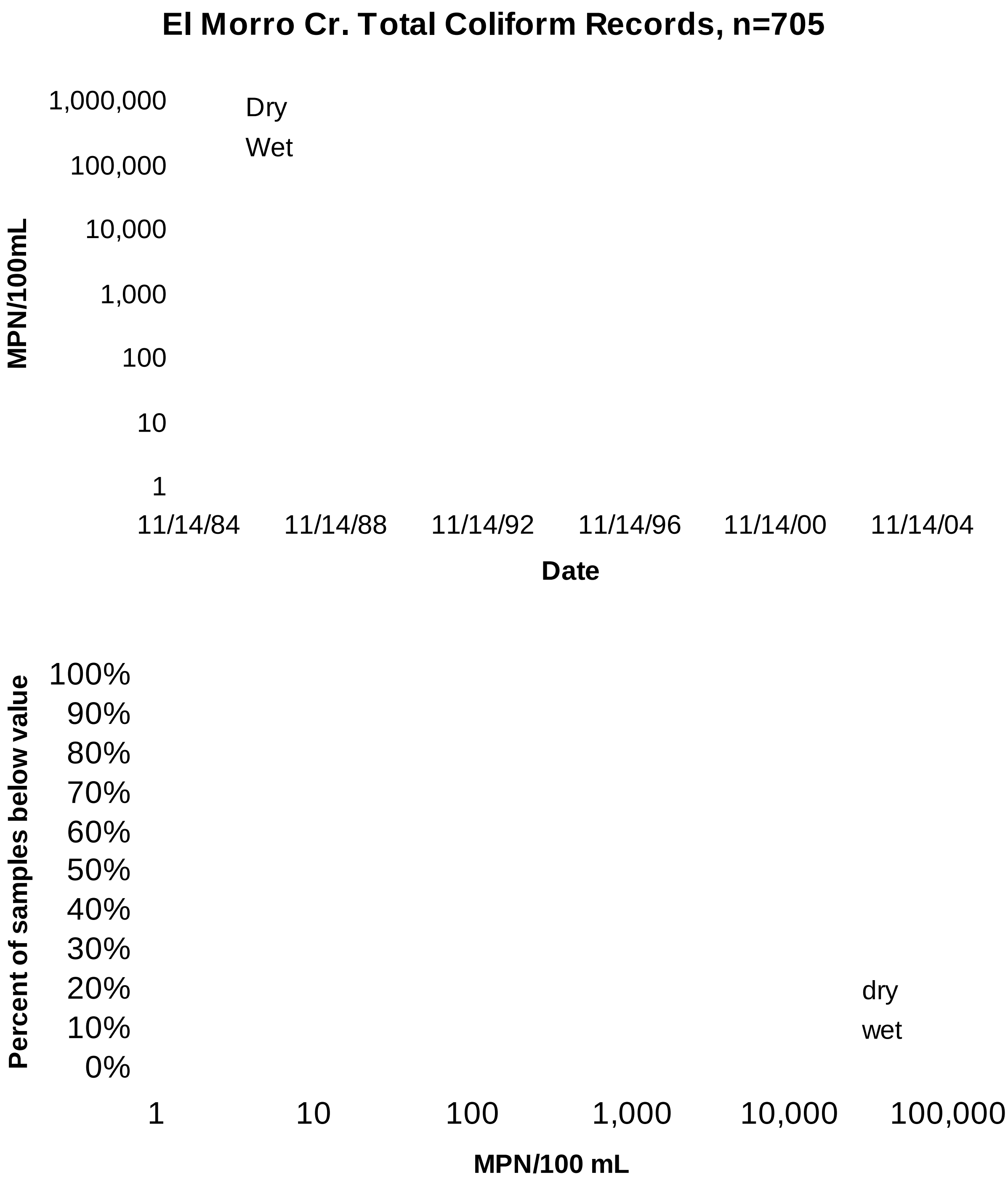


Figure A 37: Percentage of samples from El Morro Creek which exceed thresholds, by month

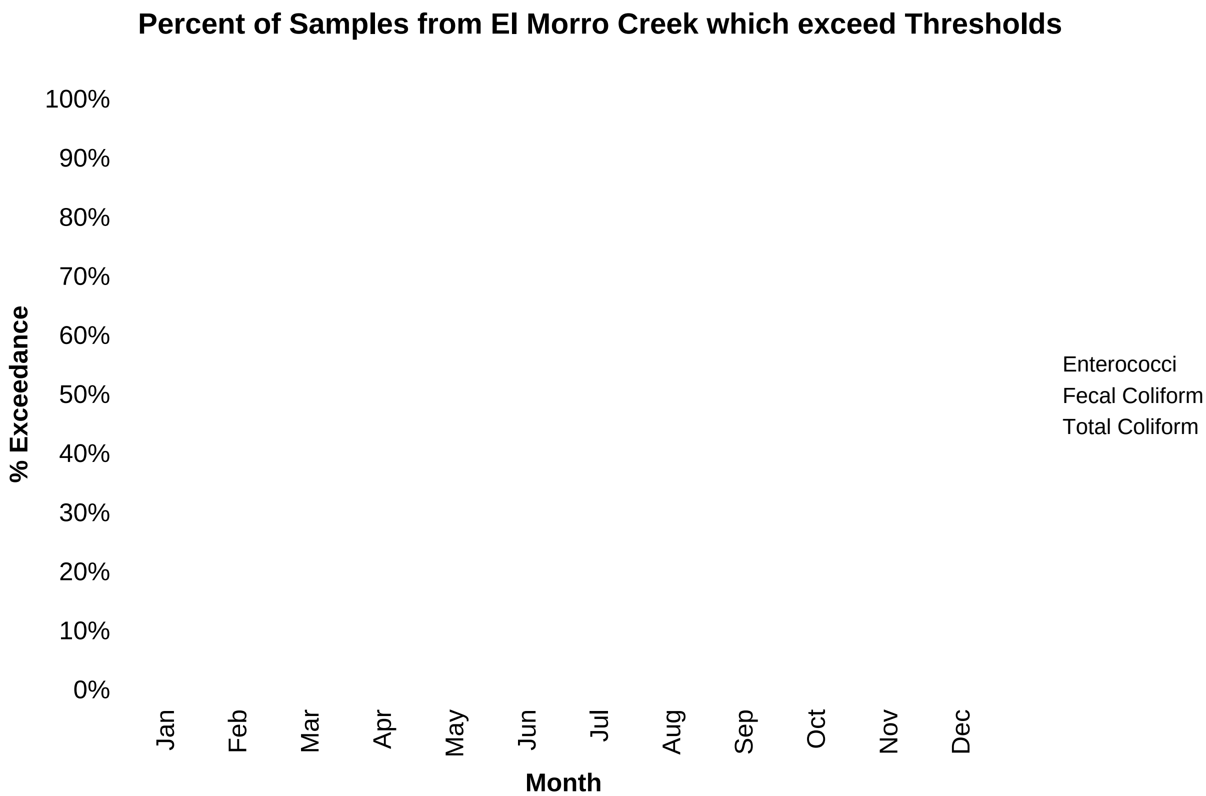
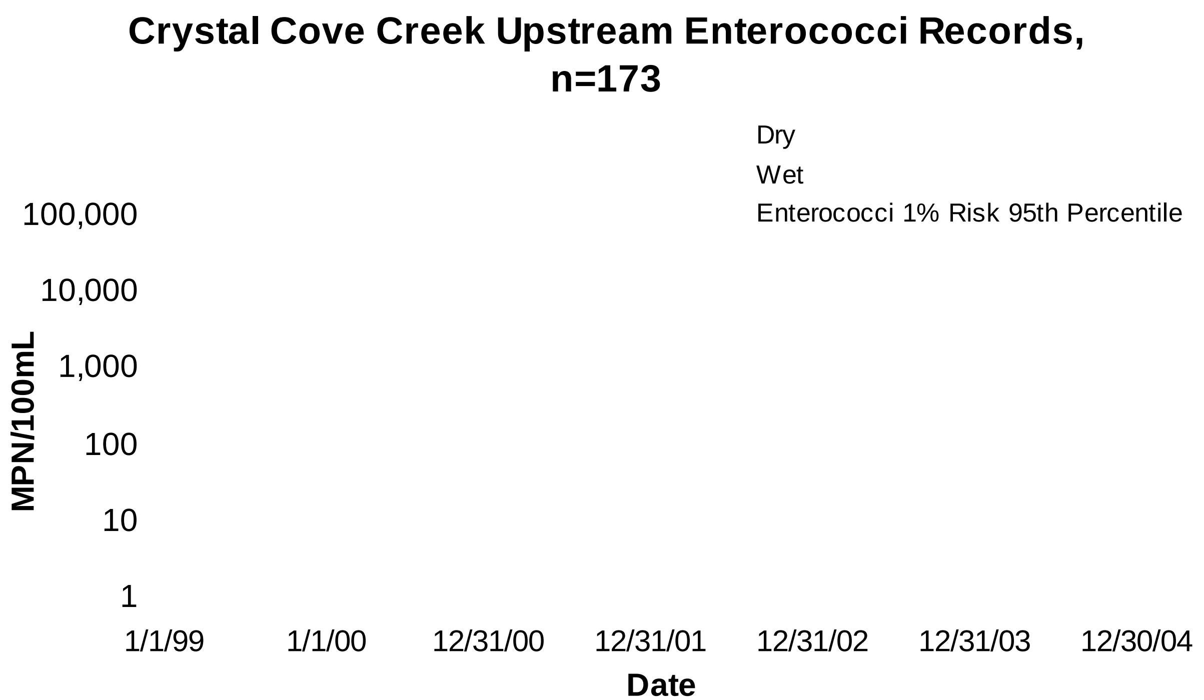


Figure A 38: Crystal Cove Creek Upstream enterococci data and corresponding cumulative frequency distribution



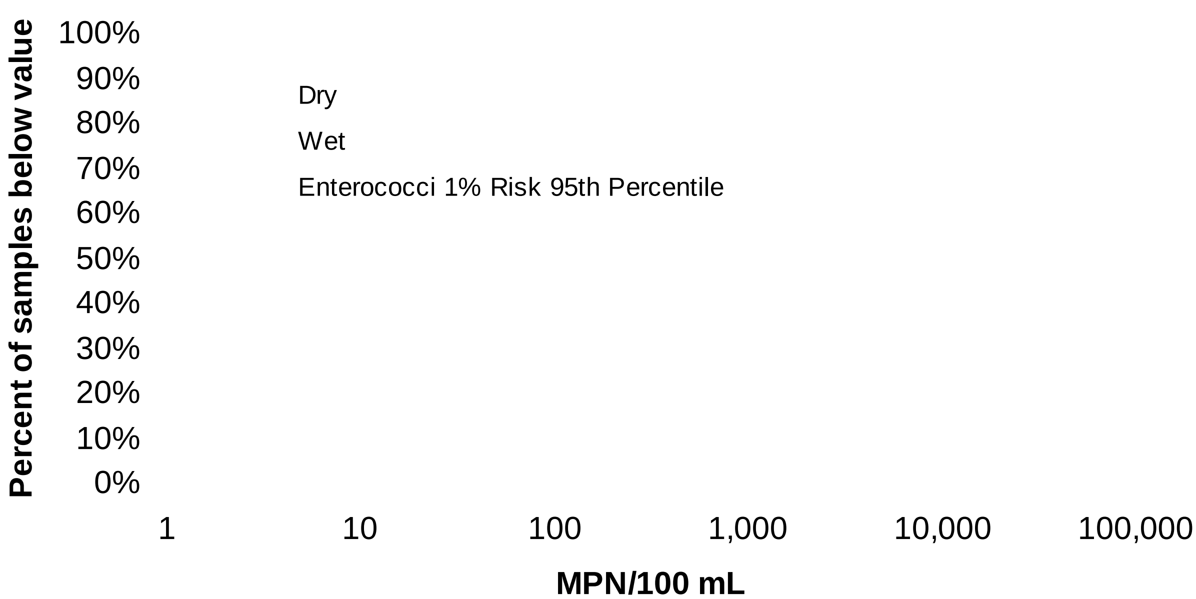
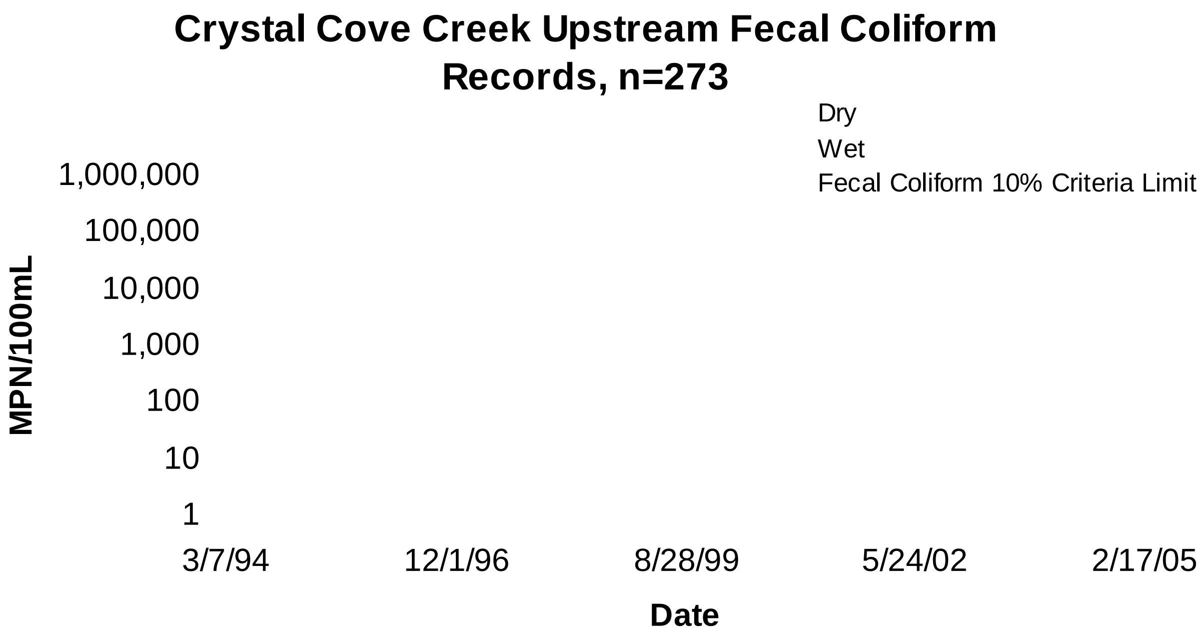


Figure A 39: Crystal Cove Creek Upstream fecal coliform data and corresponding cumulative frequency distribution



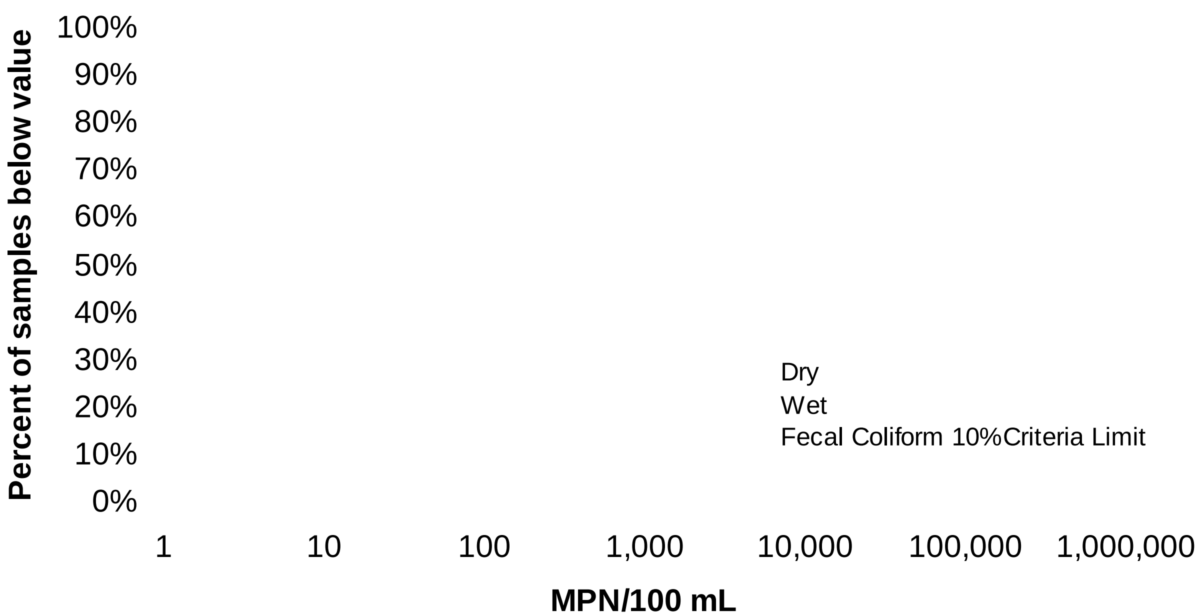
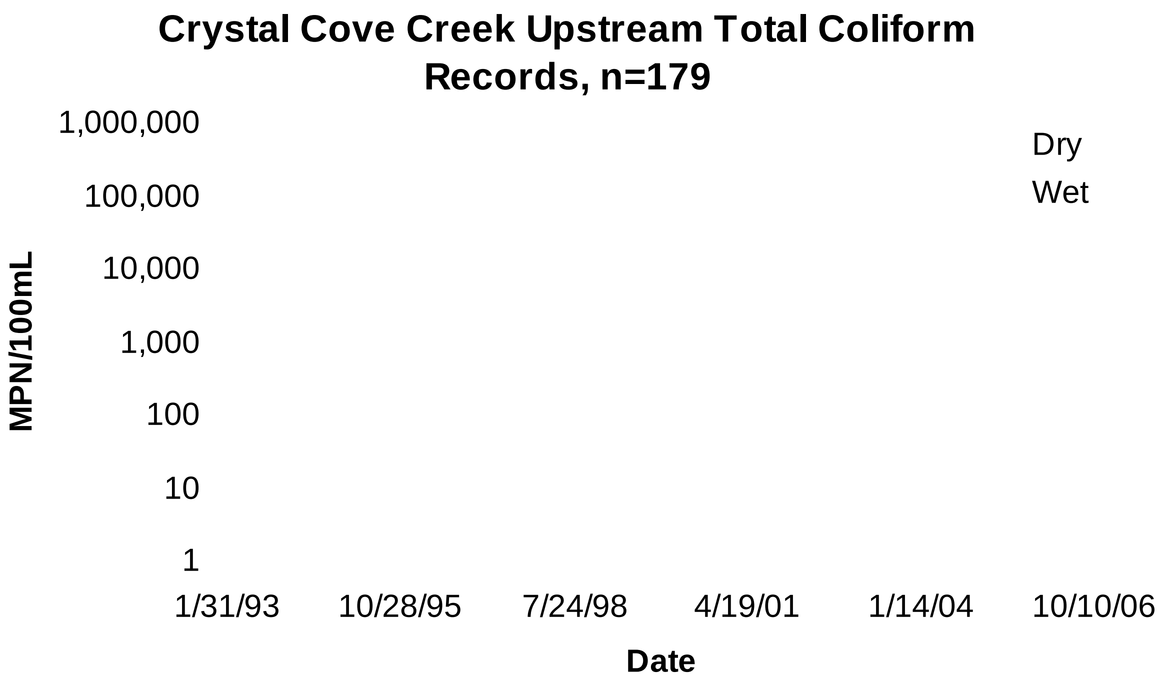


Figure A 40: Crystal Cove Creek Upstream total coliform data and corresponding cumulative frequency distribution



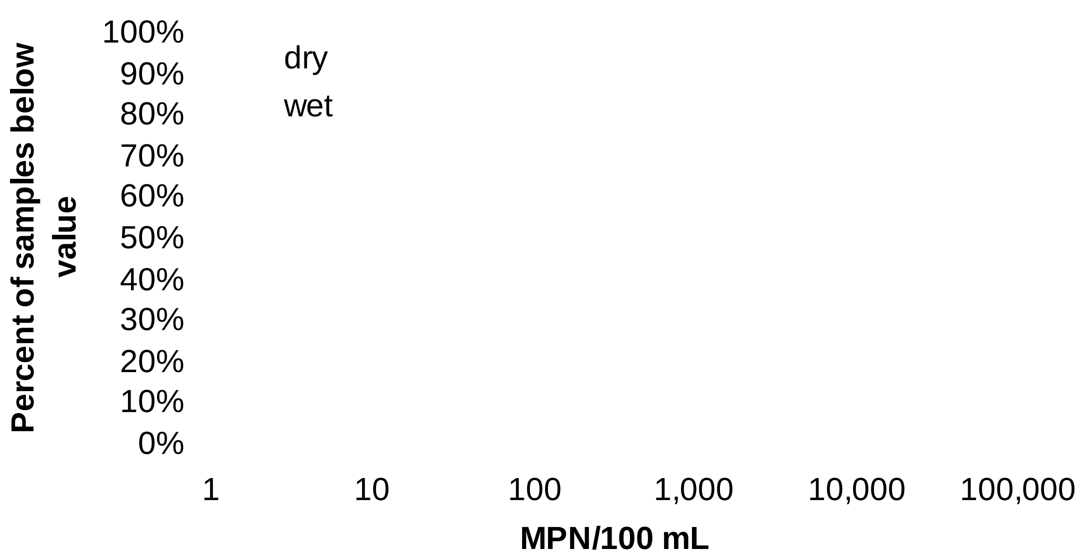


Figure A 41: Percentage of samples from Crystal Cove Creek Upstream which exceed thresholds, by month

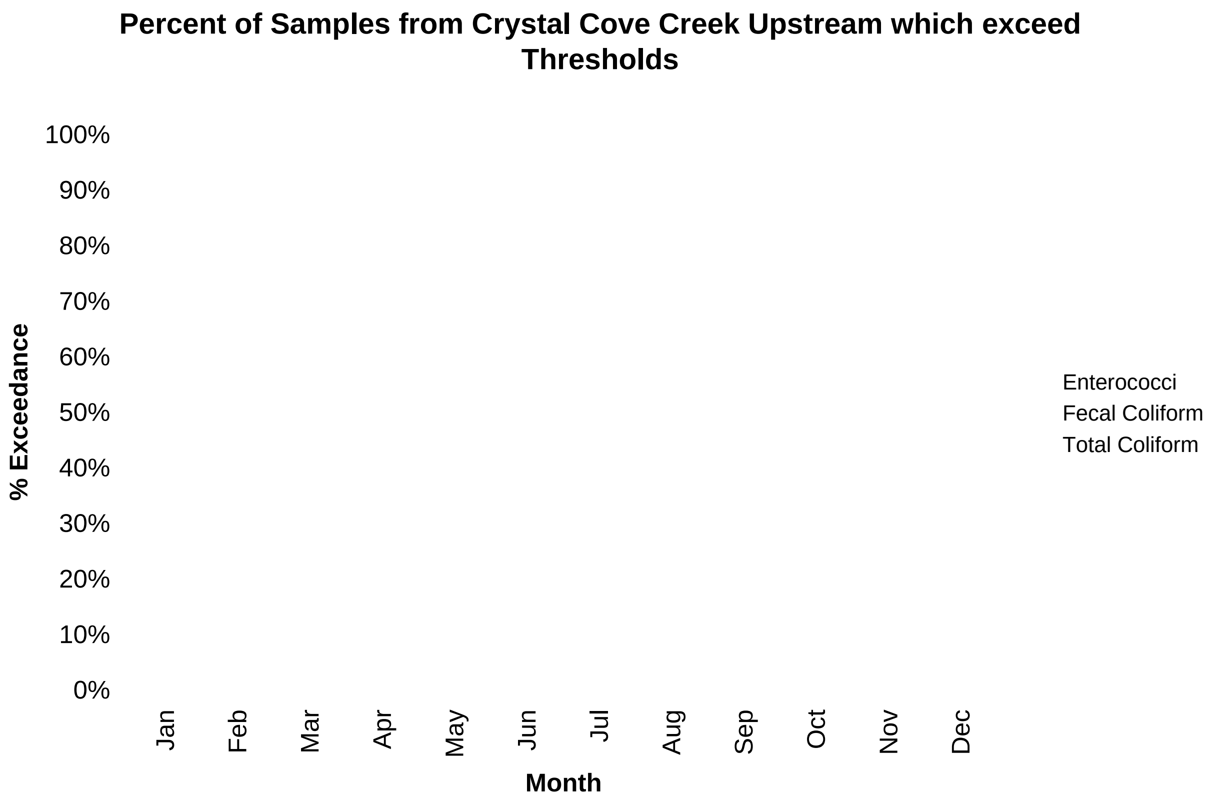
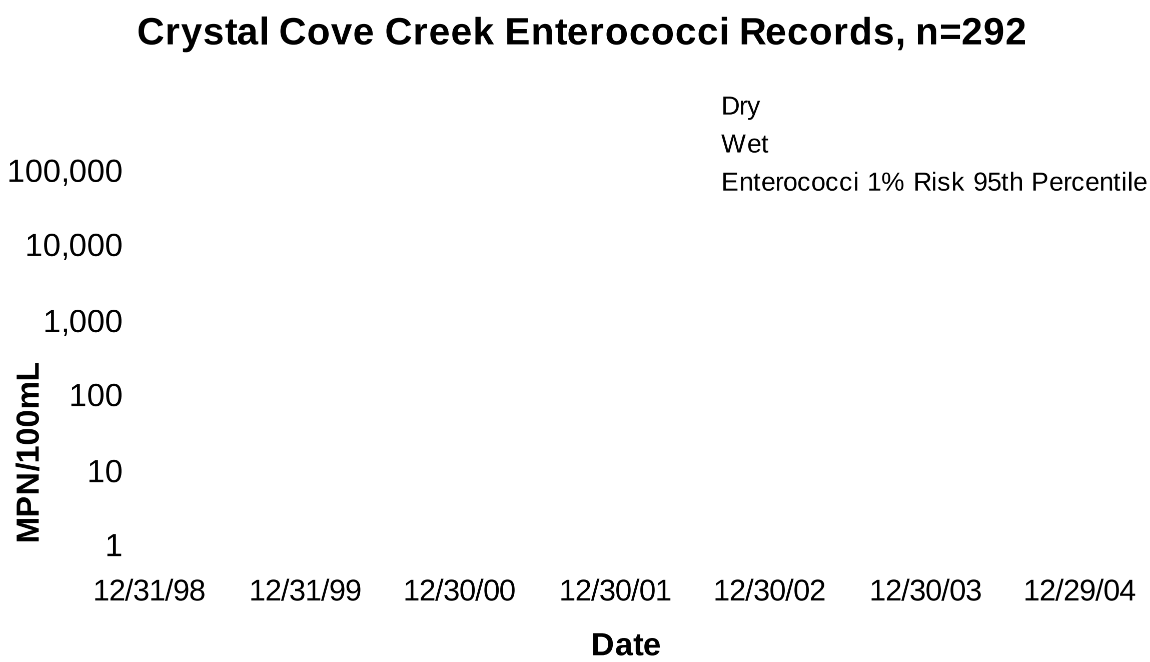


Figure A 42: Crystal Cove Creek enterococci data and corresponding cumulative frequency distribution



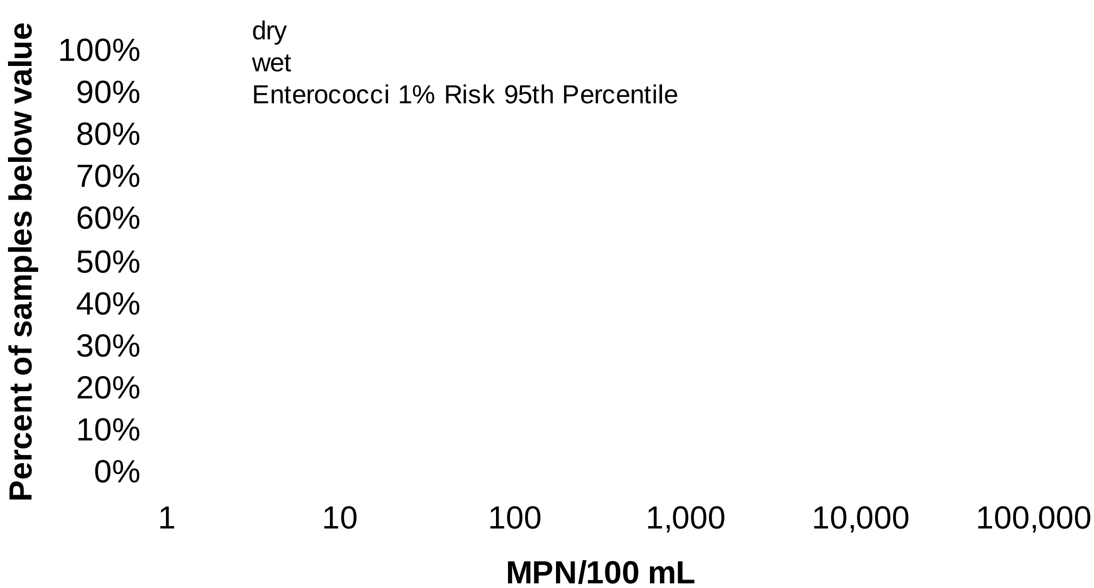
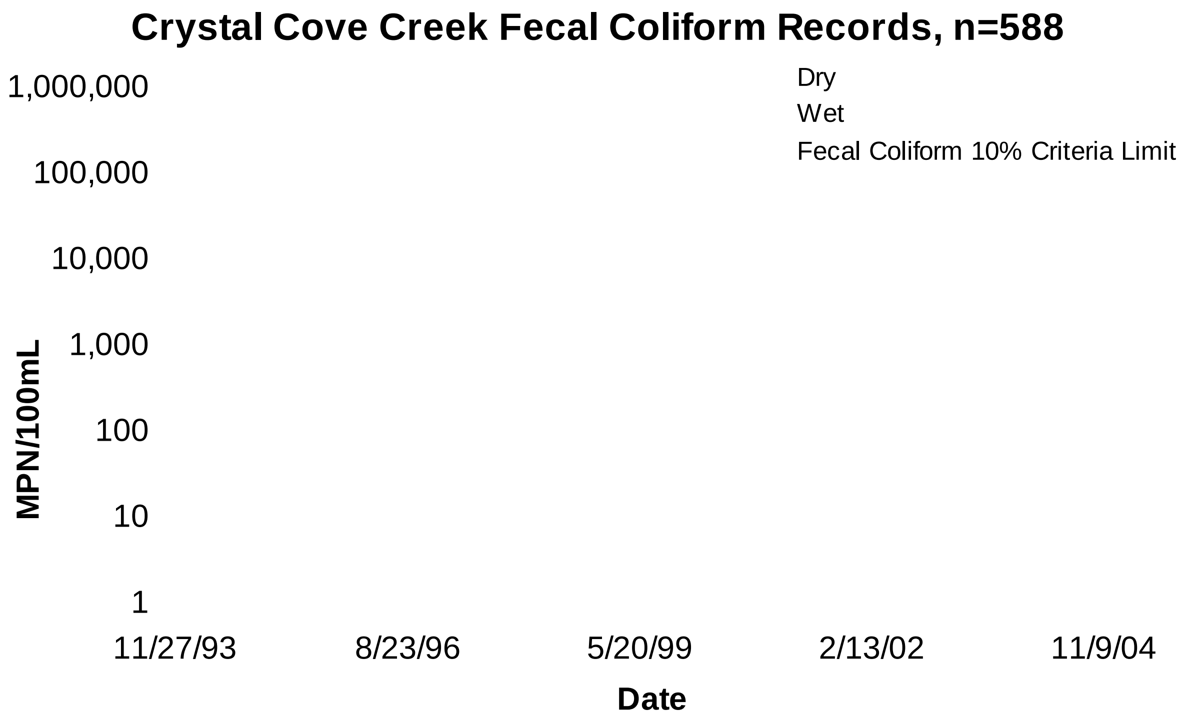


Figure A 43: Crystal Cove Creek fecal coliform data and corresponding cumulative frequency distribution



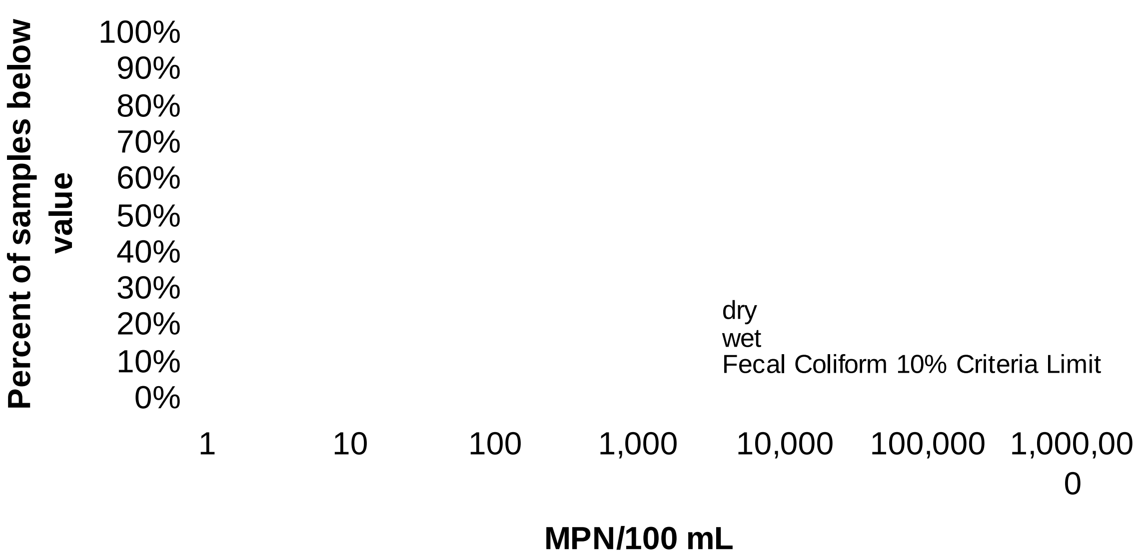
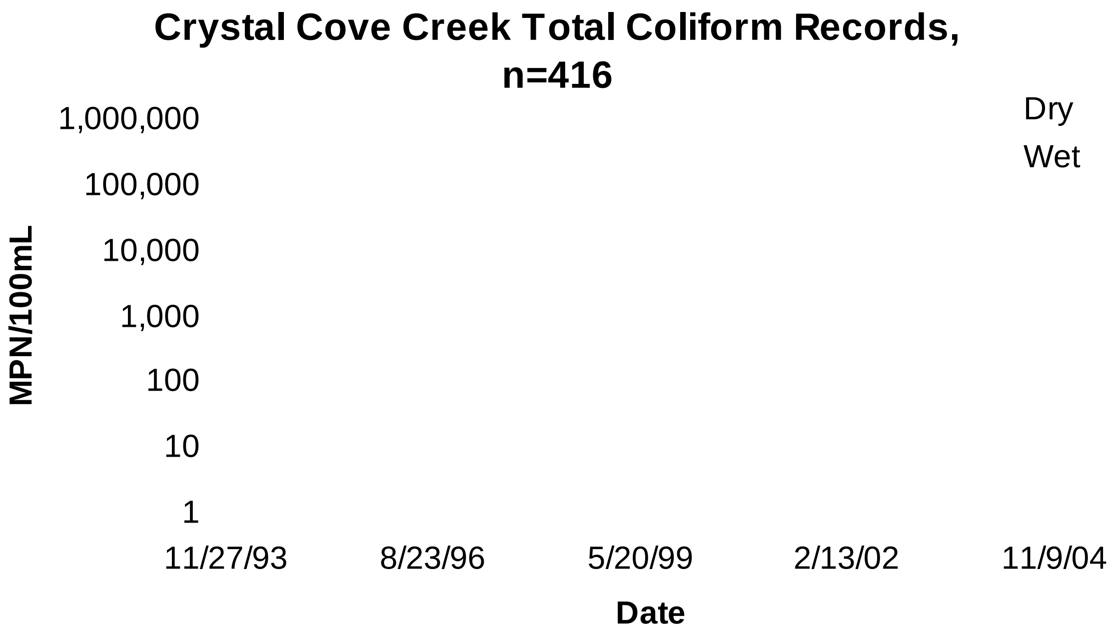


Figure A 44: Crystal Cove Creek total coliform data and corresponding cumulative frequency distribution



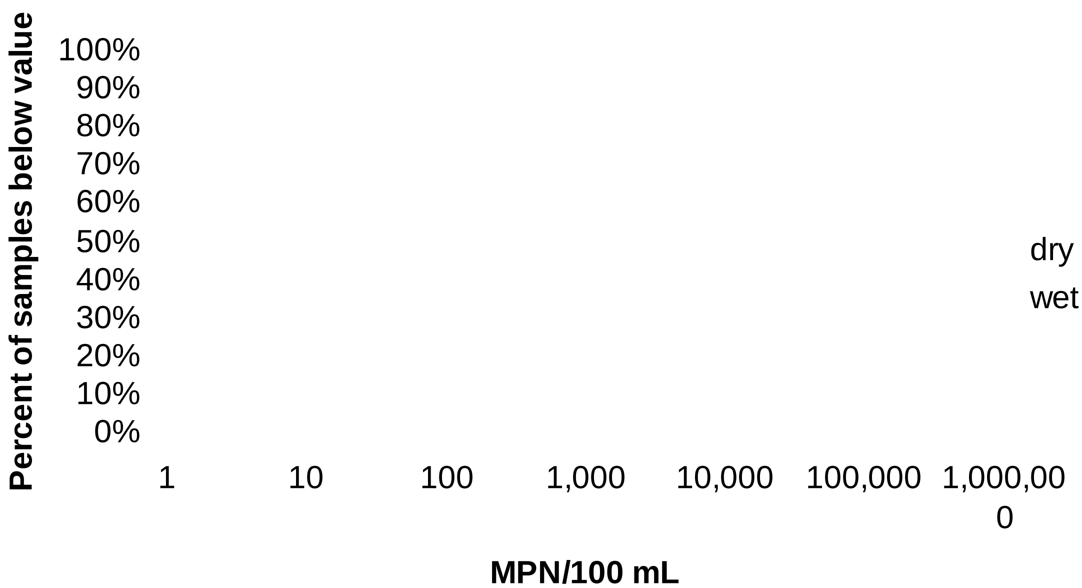


Figure A 45: Percentage of samples from Crystal Cove Creek which exceed thresholds, by month

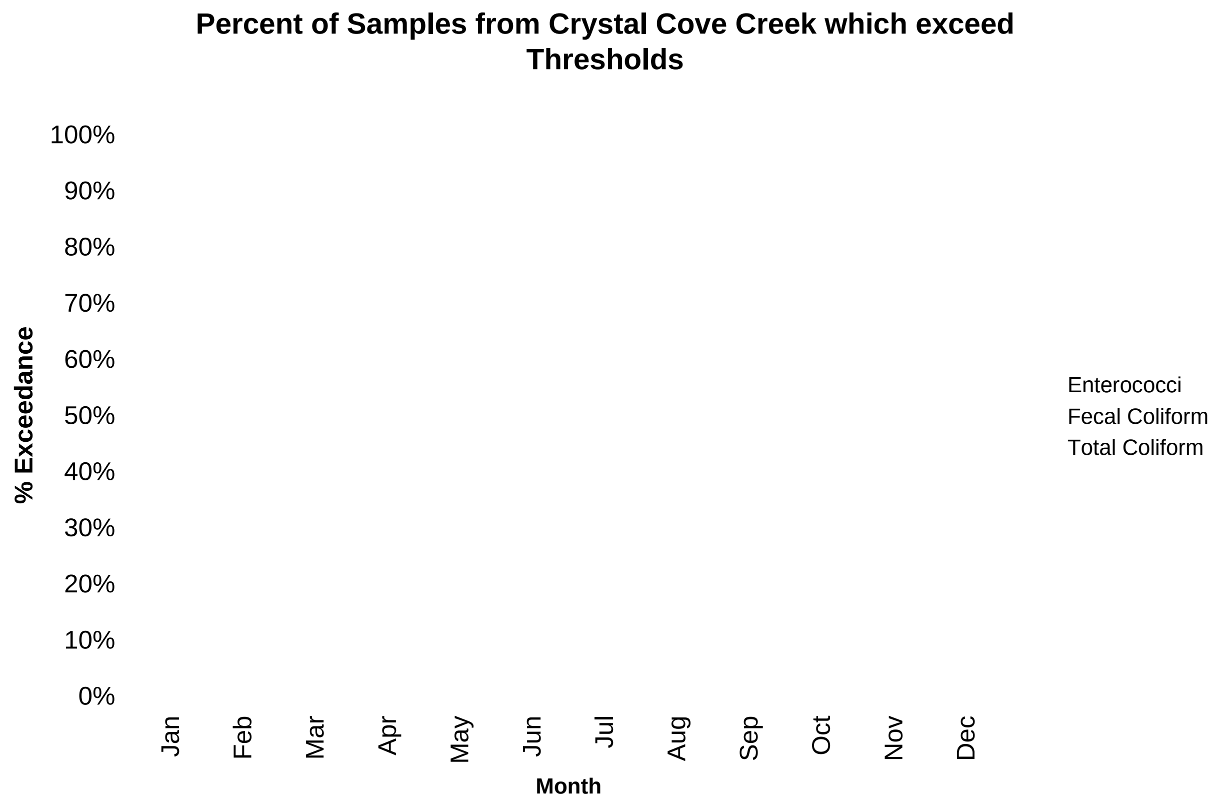
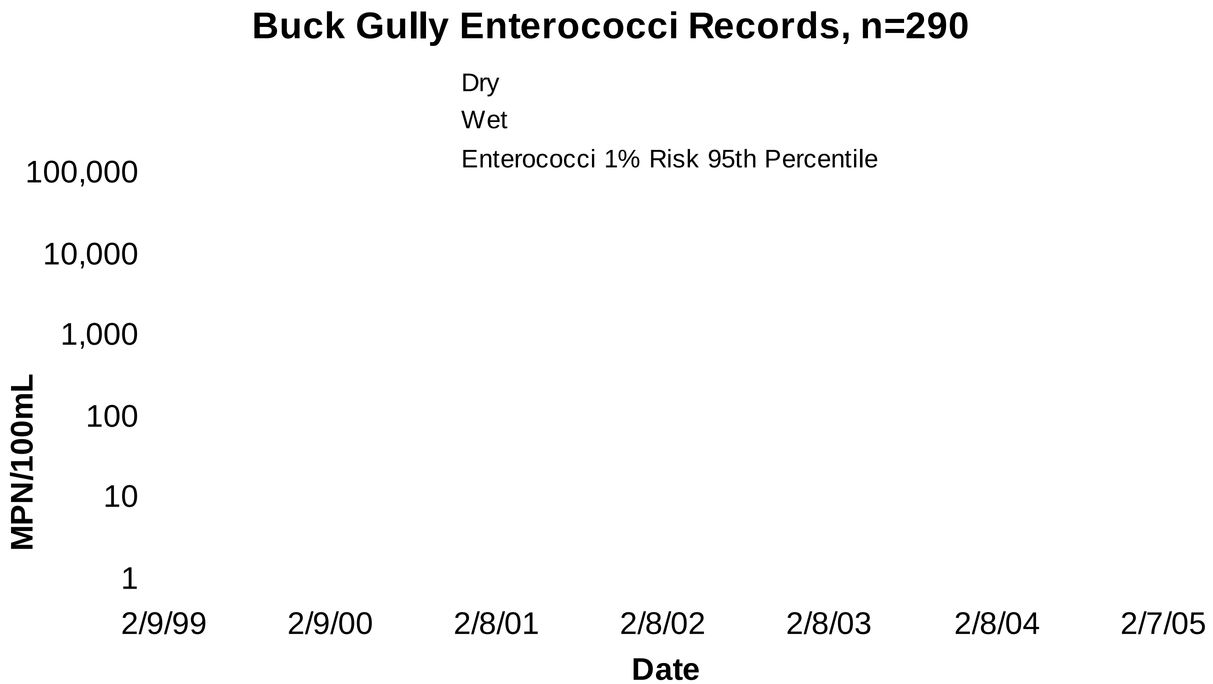


Figure A 46: Buck Gully enterococci data and corresponding cumulative frequency distribution



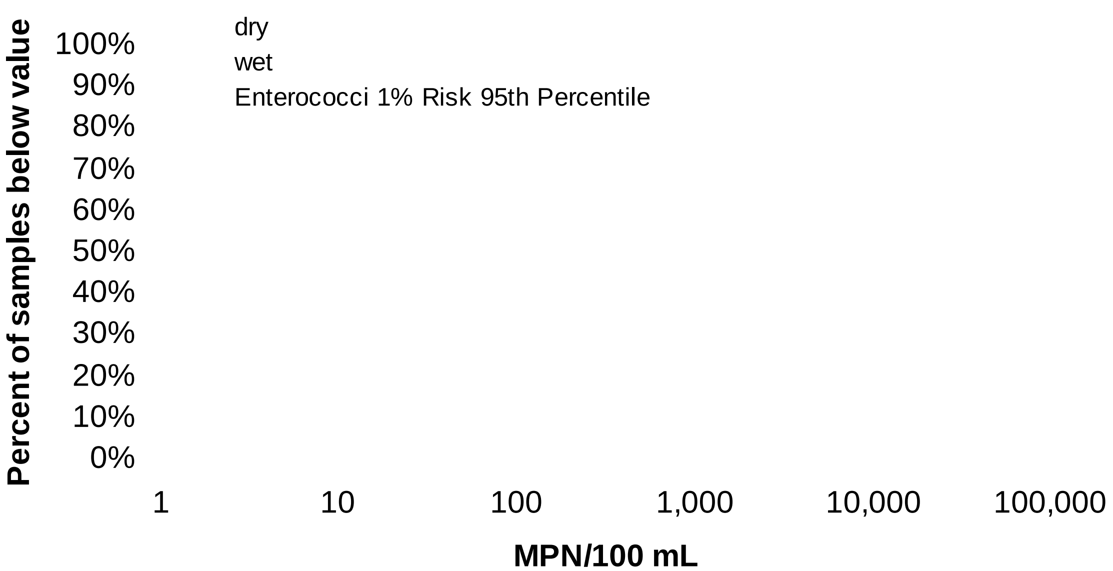
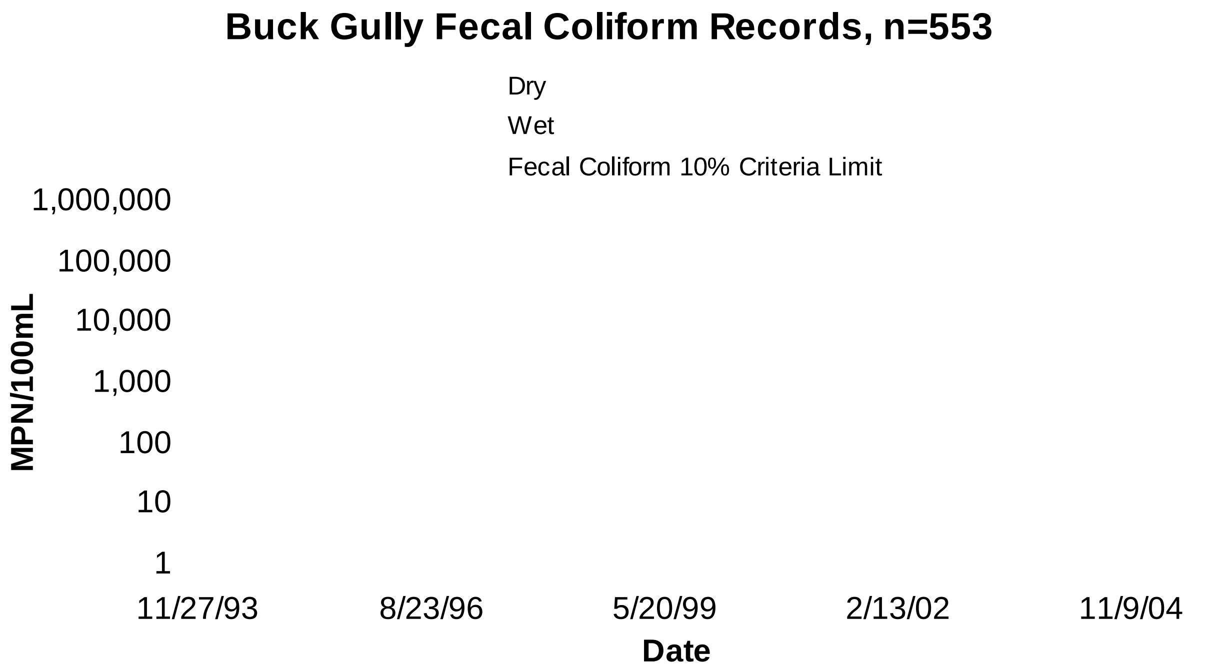


Figure A 47: Buck Gully fecal coliform data and corresponding cumulative frequency distribution



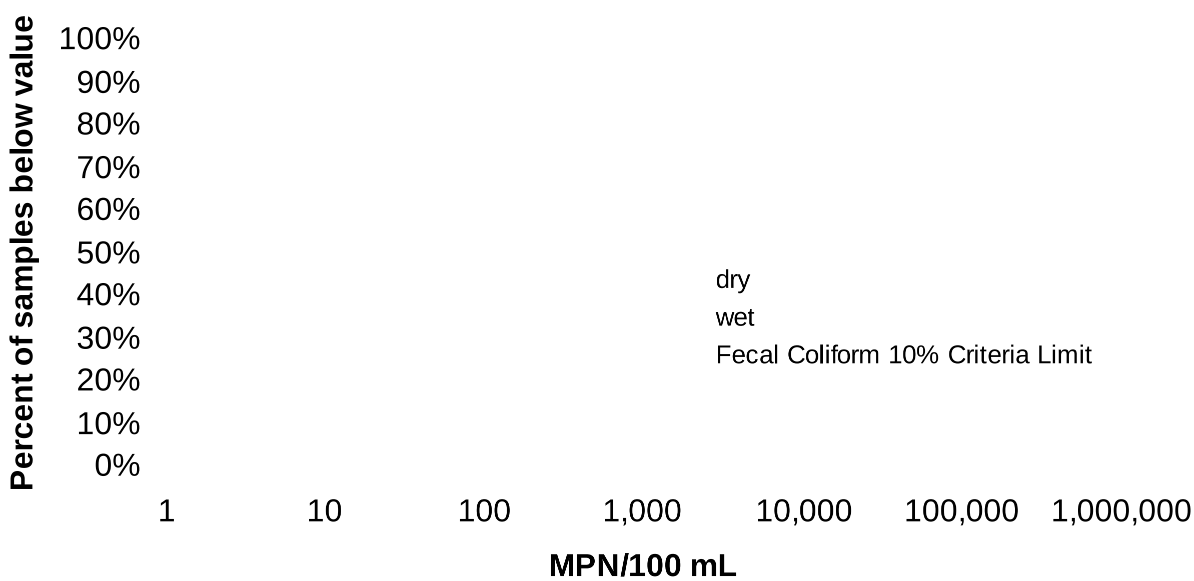
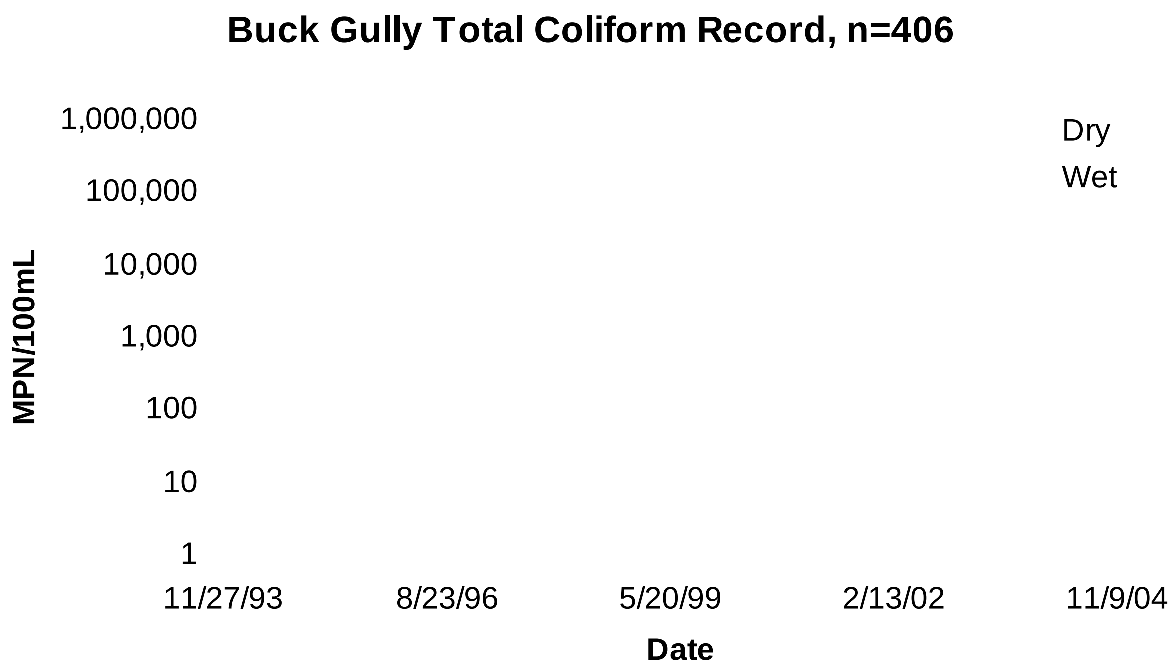


Figure A 48: Buck Gully total coliform data and corresponding cumulative frequency distribution



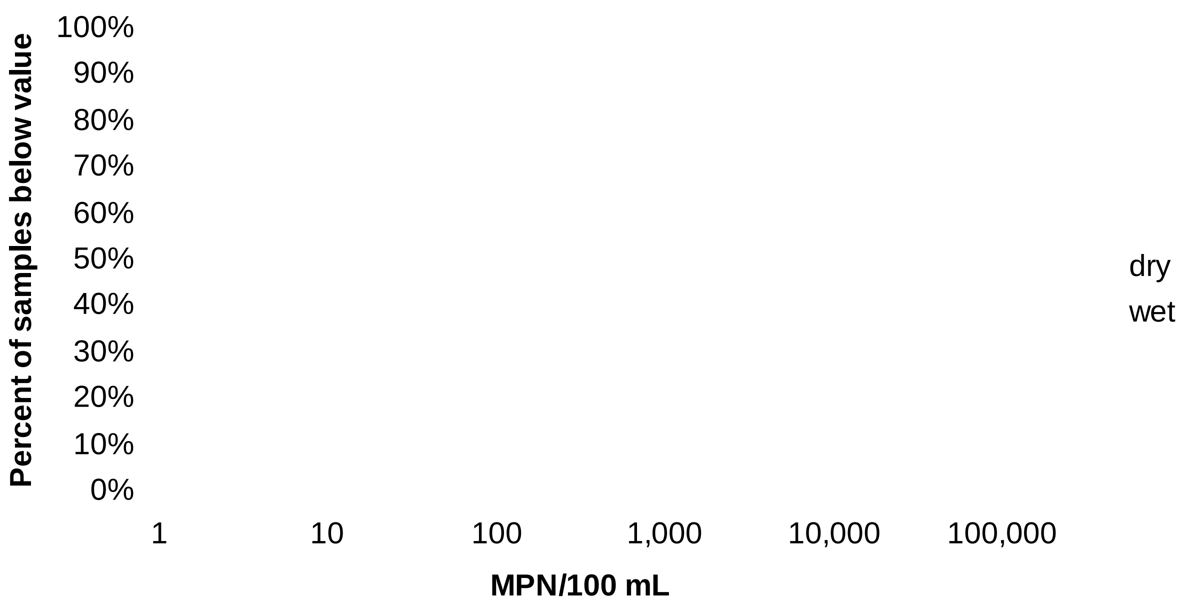


Figure A 49: Percentage of samples from Buck Gully which exceed thresholds, by month

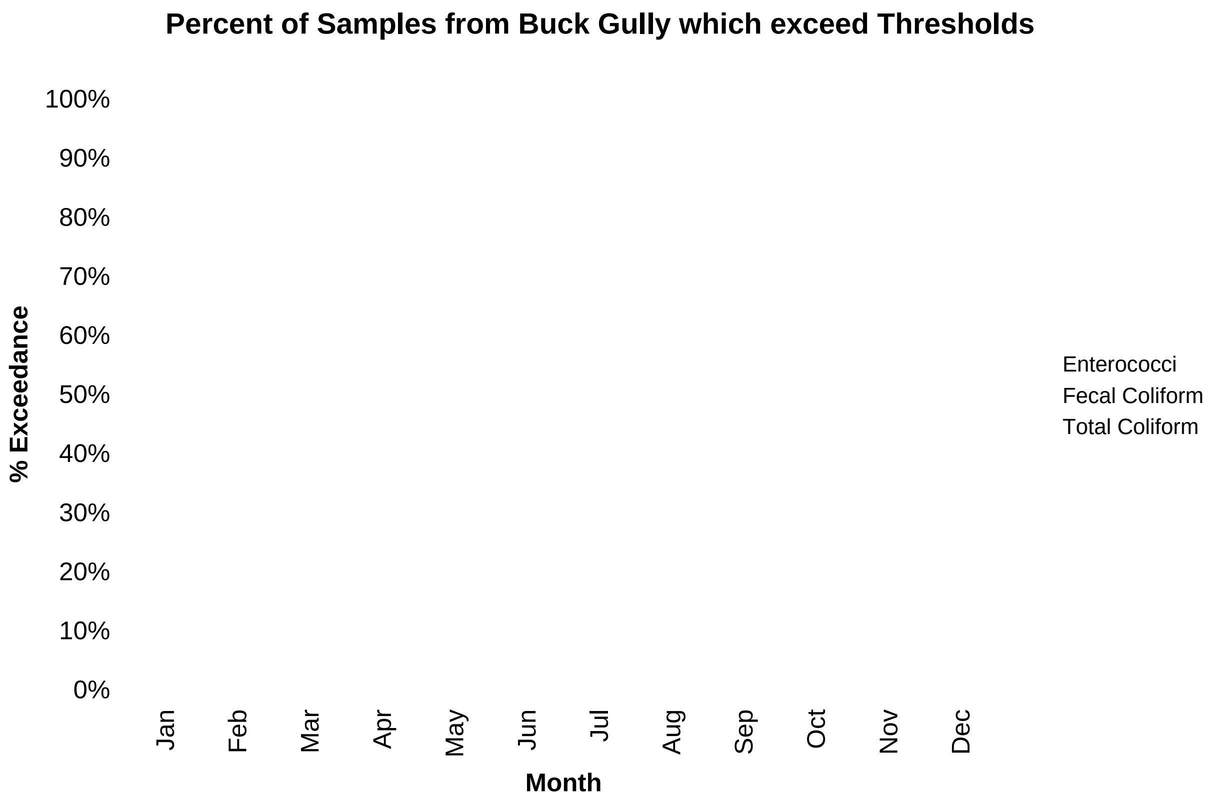
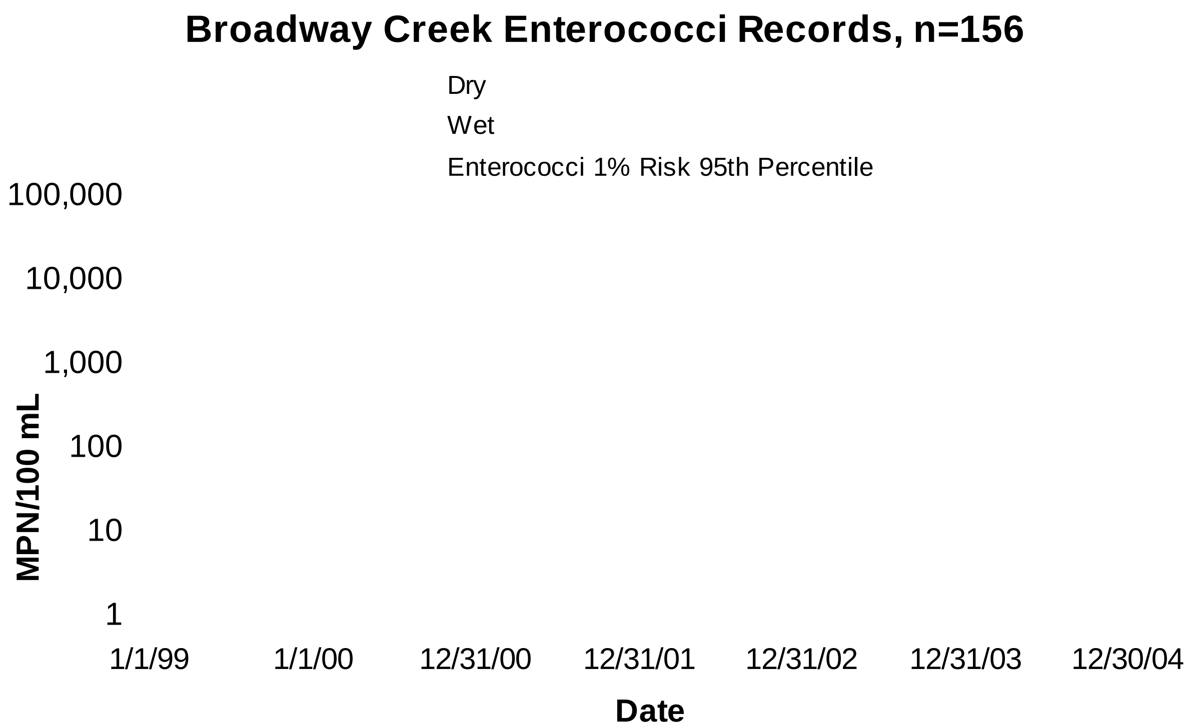


Figure A 50: Broadway Creek enterococci data and corresponding cumulative frequency distribution



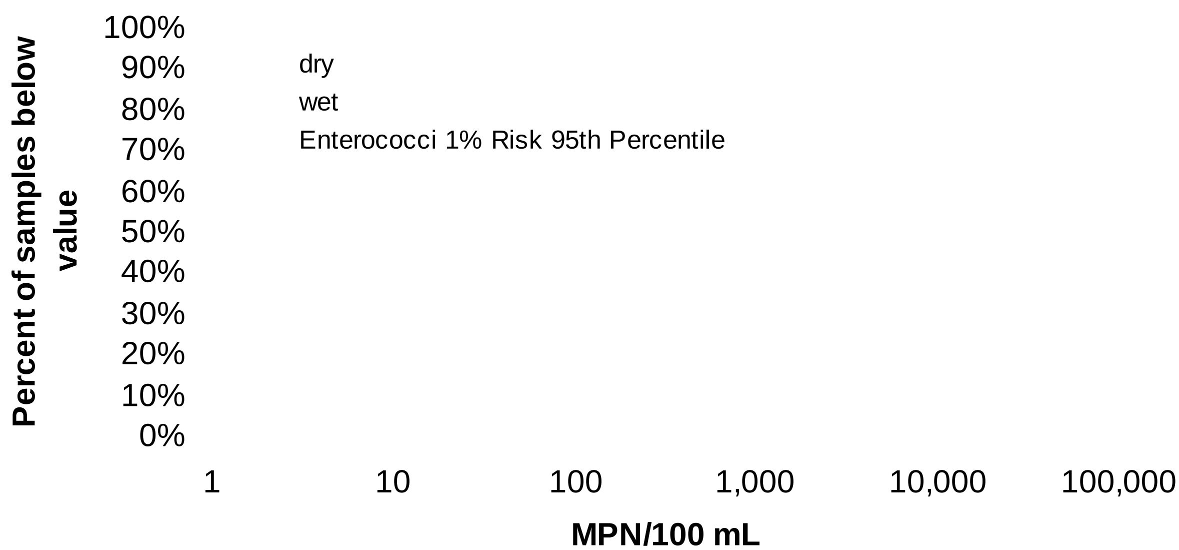
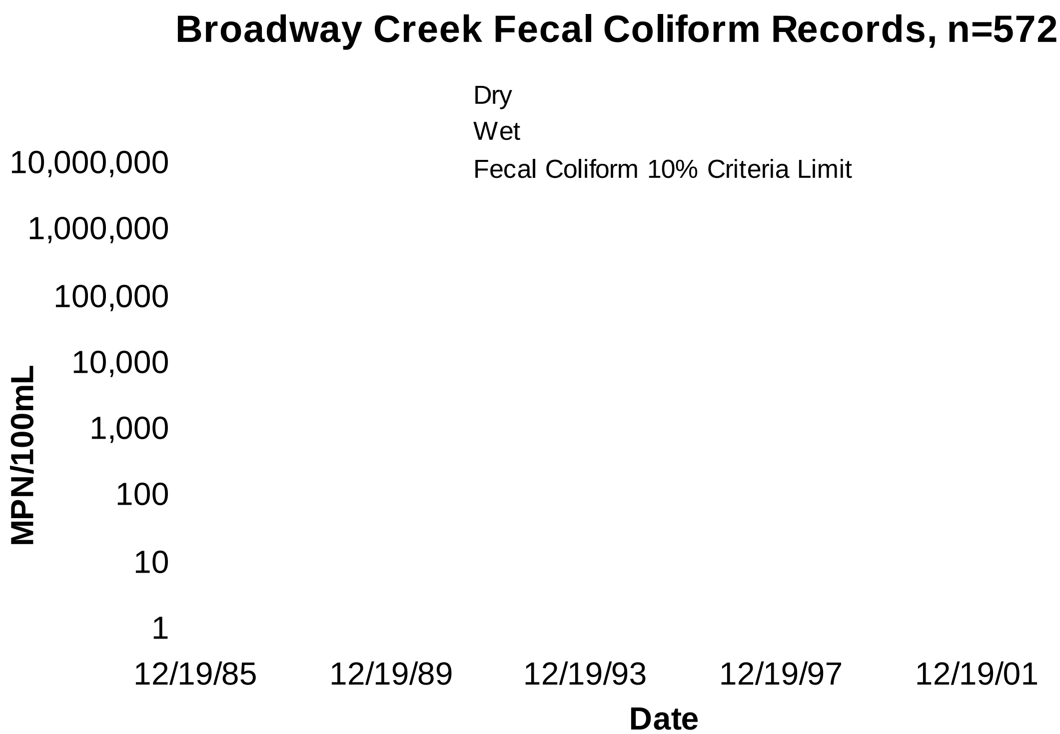


Figure A 51: Broadway Creek fecal coliform data and corresponding cumulative frequency distribution



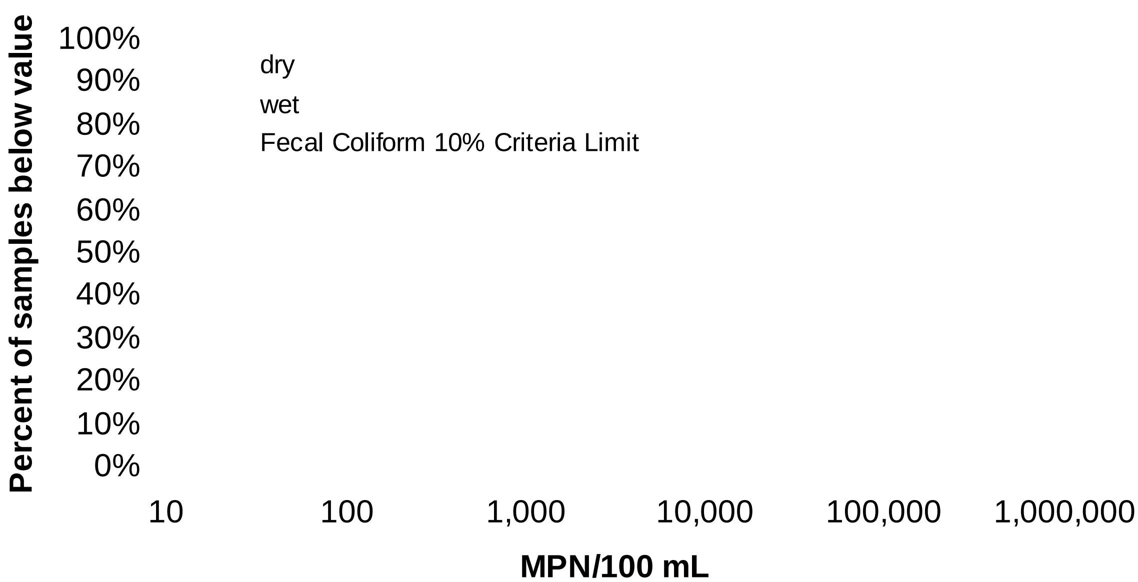
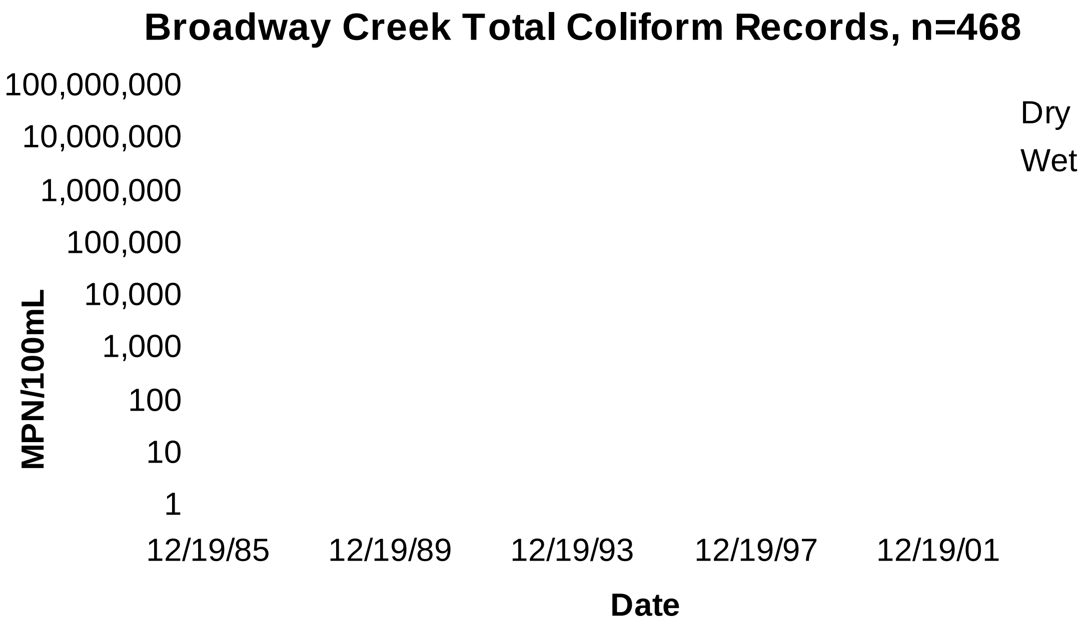


Figure A 52: Broadway Creek total coliform data and corresponding cumulative frequency distribution



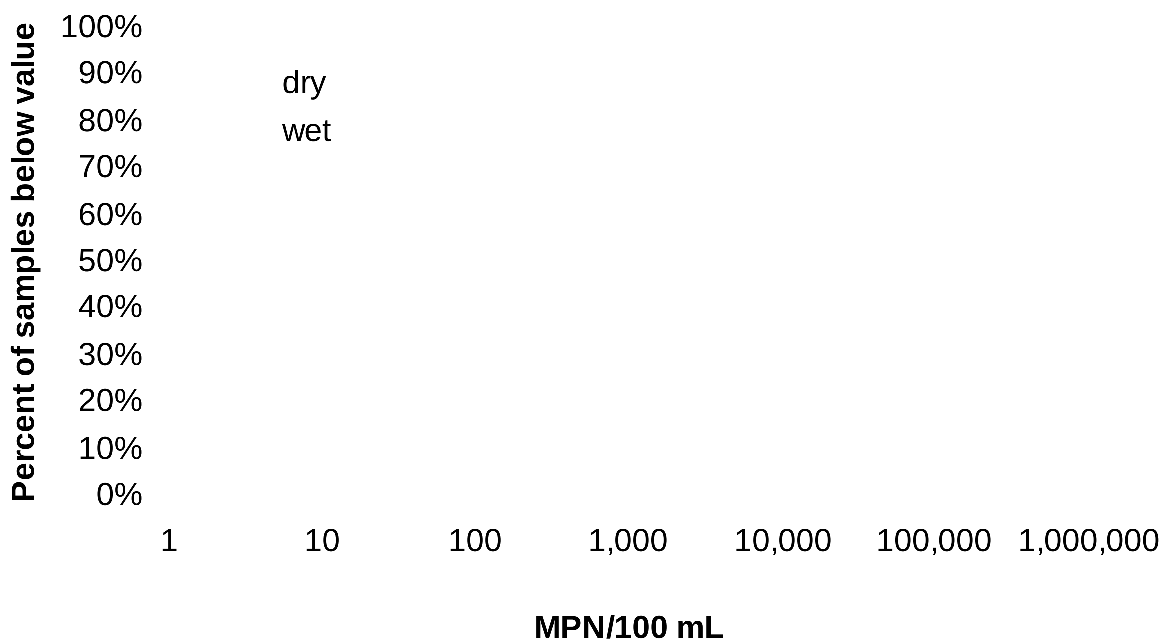
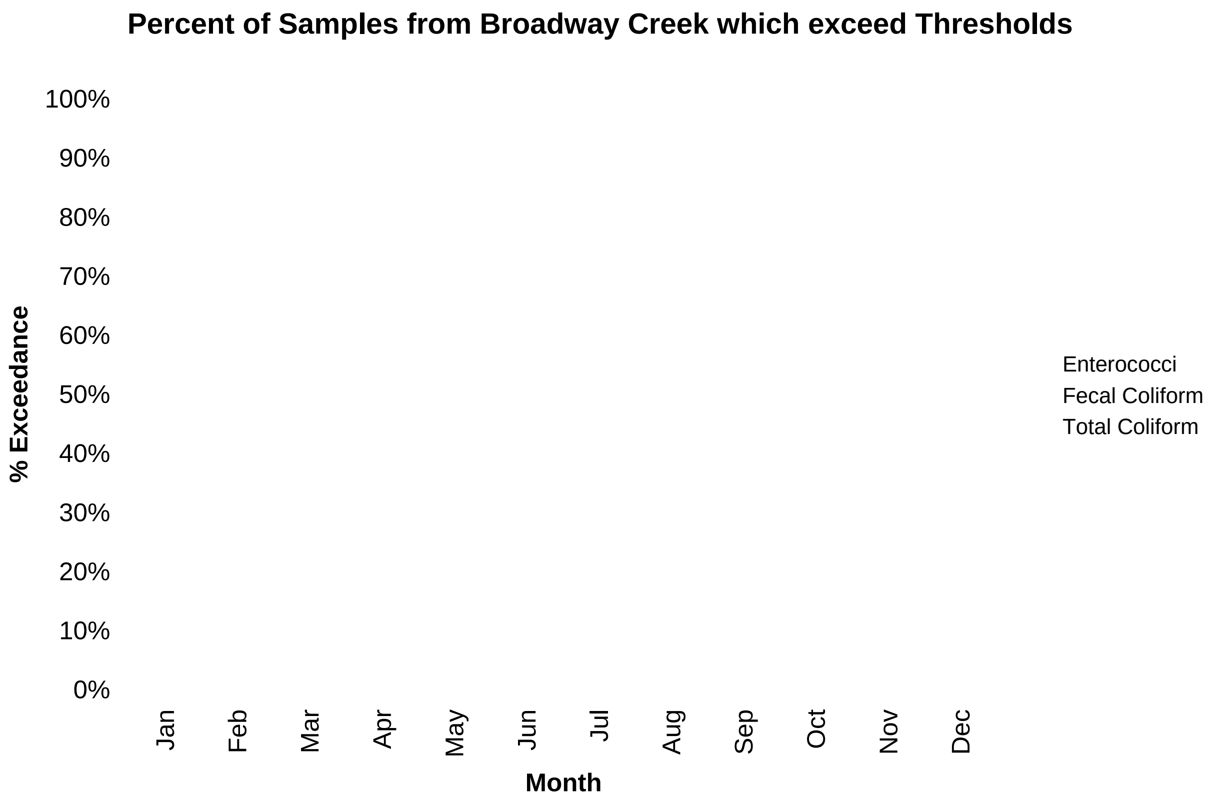


Figure A 53: Percentage of samples from Broadway Creek which exceed thresholds, by month



APPENDIX B

DATA FROM SANTA ANA REGION

FIGURES REPRODUCED FROM CDM 2005

Figure B 1: Santa Ana Watershed and sites selected by CDM for detailed bacteriological analysis (CDM 2005 Figure 19)

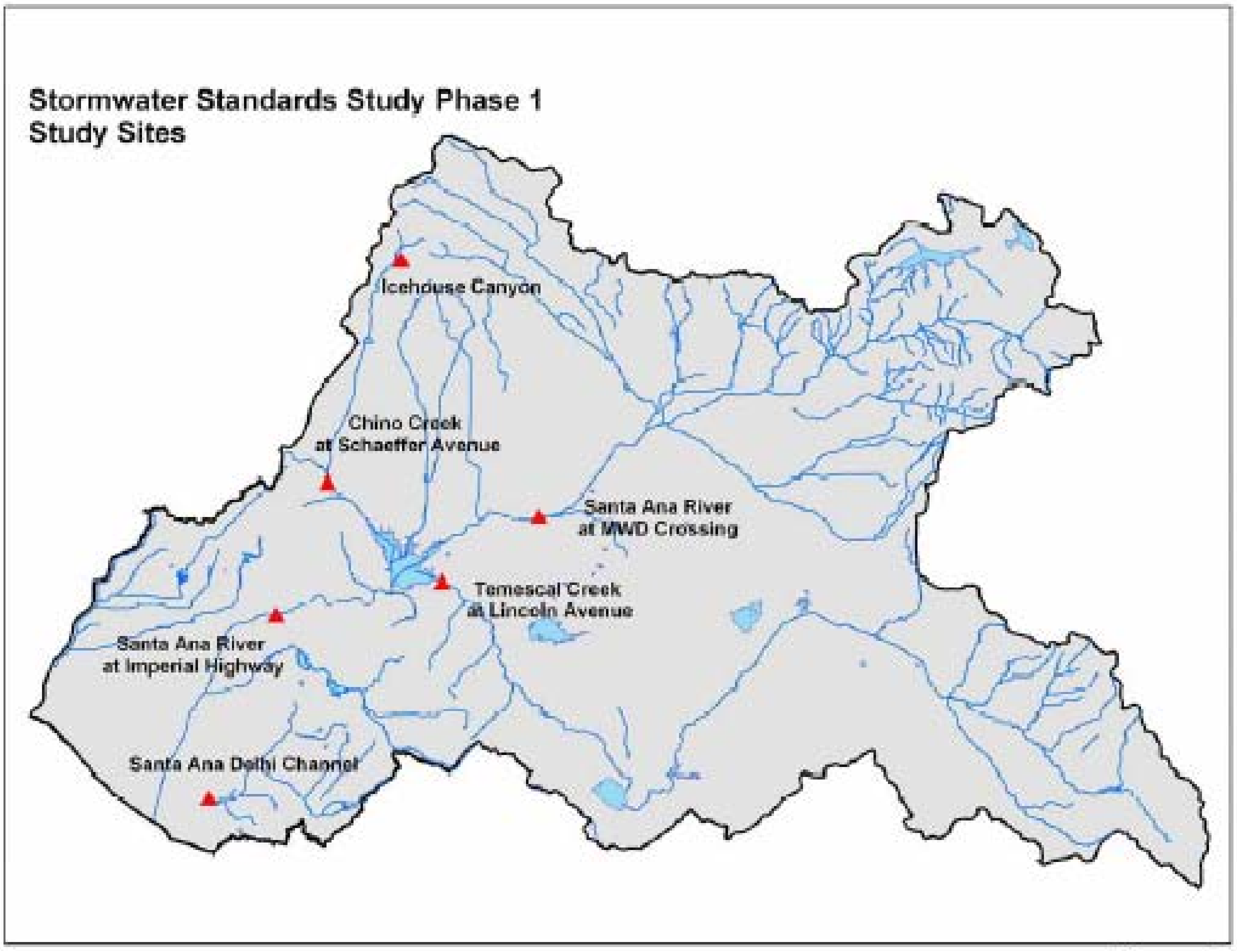


Figure 19
Study Sites Selected for Detailed Analysis

Figure B 2: Flow rate and bacteria concentration, Chino Creek (CDM 2005 Figure 35)

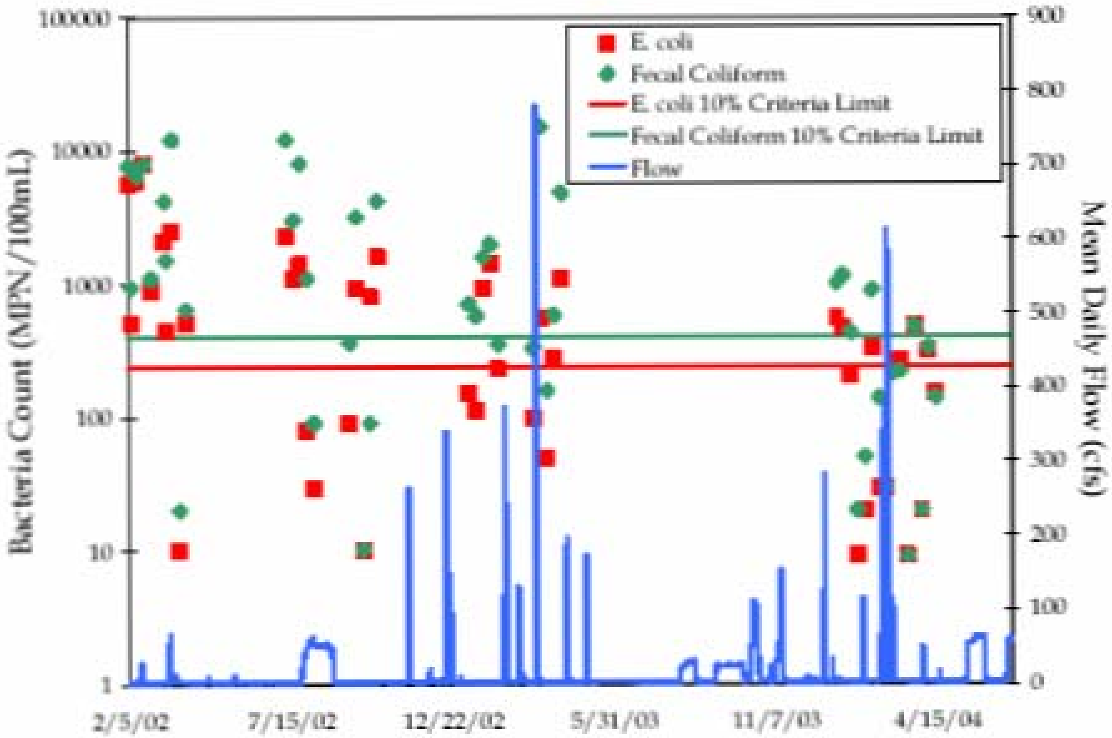


Figure 35
Time Series of Bacteria Counts and Flow at the Chino Creek at Schaeffer Avenue Study Site

Figure B 3: Flow rate and bacteria concentration, Santa Ana Delhi Channel (CDM 2005 Figure 53)

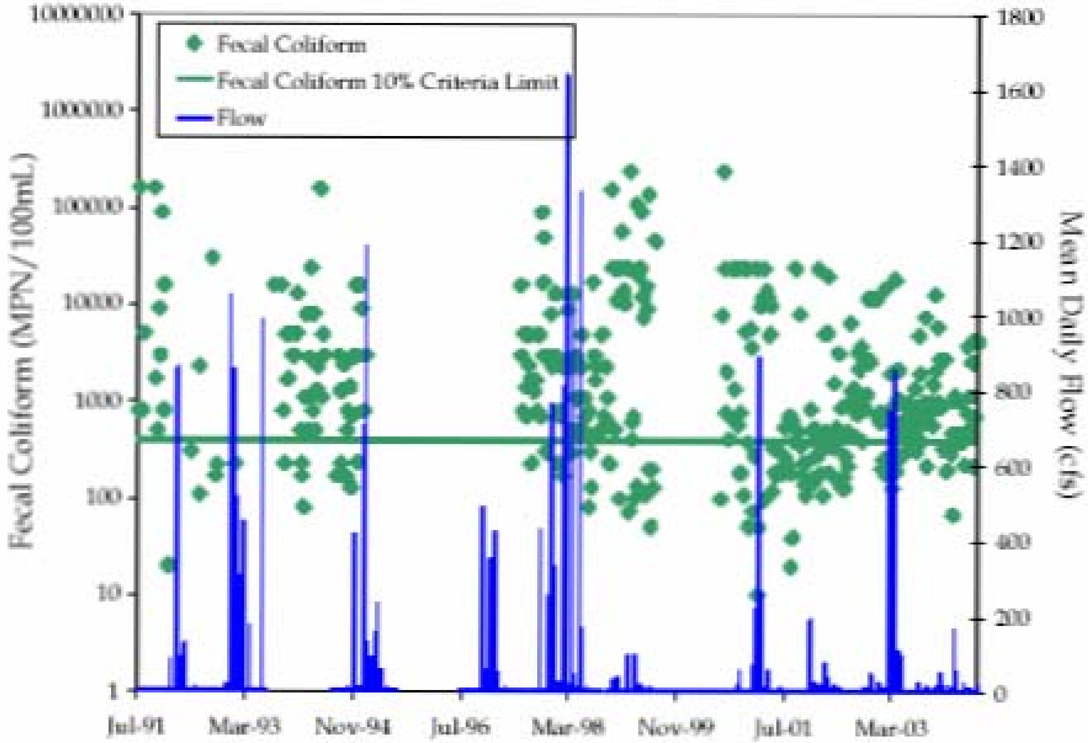


Figure 53
Time Series of Bacteria Concentrations and
Flow in the Santa Ana Delhi Channel - Backbay

Figure B 4: Flow rate and bacteria concentration, Temescal Creek (CDM 2005 Figure 72)

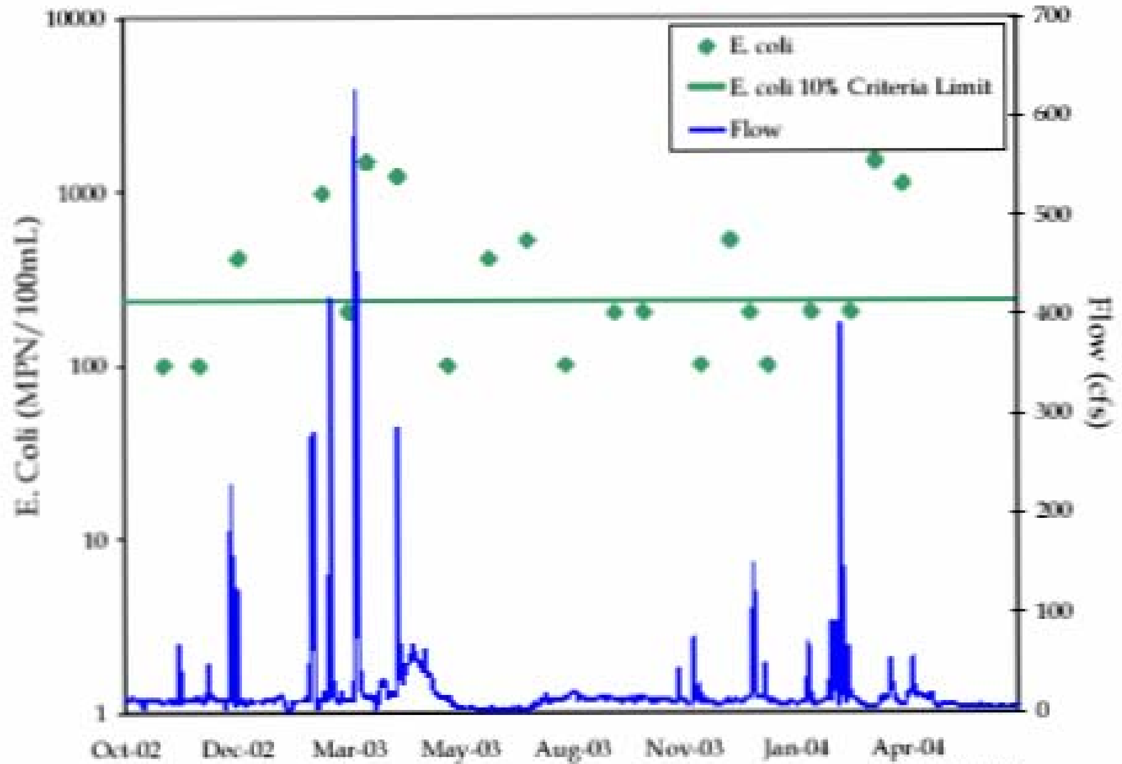


Figure 72
Time Series of Bacteria Concentrations and Flow in Temescal Creek from October 2002 to April 2004

Figure B 5: Flow rate and bacteria concentration, Santa Ana River at MWD Crossing (CDM 2005 Figures 98 and 99)

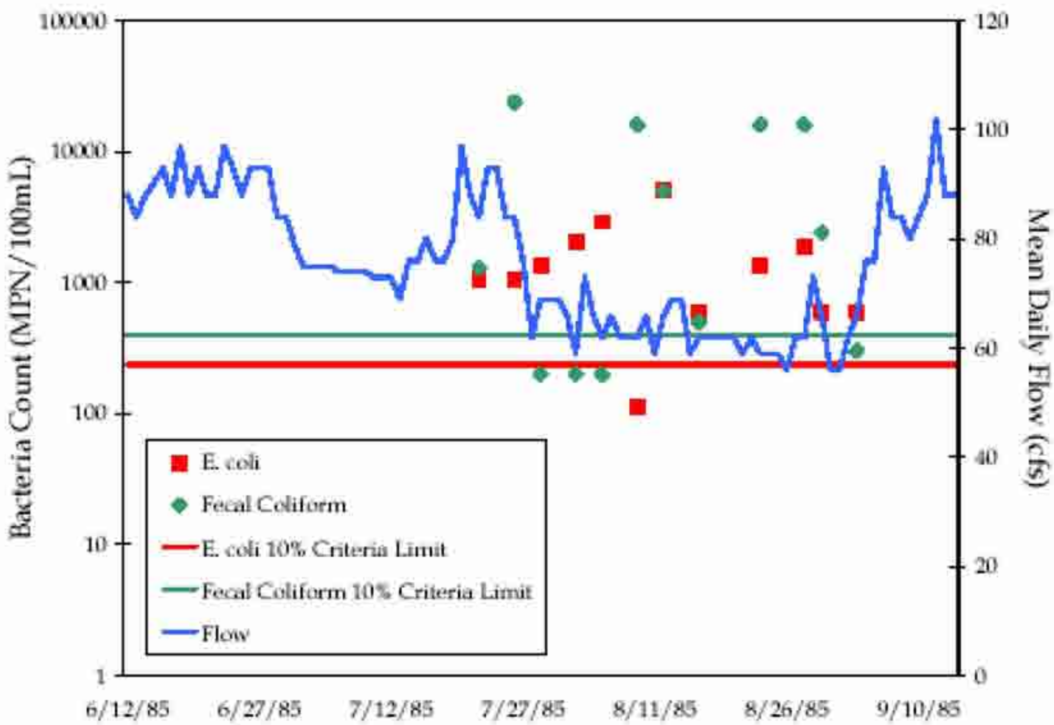


Figure 98
Time Series of Bacteria Concentrations and Flow in the Santa Ana River at the MWD Crossing Study Site

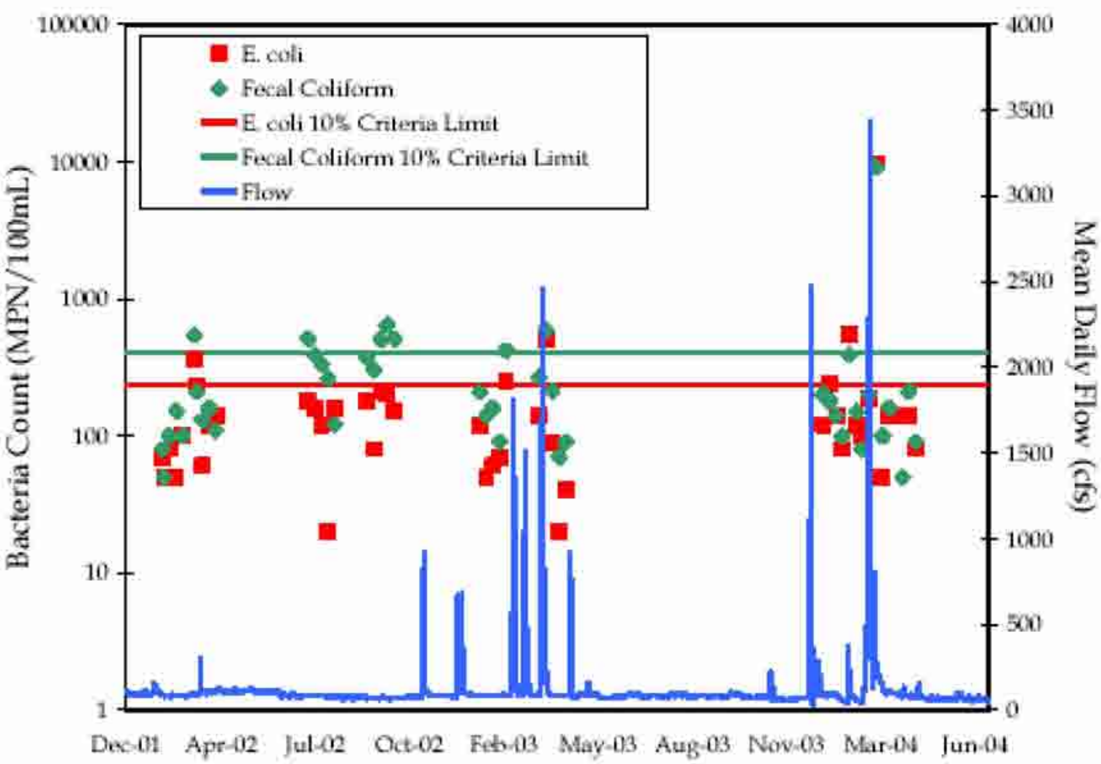


Figure 99
Time Series of Bacteria Concentrations and Flow in the Santa Ana River at the MWD Crossing Study Site

Figure B 6: Flow rate and bacteria concentration, Santa Ana River at Imperial Highway (CDM 2005 Figure 83)

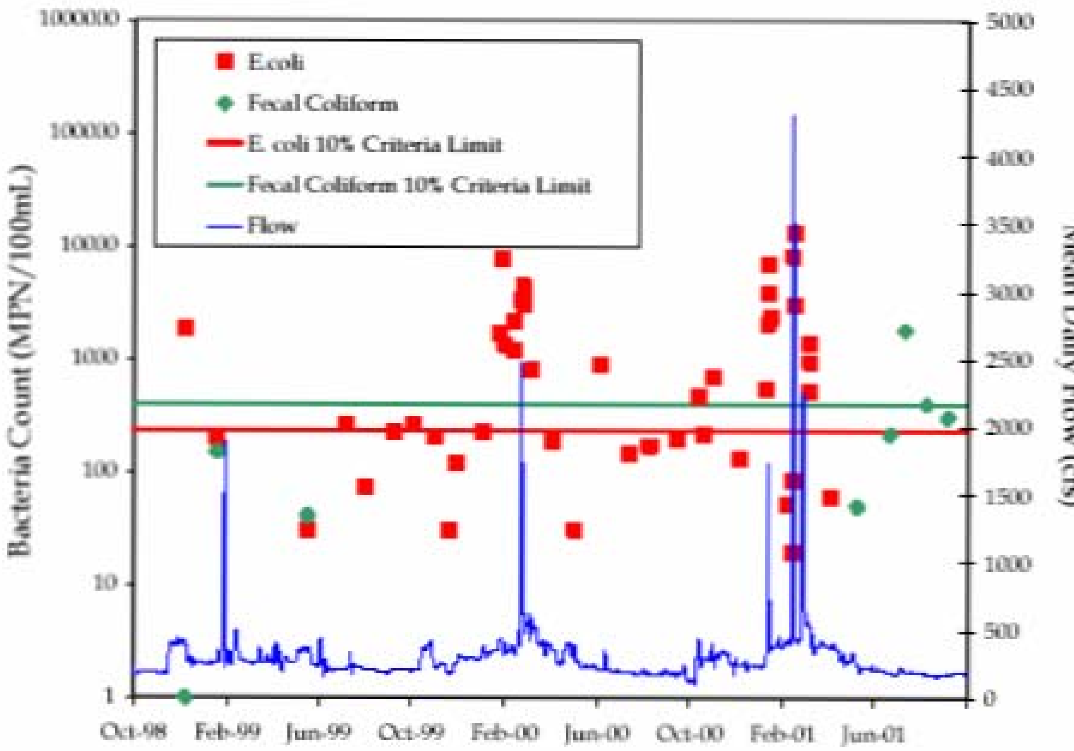


Figure 83
Time Series of Bacteria Concentrations and Flow in the Santa Ana River at the Imperial Highway Study Site

Figure B 7: Flow rate and bacteria concentration, Santa Ana River at Imperial Highway (CDM 2005 Figure s 84 and 85)

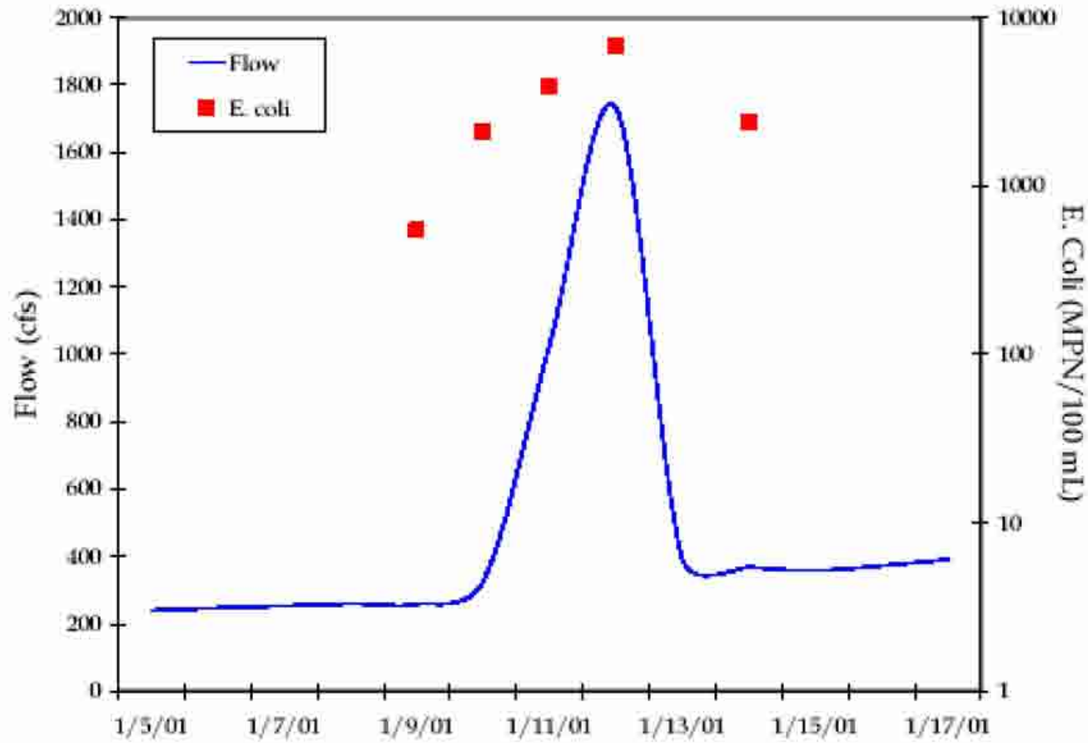


Figure 84
January 2001 Wet Weather E. coli Sampling Event

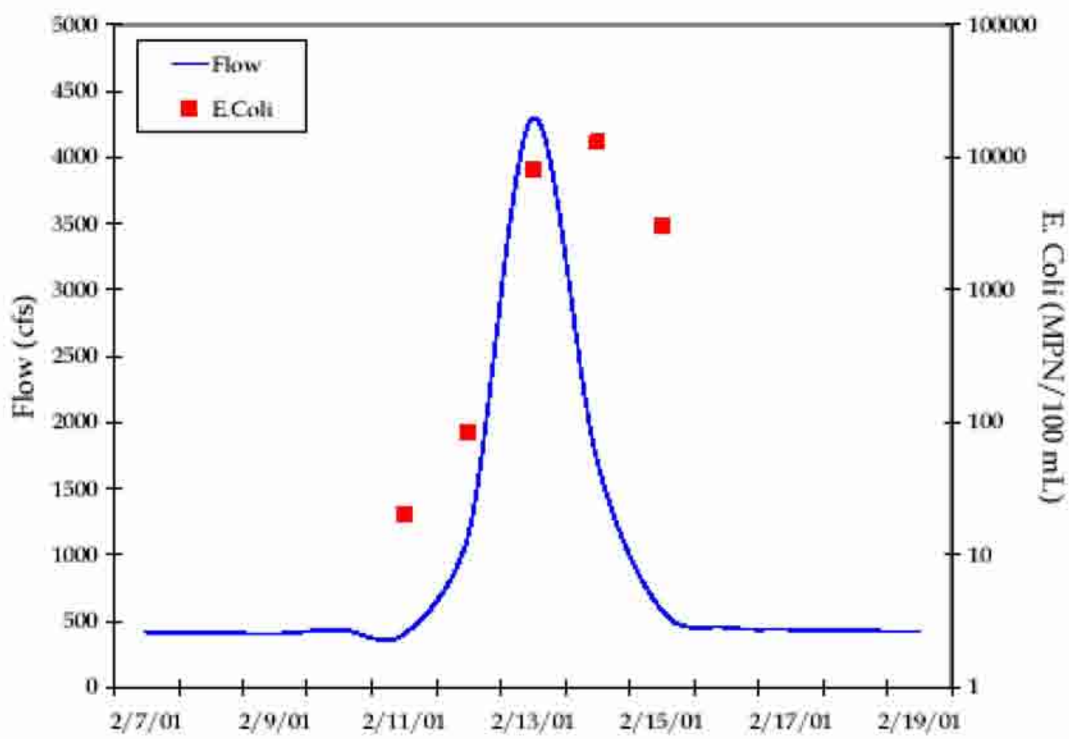


Figure 85
February 2001 Wet Weather E. coli Sampling Event

Figure B 8: Percent of months exceeding objectives (CDM 2005 Figure 102)

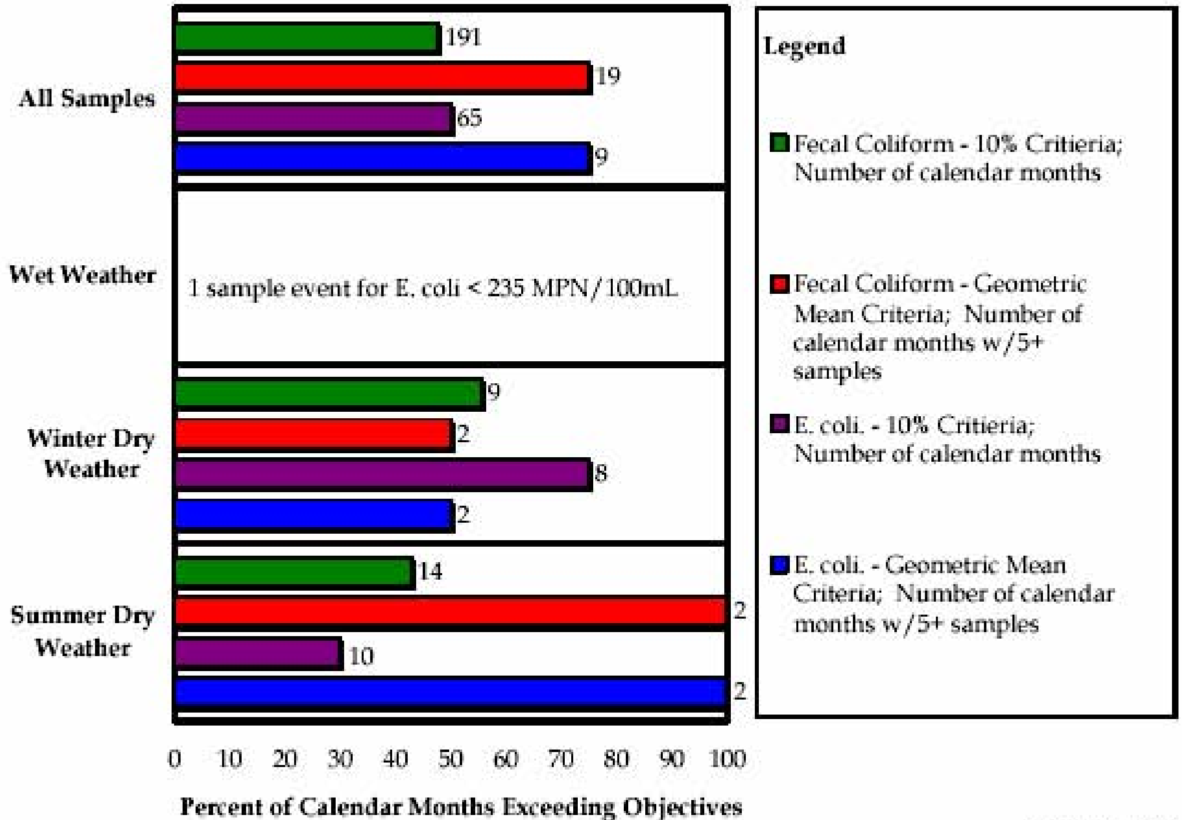


Figure 102
Comparison with Existing and Potential Bacteria Water Quality Objectives
Santa Ana River at MWD Crossing

Figure B 9: Percent of months exceeding objectives (CDM 2005 Figure 110)

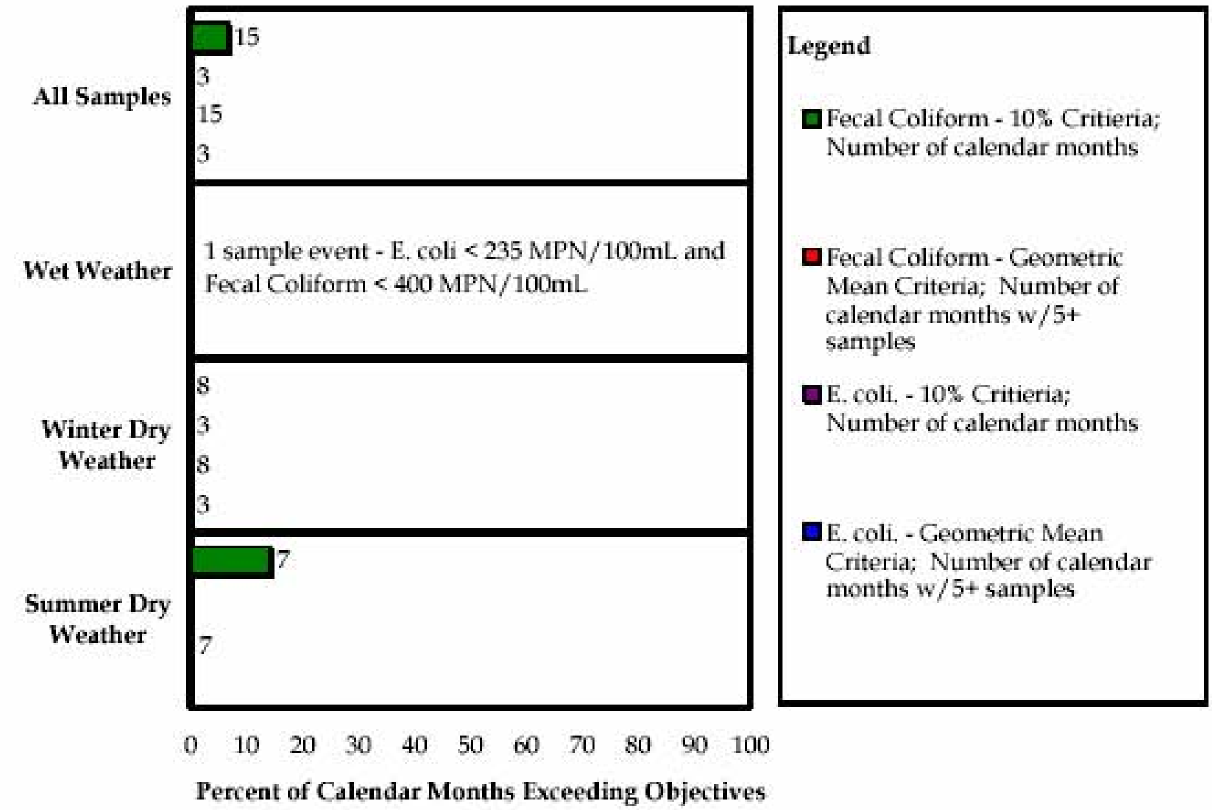


Figure 110
Comparison with Existing and Potential Bacteria Water Quality Objectives
Icehouse Canyon Creek

Figure B 10: Percent of months exceeding objectives (CDM 2005 Figure 88)

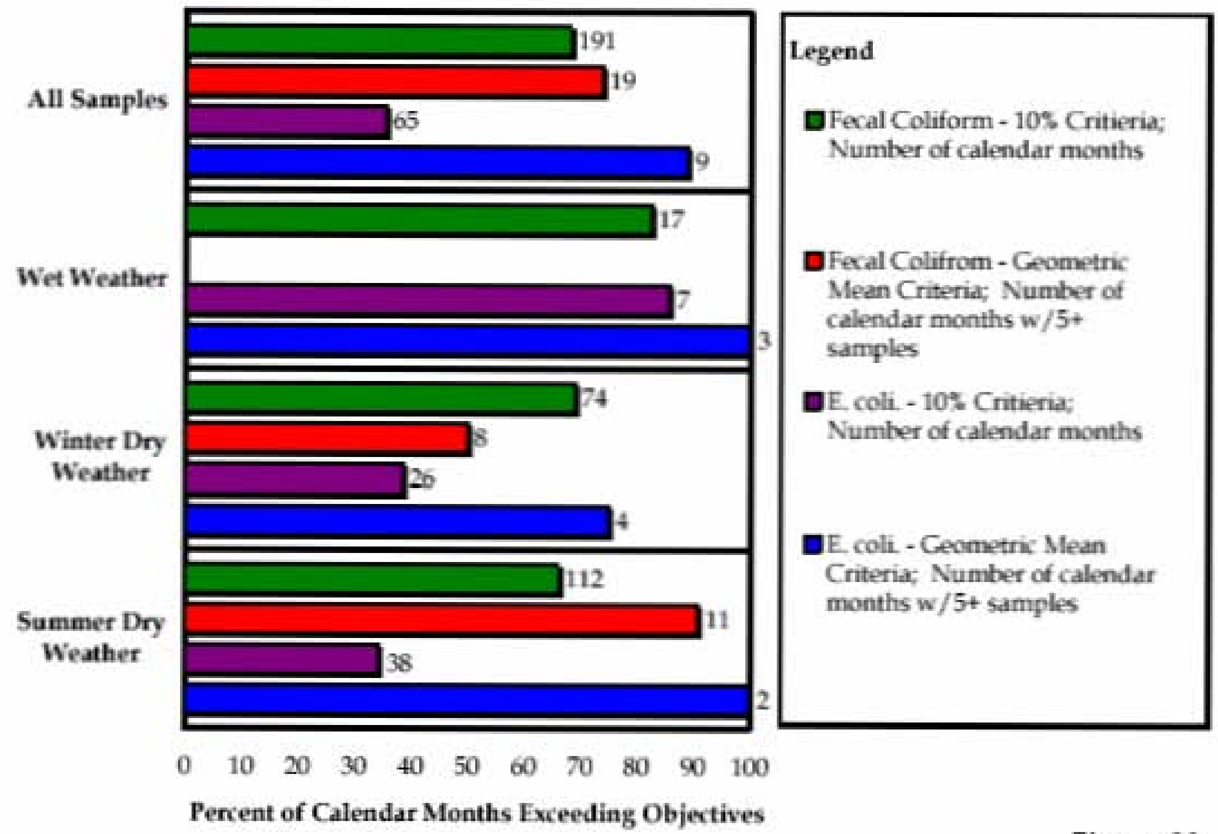


Figure 88
Comparison with Existing and Potential Bacteria Water Quality Objectives
Santa Ana River at Imperial Highway

Figure B 11: Percent of months exceeding objectives (CDM 2005 Figure 74)

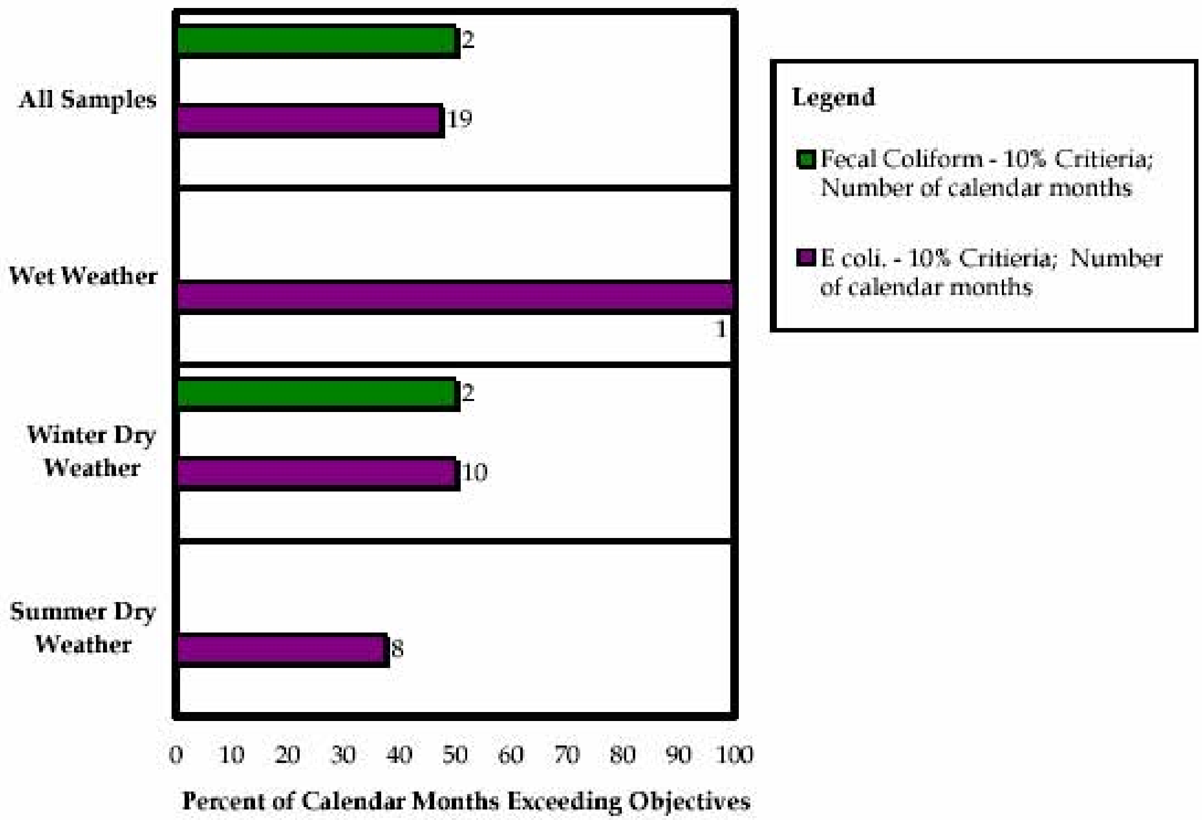


Figure 74
Comparison with Existing and Potential Bacteria Water Quality Objectives
Temescal Creek Near Lincoln Avenue

Figure B 12: Percent of months exceeding objectives (CDM 2005 Figure 38)

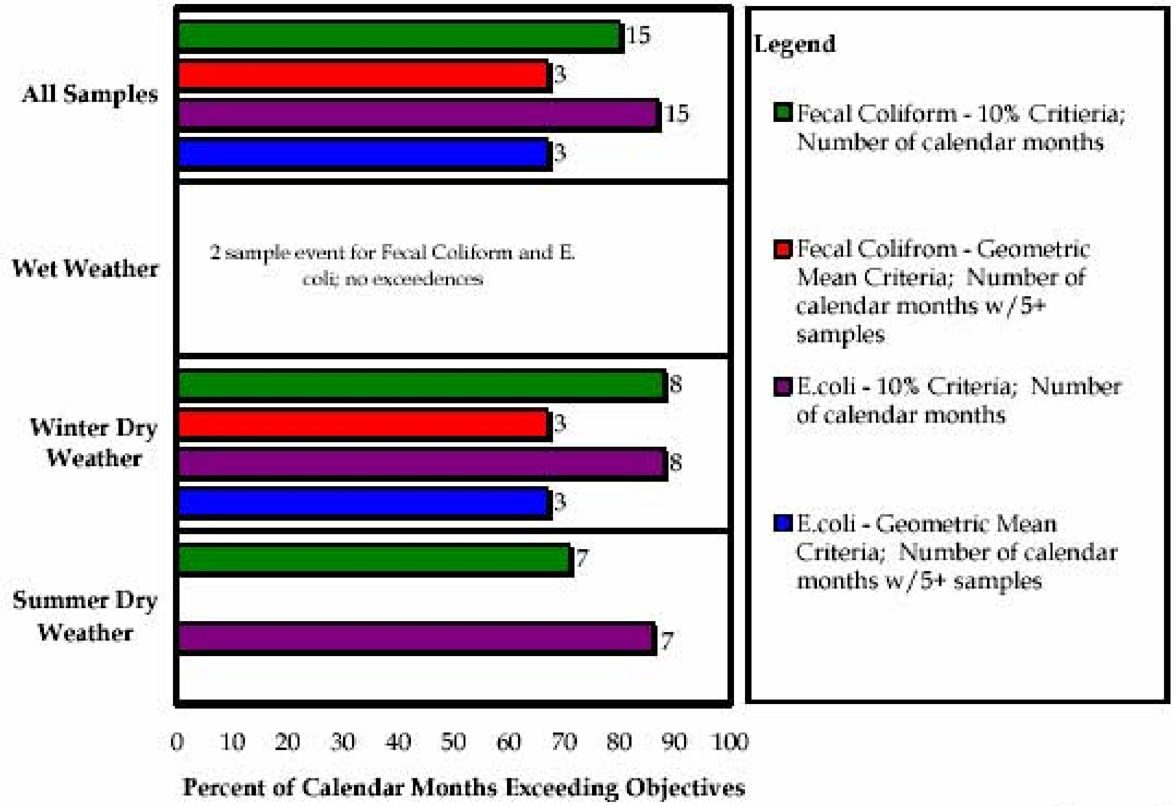


Figure 38
Comparison with Existing and Potential Bacteria Water Quality Objectives
Chino Creek At Schaeffer Ave.

Figure B 13: Percent of months exceeding objectives (CDM 2005 Figure 57)

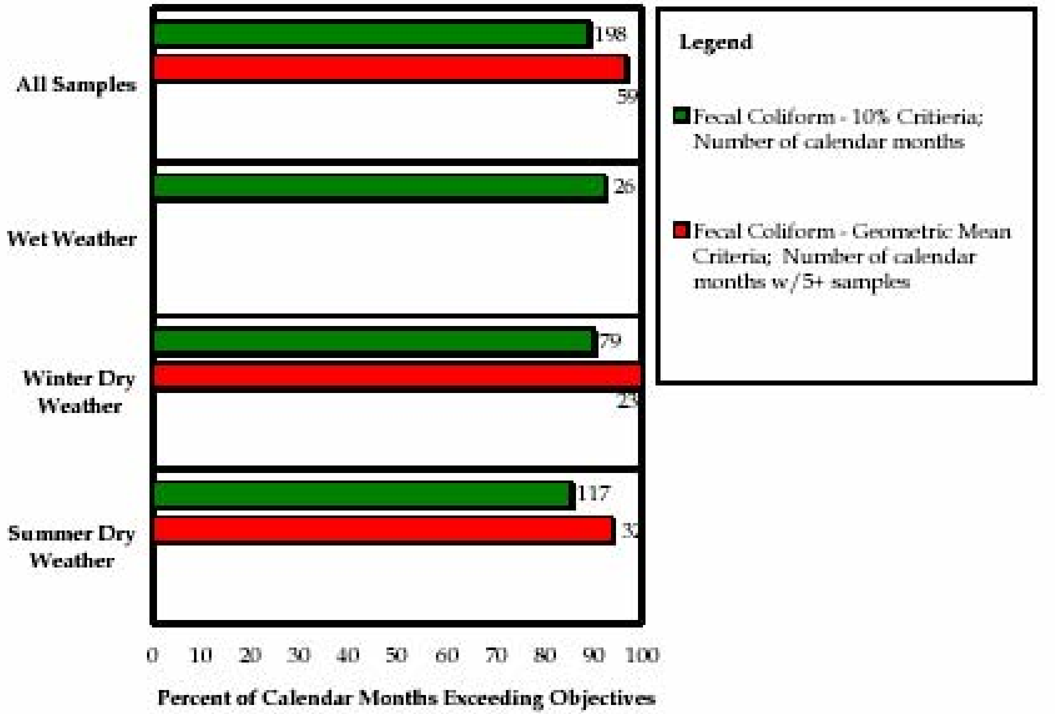


Figure 57
Comparison with Existing and Potential Bacteria Water Quality Objectives
Santa Ana Delhi Channel near Irvine Ave.

APPENDIX C

DATA FROM ALISO CREEK

G E O S Y N T E C   C O N S U L T A N T S

838 SW First Avenue, Suite 530
Portland, Oregon 97204

(503) 222-9518
(503) 242-1416 Fax

MEMORANDUM

TO: SUSAN PAULSEN, FLOW SCIENCE

FROM: BRUCE WILLIAMSON, LISA AUSTIN, GEOSYNTEC CONSULTANTS

SUBJECT: ALISO CREEK BMP EFFECTIVENESS ANALYSIS

DATE: APRIL 13, 2005

CC: PETER MANGARELLA, GEOSYNTEC CONSULTANTS

Introduction

This purpose of this technical memorandum is to assess the efficacy of Best Management Practices (BMPs) installed in parts of Aliso Creek, Orange County, California (Figure 1) on the removal of pathogen indicators. Pathogen indicator data collected by Orange County Resources and Development Management Department in this watershed and on these BMPs has received increasing attention when project design features are evaluated by regulatory authorities. Therefore, it is important that we have a good understanding of these findings and their uncertainties.

The two BMPs assessed in this memo are:

1. Dry weather flows are passed through multimedia filtration/UV sterilization using a proprietary treatment unit 'Clear Creek Systems'. This treats low flow runoff from a two square mile catchment with mixed urban land use. The storm drain facility and catchment are designated as J01P28 in the watershed map and plans (Figure 1, 2B).

2. Wetland ponds to intercept watershed runoff and treat dry weather flow and first flush. These treat low flow and first flush runoff from a two square mile residential catchment. The storm drain facility and catchment are designated as J03P02 in the watershed map and plans (Figure 1, 2A).

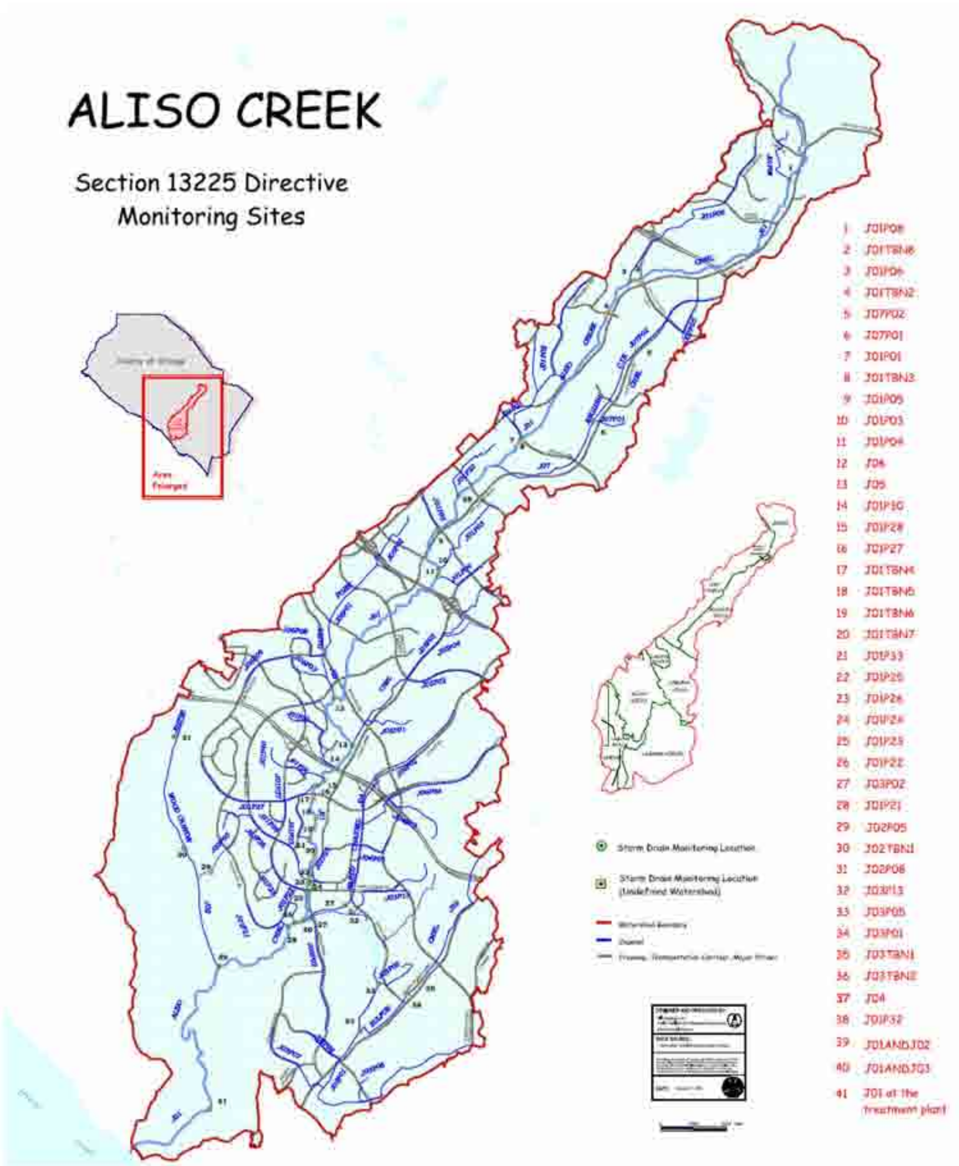
All monitoring of the BMPs and their receiving waters took place during dry weather. Consequently, low flows were mostly sampled, but during the wet season a proportion of these were probably elevated flows during storm recessions.

The data were collected by the County of Orange and its city partners and is available in reports listed at http://www.ocwatersheds.com/watersheds/Aliso_reports_studies.asp, and also in Evaluation Reports by the County of Orange.[1,2]

[1] County of Orange Resources and Development Management Department, Watershed and Coastal Resources Division. 'Aliso Creek Clean Beaches Initiative. Final Report for Agreement 01-227-550-0' submitted to Regional

Note that the Aliso Creek watershed Quarterly Progress Reports (QPR) refer to other BMPs installed in stormwater drains of urban watersheds at a number of locations in the Aliso Creek watershed. These include grassy swales for treating park runoff to Sulfur Creek in Laguna Niguel and a wetland biofilter in another branch of Sulfur Creek in Laguna Hills The status of the these BMPs is unclear, and no monitoring data for these BMPs were located in the QPR.

Figure 1



and State Boards in January 2005 and 'Wetland Capture and Treatment Final Report for Agreement No. 01-122-259-0' submitted to Regional and State Boards in March 2004.

[2] "Wetland Capture and Treatment Final Report for Agreement No. 01-122-259-0" submitted to Regional and State Boards in March 2004.

Figure 2A: Location of J03P02

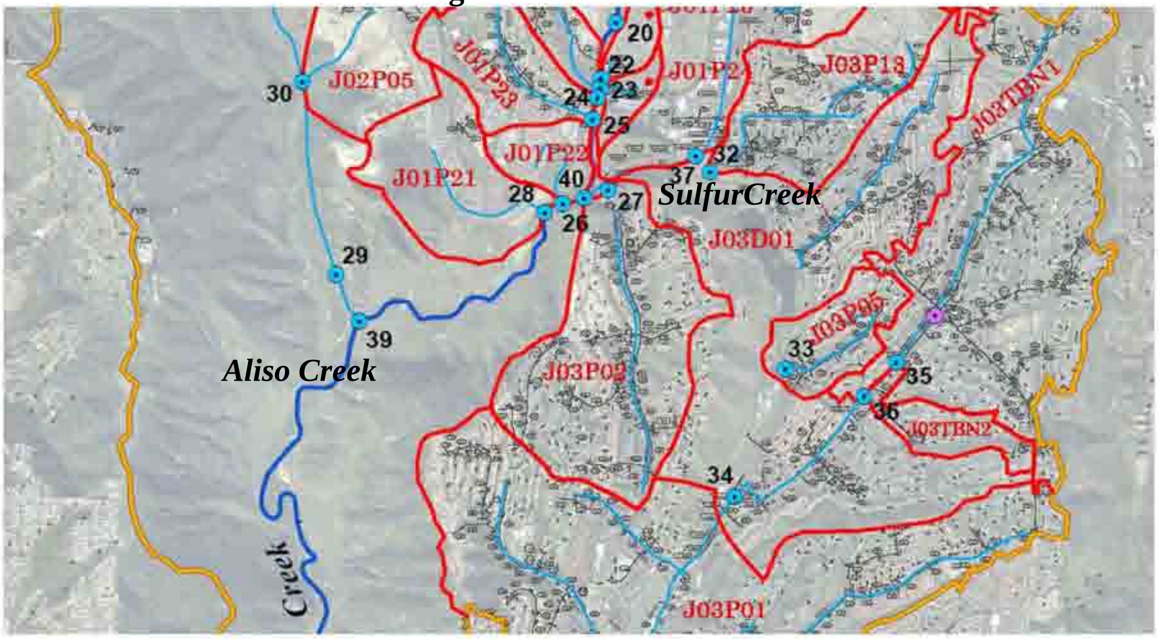
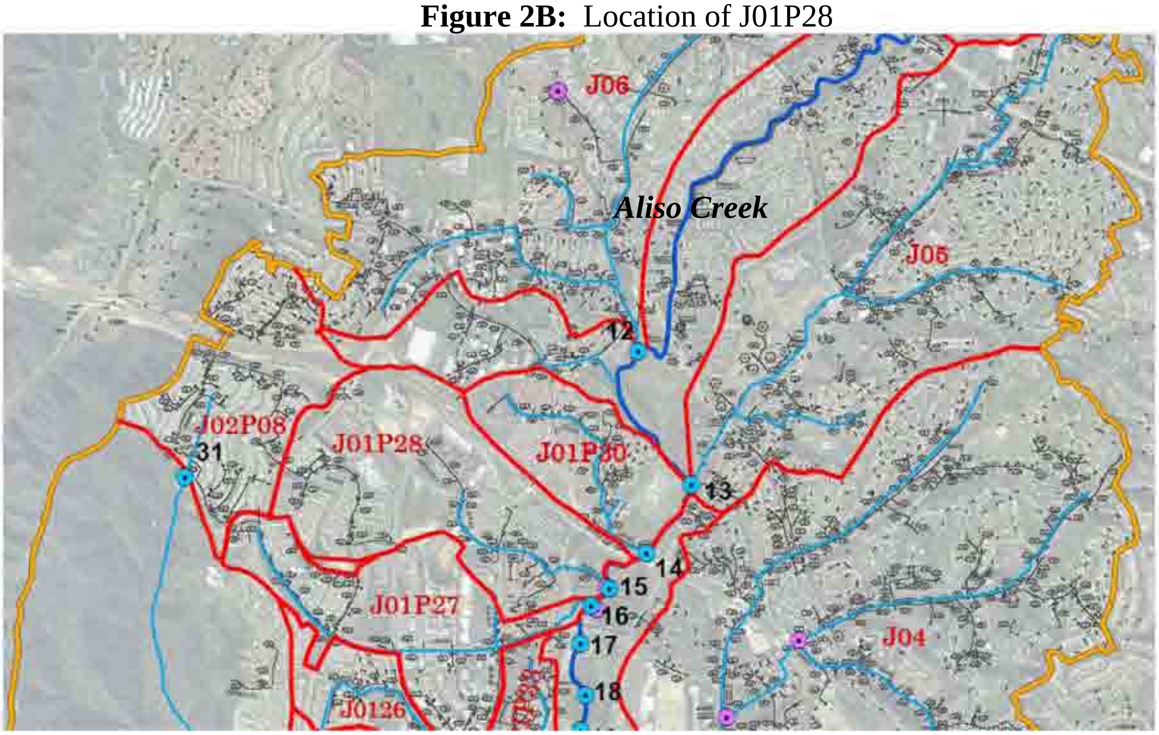


Figure 2B: Location of J01P28



Site Description

Aliso Creek Watershed

Aliso Creek watershed encompasses 30.4 square miles and includes portions of the cities of Aliso Viejo, Dana Point, Laguna Niguel, Laguna Woods, Laguna Beach, and Lake Forest. Its main tributary, Aliso Creek, originates in the Santa Ana Mountains inside the boundaries of the Cleveland National Forest. Smaller tributaries include Wood Canyon, Sulphur Creek, the Aliso Hills Channel, and English Channel (Figure 1).

Aliso Creek is the subject of a Directive issued by the San Diego Regional Water Quality Control Board (RWQCB) in 2001 for an investigation of urban runoff in the Aliso Creek watershed. The Directive found that the Permittees may be discharging waste with high bacteria levels from municipal storm drain outfalls into Aliso Creek and its tributaries. The Directive required the Permittees to begin a comprehensive monitoring program and undertake investigations within the storm drain system to identify the causes of the problem and the control actions needed to correct the problem. This has resulted in a comprehensive study involving weekly sampling of approximately 35 storm drains and their respective receiving waters, and numerous other initiatives in identifying sources and source control.

Part of the creek (J03P02) is subject to a Cleanup and Abatement Order (CAO) issued by the RWQCB in 1999. This was the result of a survey which showed that pathogen indicators (PI) in the drain were much higher than in Aliso Creek. Experience gained from the more comprehensive monitoring carried out since that time has shown that J03P02 is in the low to middle of the range of PI concentrations compared to the rest of the Aliso Creek watershed.

Sand Filtration/UV Sterilization

The J01P28 Interim Water Quality Improvement Package Plant BMP was executed in response to the San Diego RWQCB 13225 Directive to clean up Aliso Creek.

This treatment unit is located near the outlet of the J01P28 subcatchment (Figure 2). This subcatchment is a tributary to the main stem of Aliso Creek. The storm drain conveys runoff water from a fully developed area of approximately two square miles in the city of Aliso Viejo. Land uses in the catchment include residential, commercial, light industry, and parks. The BMP was installed in July 2003.

The CCS treatment system includes three multi media filters, two organo clay filters and two ultraviolet light disinfection chambers. The package plant treatment system has three main phases:

- Sediment and debris removal
- Oils, pesticides, and trace metals removal
- Disinfection

The larger debris and trash removal is performed at the inlet strainer that is located in an energy dissipation basin within the storm drain. Sediment removal is performed in the basin and in the multimedia filter. Oils, pesticides and trace metals are removed via adsorption onto the organo-clay media while the ultraviolet light chamber removes bacteria and viruses.

The package plant treatment system filters and disinfects approximately 100,000 gallons per day of urban dry weather runoff. The design capacity is 250,000 gallons per day. By October 2004, a total of 1.4 million gallons had been treated.

Monitoring results from the years 2001 through June 2003 were combined to form the "before" dataset, while results from August 2003 through December 2004 constituted the "after" dataset.

Once discharged from the unit, the water flows through a ponded area approximately 20 feet long, 6 feet wide and 1.5 feet deep, then 30 feet through a natural ditch to Aliso Creek. A monitoring site is located in the natural ditch 15 feet from Aliso Creek.

Wetlands

Wetlands have been installed near the outlet of subcatchment J03P28, which is a tributary to Sulfur Creek, itself a tributary to Aliso Creek (Figure 2A). The wetlands are positioned at the bottom of the catchment and designed to capture 100% of the low flows before they discharge to Aliso Creek. The catchment (538 acres) is entirely residential (1600 households, new to 30 years old). A number of structural BMPs have been implemented from 2000 to the present day.

1. From May 2000 to March 2001, dry weather flows were diverted to the AWMA Regional Sewage Treatment Plant.

2. From March 2001 to April 2003 (actually it is not clear when unit stopped operating), dry weather flows in the drain were treated by a mobile Clear Creek Systems filtration/UV treatment unit. The flow was diverted to the treatment plant (e.g., 15% of total flow in the July-September 2002 quarter) when the filter clogged or the UV malfunctioned.

3. The three wetlands were constructed progressively starting in about March 2001 and were completely online from April 2003[2].

J0302 has been subject to detailed studies because of the CAO. These include visual (video) inspection of sewer and storm drain pipes, field reconnaissance, resident surveys, flow monitoring, a wide range of upwatershed sampling and the identification the sources of the pathogenic indicator bacteria. Samples were examined for human enteroviruses, antibiotic resistance, and genotypes of E. coli. The researchers concluded that the primary sources of PI in J03P02 are not likely to be human, and are likely to be due to cows (soil fertilizer amendments), birds, rabbits, and some unidentified other animals. In the Aliso Creek QPRs, the Co-Permittees indicate that the following sources probably contribute to fecal coliform (FC) in J03P02:

- Organic soil amendments
- Turfgrass areas

- Wildlife
- Domestic pets
- Accumulated organic debris in the surface and subsurface storm drain system
- Street sweeping debris

The wetlands – called East, West and North, were positioned to capture 100% of catchment runoff during dry weather and first flush. Design features are summarized in Table 1. The hydrological network is outlined in Figure 3.

Wetland inflow is taken by intercepting flows in the stormwater pipes, including the 60-inch main pipe. After passing through the wetlands, some of the treated stormwater is routed back though the 60-inch pipe to an open channel just before its confluence with Sulfur Creek. Effluent from the West Wetland is discharged directly to this open channel, and does not pass through the pipe. Another untreated, unmonitored inflow also discharges to this point (Figure 2).

Table 1: Wetland design features (reference see footnote 2).

Wetland	**Total Catchment Area (acres)**	**Planned intercepted area (acres)**	**Wetland Area (acres)**	**Depth (ft)**
East	374	37	0.3	1
West	342	312	0.69	0.5
North	122	122	0.3	1

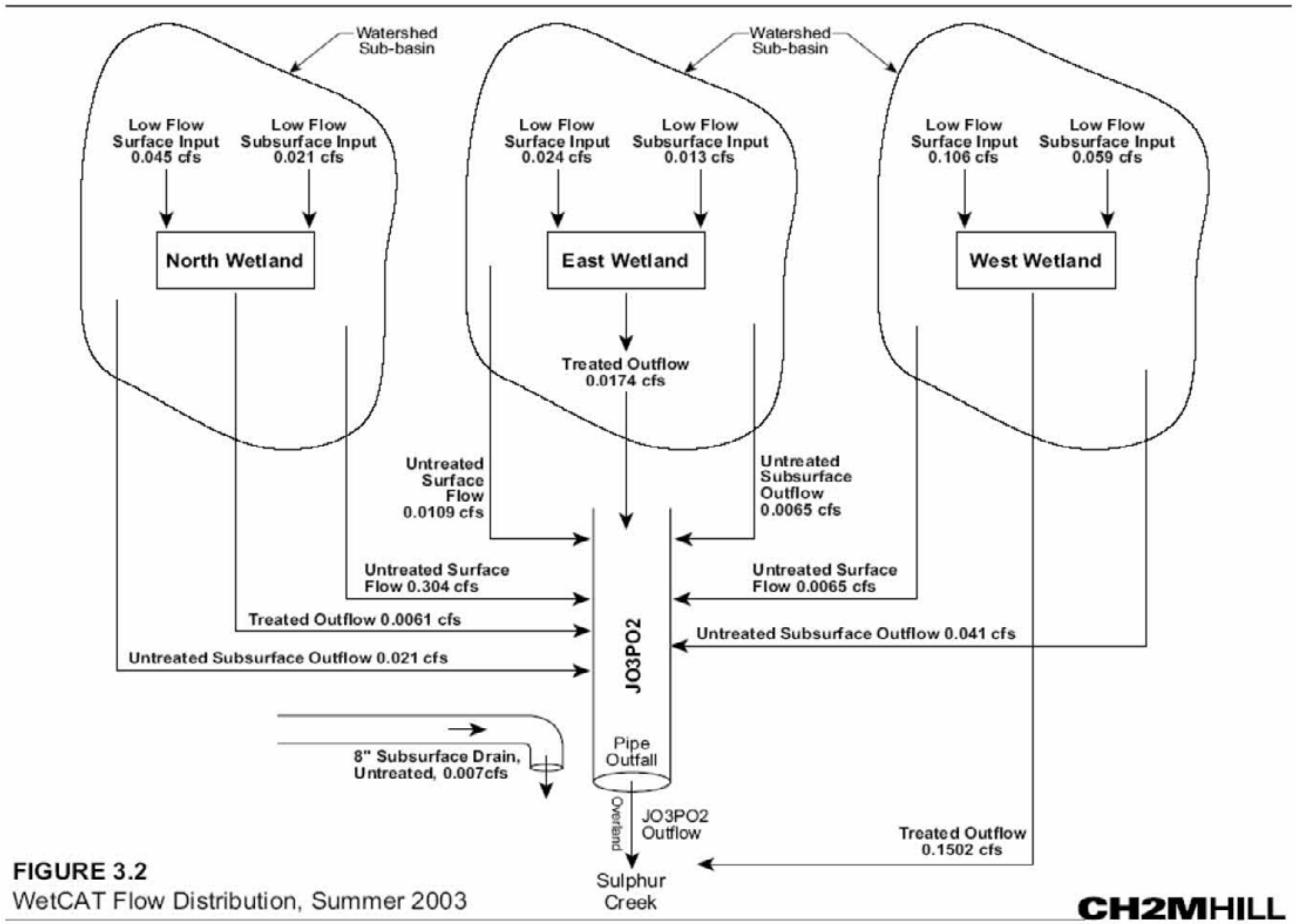
Sampling Procedures

All sampling was conducted during "dry weather," which is defined as no rain on the day of sampling. Sampling was conducted under strict protocols (see Aliso Creek 8th Quarterly Progress Report). Quality Assurance/Quality Control (QA/QC) sampling procedures were implemented that should have prevented contamination during sampling and significant changes to the sample during transport to the laboratory.

Directive Monitoring: Each location has three monitoring sites: two of these are on the main stem, 25 feet upstream and downstream of the storm drain discharge, the other is on the storm drain itself, approximately 15 feet above its confluence with the stream. These three sites were monitored weekly, so that at least five samples were collected each month, at random intervals. Some of these monitoring sites are shown in Figure 1.

BMP Monitoring: In addition to the directive sampling program, the influent and effluent to the BMPs were monitored.

Figure 2. Source: Wetland Capture and Treatment Final Report (2004)[2]. Note: untreated Surface Flow from North Wetland should probably be 0.0304 cfs.



Summary of Monitoring Results

J01P28 - Multimedia Filtration/UV Digestion

Influent/effluent. Comparison of the influent and effluent concentrations demonstrates a 99.6% reduction in fecal coliform levels. The geometric mean decreases from 77,414 CFU/100mL to 317 CFU/100mL.

Stream and drain monitoring. A statistical analysis of the levels in the receiving water (the "directive" dataset) is summarized in Table 2 and as box plots in Figure 3-4. These refer to all data collected before BMP installation. The County monitoring reports summarize data for quarterly monitoring periods. In the QPR, quarterly monitoring data are compared between years to reduce variance from seasonality, and constitute a more powerful assessment of the data. However, for our purposes here, the lumped data is sufficient to demonstrate their findings.

Table 2: Comparison of geometric means (cfu/100 ml) before and after multimedia filtration/UV sterilization. The BMP is installed about 35 feet upstream of the storm drain monitoring site.

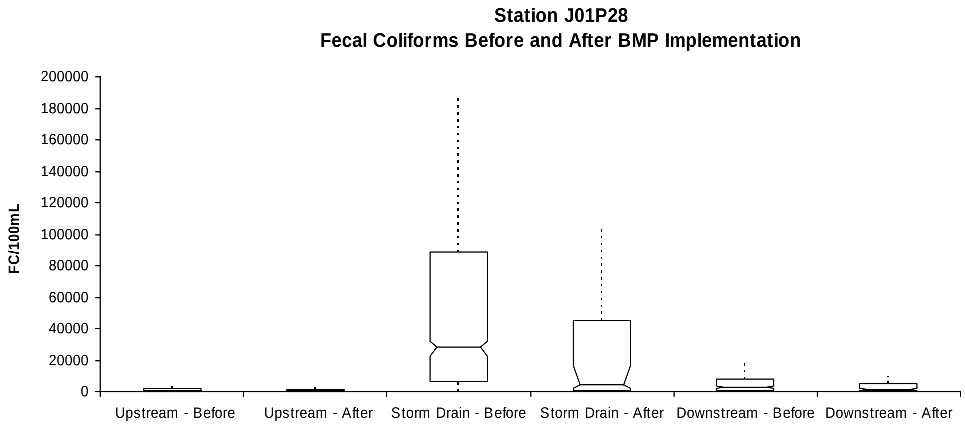
Locations	**TC**		**FC**		**ENT**	
	before	after	before	after	before	after
u/s	5353	2851	775	773	990	662
storm drain	52267	15232*	14633	5827*	9171	1401*
d/s	17248	5142*	2722	1696*	1791	839*

* = significant change (1-way ANOVA, $\alpha<0.05$)

Regrowth. Comparison of effluent and the 'directive' storm drain monitoring site, show a large increase in FC levels in the approximately 35 feet between the unit discharge and the storm drain monitoring site. No other discharges were found, which suggest that rapid re-growth has taken place in the water column, or re-infection has occurred from sloughing or resuspension of bacteria from immersed channel-side vegetation, organic debris and/or sediments. The geometric mean increases in this short distance from 317 cfu/100mL to 2,575 cfu/100mL.

Further work is planned by the County on the re-growth issue. Permits have been requested to perform clean up work on the habitat and the storm drain outlet basin.

Figure 3: FC levels for J01P28 monitoring site.



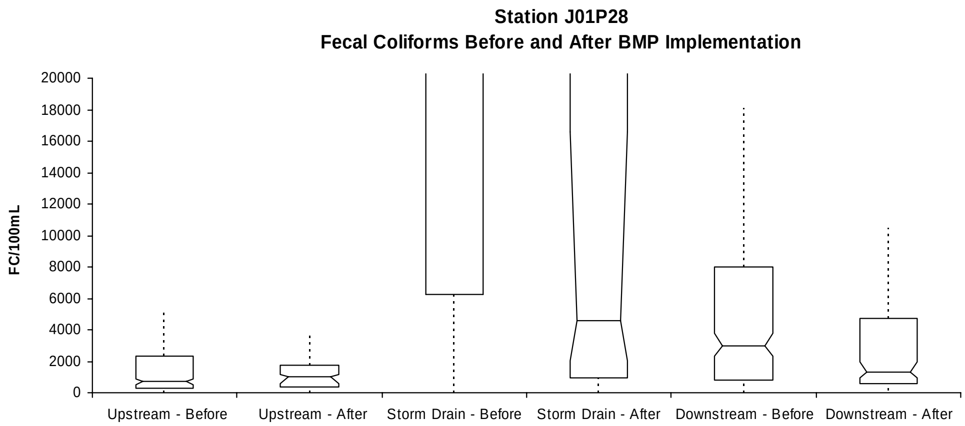


Figure 4: ENT levels for J01P28 monitoring site.

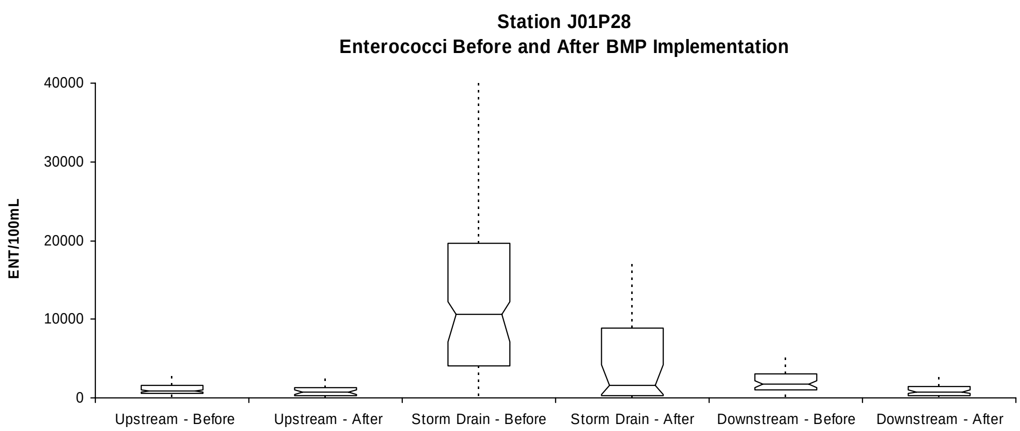
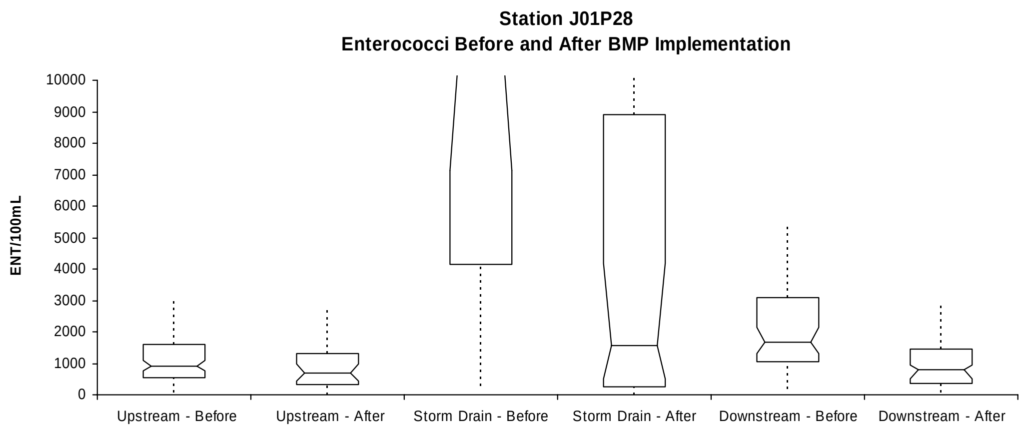


Figure 4 (continued)



J03P02 – Wetland BMPs

Influent/effluent. All monitoring took place during dry weather. Flows were measured, but only once per month and not for each sampling occasion. Most sampling took place at lows flows. The flow was typically 0.25 cfs with a range of 0.13-0.56 cfs.

Wetland monitoring in the three wetlands showed 90 to 99 percent reduction in FC levels from 2001 to present day (e.g. see Table 3). (Note that the three wetlands were installed and monitored progressively – results from 2001 were from one wetland only). Overall, 90 percent of treated effluent samples met the REC-1 objectives for FC. Although enterococci (ENT) levels dropped by 60 to 99 percent in wetlands, wetland effluent did not meet the steady state objective of 33 cfu/100ml during the period of monitoring (2001-2004). Few individual wetland samples met the single-sample objective.

Table 3: East Wetland fecal coliform (cfu/100mL) removal March 2001 – August 2002.

Parameter	Inflow	Outflow	Removal
Median	5000	50	99%
Mean	14900	150	99%
Geometric mean	2,800	35	99%

Overall there has been a progressive decline in FC and ENT since the wetlands have progressively come on line.

As well as the wetland monitoring, the effluent from the mobile UV sterilization unit was monitored when it was installed (between March 2001 to April 2003). The influent was not monitored directly. A cursory scan of the results suggests that the treatment unit effluent quality met REC-1 requirements on most months, but failed at times, which was attributed to the sand filter clogging.

Stream and drain monitoring. No "before BMP implementation" could be found because the 'directive' monitoring period encompassed either diversion to the sewage treatment plant, UV sterilization and/or wetland treatment. (However, some data is available somewhere, because it led to the CAO).

The dry weather discharge from the storm drain had little or no effect on the FC levels in Sulfur Creek. The flow from J03P02 is about 10 percent of the flow in Sulfur Creek.

The bacterial quality of the J03P02 storm drain discharge has steadily improved over the monitoring period. However, the improvement is quite complex, as described in the following section.

Re-growth. There is evidence that re-growth occurs between the wetlands and the storm drain monitoring sites. The concentrations in the open channel at the end of the pipe are about twice what is expected based on mass flow considerations.

However, there are some ambiguities in the various Quarterly Reports about the nature of the connection between the catchments, wetlands, and the J03P02 monitoring site[3]. This has been resolved in the detailed report on the BMP project for J03P02[2]. Measurements show that a high proportion of the flow is not intercepted (about 37 percent). Figure 2 also shows that the largest wetland ('West') bypasses and discharges downstream from the pipe.

Therefore, the apparent re-growth phenomenon could be wholly or partly due to the "recontamination" by the un-intercepted flows from the catchment. The project investigated this by carrying out a mass balance calculation. Unfortunately the report does not give any details on the calculations, but states that concentrations at the end of the pipe after discharge are about twice what is expected based on these mass flow considerations.

GeoSyntec confirmed that there was about this order of magnitude difference between observed and calculated mass flows using flows given in Figure 2 and using appropriate median FC numbers for the summer 2003 monitoring period. However, the proposition of re-growth, while plausible, is uncertain because:

- There is a significant input of untreated surface and subsurface flows into and at the end of the J03P02 pipe
- Most flows were estimated and not measured
- Many of the FC and ENT concentrations used in the mass flow calculations were not measured and assumed values were taken from the monthly monitoring data.
- There is a high degree of variability in monitored FC and ENT

The rates of this apparent re-growth appear to be seasonal and variable. As described above, usually observed levels at the J03P02 monitoring site are higher than the combined flows from the wetland. Fecal coliform and enterococci increase by about 100 percent in-pipe during spring, summer, and fall. However, this apparent re-growth does not occur during winter months and

[3] Most comments imply a 200 foot pipe, but 14th QPR refer to pipe outlet and 200 feet overland distance.

sometimes die-off can be observed. For example, the winter FC levels in 2004 were 1/8th of those predicted from the combined treated and untreated contributions, while ENT levels are about the same as predicted levels. The report suggests that die-off and re-growth (or re-contamination) of ENT and FC may be temperature and salinity dependent.

The overall findings of the BMP study to this particular watershed is that as the BMPs came on line, there was a steady improvement in the quality of the J03P02 discharge to Sulfur Creek during some seasons[4]. Results from monitoring the drain downstream of the BMPs show:

- Spring (Apr-Jun) geomeans for FC fell from 2001-2003. The 2004 geomean was similar to that for 2003.
- Summer (Jul-Sep) geomeans for FC have not fallen with statistical significance
- Winter (Jan-Mar) geomeans for FC fell from 2002 – 2004.

Discussion and Conclusions

Filtration coupled with UV sterilization reduced indicator bacteria to below the REC-1 standard. This was demonstrated at both sites. However, the benefits are compromised by what appears to be re-growth. At J01P28, the re-growth/re-inoculation occurred in a natural steam reach consisting of a pool and run, which was shaded with riparian vegetation dangling in the stream. It occurred within only 35 feet of the discharge point from the treatment unit.

Wetlands reduced fecal coliform (FC) levels by 90 to 99 percent to below the REC-1 guideline for 90 percent of the samples. They also reduced enterococci (ENT) levels by 60 to 99 percent, but the effluent from the three wetlands always exceeded the steady-state ENT objective, and usually exceeded the single sample objective. As with J01P28, the benefits of wetland treatment were compromised by the low-flow capture rate and what appears to be re-growth or re-contamination after discharge from the BMPs. Concentrations of FC and ENT increase between the wetland effluent and the J03P02 monitoring site 15 feet from its confluence with Sulfur Creek. The summary report proposed that most of the re-growth/re-inoculation occurred within a 200-foot pipe carrying wetland effluent to the confluence with Sulfur Creek.[2]

The study report proposed that re-growth was plausible because there was opportunity and time for re-growth to occur. The combined effluent from the East and North wetland is conveyed to Sulfur Creek through the pipe, which has a transit time during low flow of 15 minutes. As stated in the Wetland Capture and Treatment Final Report 2004[2] "Given ….. the microbiologists 'rule of thumb' that bacterial populations can double every 15 minutes under ideal conditions, rapid in-pipe propagation of FC and ENT in the dark pipe may be the main factor, or may be combined with recontamination from bioslimes or muck deposits" (Clean-Up & Abatement Order 99-211 17th QPR). Another possible reason is that the structures which divert low flow from the stormwater pipes to the wetland also trap and retain organic debris, which may act as substrates

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[4] This is somewhat surprising given that the drain water was treated by multimedia filtration/UV disinfection or diverted to the sewer system while the wetlands were constructed.

for re-growth. However, re-contamination by unmonitored inflows may also be partly or wholly responsible for the observed increase between the BMPs and the confluence.

The results suggest that the benefits of BMPs may be compromised by re-growth, which occurred in both the natural channel and pipe downstream of the monitored BMPs. The various investigators have concluded that treatment systems would need to be positioned at the bottom of the watershed directly before discharge to the receiving water body – mainly to prevent regrowth during warm weather conditions.[1] Another important general conclusion in the study (see City of Laguna 6th QPR Aliso Creek 13225 Directive) states 'that "primary" bacteria concentrations (from direct deposits of bird droppings, for example) in runoff can be magnified by the "secondary" propagation of bacteria populations within the environment, so that *controlling propagation* may ultimately become as important as *source reduction* in reducing overall outfall concentrations. The research results also suggest that the presumption of a statistically valid relationship between certain concentrations of fecal coliform and an acceptable vs. unacceptable magnitude of public health risk (which is the basis for the REC-1 and REC-2 objectives) may be seriously flawed.'

The proposition that re-growth occurs after treatment has wide ranging implications for stormwater management. Given the uncertainties outlined above as to whether re-growth occurs after wetland treatment, the County study results should be confirmed by more detailed studies and sampling, such as:

- more frequent sampling of concentrations taking into account time of travel
- stormwater runoff monitoring (not just dry weather flows)
- measurement of flows where possible.

It is unknown whether the re-growth phenomenon apparent at the Aliso Creek sites would result in much higher concentrations over longer distances, but such an experiment cannot be conducted at the County-selected sites.

Finally, it is re-emphasized that monitoring was only conducted during dry weather conditions – mostly low flow and do not reflect storm runoff conditions, except for possibly occasionally during the storm regression phase. The impact of storm runoff on the treatment efficacy of the BMPs tested at Aliso Creek is unknown. Likewise, it is unknown what impact high flow may be on the mechanisms that lead to re-growth or re-inoculation; such flows may deliver organic debris and sediments and also slough off slimes and accumulations of organic detritus.

APPENDIX E

EFFECT OF URBANIZATION ON GROUNDWATER RECHARGE IN THE SANTA CLARITA VALLEY

Effect of Urbanization on Aquifer Recharge in the Santa Clarita Valley

TO: Tom Worthington/Impact Sciences, Inc.

FROM: John Porcello/CH2M HILL

DATE: February 22, 2004

Introduction

In a groundwater basin, the effect of urbanization on recharge to underlying groundwater is dependent on land uses, water uses, vegetative cover, and geologic conditions. Groundwater recharge from undeveloped lands occurs from precipitation alone, whereas areas that are developed for agricultural or urban land uses receive both precipitation and irrigation of vegetative cover. In an urban area, groundwater recharge occurs directly beneath irrigated lands and in drainages whose bottoms are not paved or cemented. This memorandum discusses the general effects of urbanization on groundwater recharge and the specific effects in the Santa Clarita Valley.

Summary of Findings

In the Santa Clarita Valley, stormwater runoff finds its way to the Santa Clara River and its tributaries, whose channels are predominantly natural and consist of vegetation and coarse-grained sediments (rather than concrete). The stormwater that flows across paved lands in the Santa Clarita Valley is routed to stormwater detention basins and to the river channels, where the porous nature of the sands and gravels forming the streambeds allow for significant infiltration to occur to the underlying groundwater.

Increased urbanization in the Valley has resulted in the irrigation of previously undeveloped lands. The effect of irrigation is to maintain higher soil moisture levels during the summer than would exist if no irrigation were occurring. Consequently, a greater percentage of the fall/winter precipitation recharges groundwater beneath irrigated land parcels than beneath undeveloped land parcels. In addition, urbanization in the Santa Clarita Valley has occurred in part because of the importation of State Water Project (SWP) water, which began in 1980. SWP water use has increased steadily, reaching nearly 44,500 acre-feet (AF) in 2003. Two-thirds of this water is used outdoors, and a portion of this water eventually infiltrates to groundwater. The other one-third is used indoors and is subsequently routed to local water reclamation plants (WRPs) and then to the Santa Clara River (after treatment). A portion of this water flows downstream out of the basin, and a portion infiltrates to groundwater.

Records show that groundwater levels and the amount of groundwater in storage were similar in both the late 1990s and the early 1980s, despite a significant increase in the urbanized area during these two decades. This long-term stability of groundwater levels is attributed in part to the significant volume of natural recharge that occurs in the streambeds, which do not contain paved, urban land areas. On a long-term historical basis, groundwater pumping volumes have not increased due to urbanization, compared with pumping volumes during the 1950s and 1960s when water was used primarily for agriculture. Also, the importation of SWP water is another process that contributes to recharge in the Valley. In summary, urbanization has been accompanied by long-term stability in pumping and groundwater levels, plus the addition of imported SWP water to the Valley, which together have not reduced recharge to groundwater, nor depleted the amount of groundwater that is in storage within the Valley.

Effect of Pavement on Recharge Beneath Specific Land Parcels

The amount of paved cover on the ground affects the degree to which rainfall and outdoor-applied urban water will be able to infiltrate to groundwater. In heavily industrialized areas with high percentages of paved cover, such as exist in portions of the Los Angeles Basin, less rainfall recharge will occur than if the land is in an undeveloped condition. Furthermore, if the bottoms of rivers and other drainages are paved, then the majority of stormwater generated during a rainfall event will be unable to infiltrate to groundwater. In contrast, the amount of recharge to groundwater will be greater in urbanized areas, such as the Santa Clarita Valley, that have natural soils in the bottoms of rivers and local drainages or that have lower percentages of paved cover on the developed areas lying outside the principal drainages. In these areas, the outdoor use of water for irrigation landscape vegetation or agricultural lands can notably increase the amount of groundwater recharge, particularly if the outdoor water is imported from outside the local groundwater basin. This is discussed further below.

Effect of Vegetative Cover and Water Use

From the 1930s through the 1960s, H.F. Blaney and other researchers at the U.S. Department of Agriculture performed numerous studies to measure the amount of infiltration to groundwater that occurs beneath undeveloped lands and irrigated farmlands, and the differences in recharge rates for different types of native vegetation and crops. In California, these studies included a 1933 study by Blaney in Ventura County, a 1963 study by Blaney and others in the Lompoc Uplands, studies by the U.S. Geological Survey and various consultants in the Montecito and Carpenteria groundwater basins, and a groundwater basin study by Santa Barbara County[1] that incorporated the results of these earlier studies.

Together, these studies concluded that deep percolation to groundwater from undeveloped lands occurs only during years of average or above-average precipitation. This occurs because:

1. Southern California's rainfall is highly seasonal in nature, whereupon most rainfall occurs during the relatively cool period November through March, when plant water

[1] See Santa Barbara County Water Agency, December 15, 1977. *Report on Adequacy of the Groundwater Basins of Santa Barbara County.*

requirements are low, and little, if any, rainfall occurs during the remaining (and warmer months) when plant water requirements increase.

2. During the summer, when little or no rainfall occurs, the native vegetation extracts the residual moisture that is present in the soil, which substantially decreases the soil moisture within the root zone of the vegetation. At the end of the dry season, soil moisture levels on undeveloped lands are below the soil's field capacity, which is the amount of moisture that must be present in the soil before free drainage of water can occur below the rooting zone of the native vegetation.

3. When the seasonal rains arrive, the incident rainfall that is not consumed by plants and does not become stormwater runoff must first raise the soil moisture level to the soil's field capacity before any groundwater recharge will occur. The various studies indicate that about 17 inches/year of rainfall is necessary to raise the soil moisture to the field capacity on an undeveloped parcel of land. This is similar to the average annual rainfall in the Santa Clarita Valley and in other lowland coastal and near-coastal valleys in southern California.

On irrigated lands, irrigation occurs during several months of the year, with the exact duration depending on the amount and timing of rainfall and also the crops or type of urban landscaping being irrigated. The principal effect of converting undeveloped land to land that receives agricultural or urban irrigation is to increase the amount of water that is applied to the land during the low-rainfall months. This application of water to the vegetative cover on the surface of the developed land parcel results in the maintenance of higher soil moisture levels during the warm, dry months than would occur without development. This has three effects:

1. Because irrigation will generally be performed in a manner that maintains the health of the vegetative cover, enough water will be applied to maintain the soil moisture at, or close to, the field capacity of the soil. This in turn will allow some deep percolation to occur from the irrigation water itself.

2. When the rainy season begins, because irrigation has maintained soil moisture at or near field capacity, less of the initial rainfall entering the root zone needs to be stored in the soil (to meet soil moisture deficits) beneath an irrigated parcel than in the case of an undeveloped parcel. Therefore, a greater percentage of the initial rainfall and annual rainfall will be able to infiltrate to groundwater. The southern California studies estimated that irrigated land parcels would allow rainfall infiltration to occur in years when annual rainfall is at least 10.5 inches/year. This threshold rainfall value is 6.5 inches less than the threshold rainfall value that the studies estimated to be necessary for generating groundwater recharge beneath undeveloped land parcels.

3. Because the majority of irrigation occurs during the dry (low-rainfall) months, the total annual recharge to groundwater from irrigated developed lands is the sum of: (a) the deep percolation arising from irrigation (during the low-rainfall months); and (b) rainfall (during the months when less irrigation is occurring). Therefore, groundwater recharge beneath developed lands is greater and occurs for a longer period of time each year than in the case of undeveloped lands where no irrigation is occurring.

Historical Observations of Groundwater Conditions in the Santa Clarita Valley

The findings of the studies described above for other groundwater basins in southern California are consistent with observations that have been made in the Santa Clarita Valley, which are based on long-term water level records, water budget analyses, and groundwater modeling. Based on a month-by-month calibration to a 20-year record of historical water level records (throughout the Valley) and stream gaging records (at the Los Angeles – Ventura County line), the model simulates 10 percent of the applied outdoor water as being available for recharge to groundwater in retail and residential areas, with greater percentages infiltrating beneath golf courses and agricultural lands. This is consistent with a 1980 study by DWR of the groundwater resources of the Santee and El Monte hydrologic subareas of San Diego County. In that study, which was performed to evaluate reclaimed water use plans, DWR concluded that approximately 20 percent of the applied outdoor water in municipal areas infiltrates to the water table, with the remaining 80 percent going to evapotranspiration and direct evaporation. DWR also concluded that there would likely be no significant change in these percentages as urbanization continues.[2]

In the Santa Clarita Valley, as in any urbanized area, urbanization increases the paved area and can increase the magnitude and intensity of stormwater runoff from paved land areas. In the Santa Clarita Valley, this stormwater runoff will find its way to the Santa Clara River and its tributaries, whose channels are predominantly natural and consist of vegetation and coarse-grained sediments (rather than concrete). The stormwater that flows across paved lands in the Santa Clarita Valley is routed to stormwater detention basins and to the river channels, where the porous nature of the sands and gravels forming the streambeds allow for significant infiltration to occur to the underlying groundwater. Consequently, for a developed land parcel, the water that runs off of the paved portion of the land parcel will infiltrate to groundwater from a detention basin or a riverbed, rather than infiltrating onsite.

Riverbed infiltration is a significant percentage of total recharge in the Santa Clarita Valley in any given year. Streamflow records and the model calibration process together demonstrate that year-to-year fluctuations in total recharge in the Valley arise not just from year-to-year variations in incident rainfall within the Valley, but also from year-to-year variations in streamflows in the Santa Clara River and its tributaries. Because the areas contributing flow to the rivers are located both within and outside of the Valley, the recharge that occurs from riverbeds is a significant source of groundwater recharge within the Valley.

Evidence that stormwater infiltration to groundwater is not significantly decreased by urbanization comes from long-term water level records at wells completed in the Alluvial aquifer. These records show that groundwater levels and the amount of groundwater in storage were similar in both the late 1990s and the early 1980s, despite a significant increase in the urbanized area during these two decades. This long-term stability is attributed in part to the significant volume of natural recharge that occurs in the streambeds, which do not contain paved, urban land areas. Also, groundwater pumping volumes have not increased

[2] See State of California, Department of Water Resources, Southern District. August 1984, *San Diego County Cooperative Ground Water Studies: Reclaimed Water Use, Phase II*. Pages 40-41.

due to urbanization, compared with pumping volumes during the 1950s and 1960s when water was used primarily for agriculture. Additionally, beginning in 1980, water was imported into the Santa Clarita Valley from the State Water Project (SWP) for urban use, with SWP water use reaching nearly 30,000 acre-feet per year (AF/yr) by the end of the 1990s, and progressively increasing from about 32,500 AF in 2000 to nearly 44,500 AF in 2003. Because two-thirds of the total urban water demand is used outdoors, a substantial portion of the imported SWP water has been and continues to be applied to urban landscaping, thereby increasing the amount of recharge to groundwater. The remaining urban water is used indoors, and is subsequently routed to local water reclamation plants (WRPs) and then to the Santa Clara River (after treatment). A portion of this water flows downstream out of the basin, and a portion infiltrates to groundwater.

In summary, urbanization has been accompanied by long-term stability in pumping and groundwater levels, plus the addition of imported SWP water to the Valley, which together have not reduced recharge to groundwater, nor depleted the amount of groundwater that is in storage within the Valley.

APPENDIX F

ASSESSMENT OF POTENTIAL IMPACTS RESULTING FROM CUMULATIVE HYDROMODIFICATION EFFECTS, SELECTED REACHES OF THE SANTA CLARA RIVER, LOS ANGELES COUNTY, CALIFORNIA

Assessment of potential impacts resulting from cumulative hydromodification effects, selected reaches of the Santa Clara River, Los Angeles County, California

Report prepared for:

GeoSyntec Consultants

Prepared by:

Scott Brown

Barry Hecht

Balance Hydrologics, Inc.

October 2005

A report prepared for:
GeoSyntec Consultants
55 SW Yamhill Street
Suite 200
Portland, OR 97204
(503) 242-1416
Attn: Lisa Austin

Assessment of potential impacts resulting from cumulative hydromodification effects, selected reaches of the Santa Clara River, Los Angeles County, California

Balance Project Assignment 205018

by

Scott Brown
Hydrologist, Geomorphologist

Barry Hecht, CEG 1245, CHg 50
Principal

841 Folger Avenue
Berkeley, California 94710-2800
(510) 704-1000
sbrown@balancehydro.com
bhecht@balancehydro.com

October 27, 2005

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1. INTRODUCTION

1.1 Background and purpose

The Newhall Ranch Specific Plan projects will urbanize a portion of the Santa Clarita Valley in Los Angeles County during the coming decades. The project is an extension of prior community growth, which commenced in earnest during the 1960s, in accordance with the adopted General Plan and adopted growth projections. Concern has been expressed that future urbanization may result in changes in the Santa Clara River, a stream of regional scale draining westward from northern Los Angeles County through Ventura County, flowing into the Pacific Ocean near Oxnard. Prior analysis by Geosyntec Consultants (2005) indicates that cumulative future urbanization in the upper watershed of the Santa Clara River, of which Newhall ranch will contribute a portion, will reach approximately 9 percent at “built-out” conditions. A survey of the literature (reviewed in GeoSyntec, 2002) shows that many western-state streams begin to exhibit effects when impervious areas exceed a threshold of about 10 percent, with some considerable site-by-site variability. Additional studies by GeoSyntec in the San Francisco Bay area (2004) and a recent Southern California regional study (Coleman and others, 2005) indicate that, for watersheds smaller than about 25 square miles, channels in granular, non-cohesive sediments may become unstable downstream from urbanizing areas when impervious coverage reaches as little as 2 to 3 percent.

This report uses an empirical approach to assess the potential effects of urbanization on channel morphology associated with the implementation of the Newhall Ranch Specific Plan, combined with other existing and future development in the upper watershed of the Santa Clara River as described in the adopted General Plan. We use historical changes in the Santa Clara River channel pattern to help bracket potential morphological effects on the river of hydromodification due to accumulated urban development. We note that historical changes (both natural and human-induced) in the three factors most likely to affect the Santa Clara River stability (magnitude and frequency of stormflow events, sediment supply and caliber, and channel vegetation) are very large relative to the effects, if any, of the Newhall Ranch project and other planned future urban development. We hypothesize that it will prove useful to learn from history, and to assess the nature and general degree of change that may result from future urbanization by applying these insights.

Much of what is learned from this analysis may be applicable in other aspects of planning and managing the Santa Clara River in the Newhall Ranch reach and reaches downstream. It is not, however, an immediate objective of this report to develop management plans, to assess potential changes in tributary channels, or to explore how habitat conditions might be changed by potential hydromodification, beyond that which is related to the physical channel form and dynamics.

1.2 Technical approach

The history of the Santa Clara River in the Santa Clarita Valley and eastern Ventura County allows us to explore the three factors most likely to affect the stability and morphology of the river downstream from existing and future development in the Santa Clarita Valley (including Newhall Ranch):

- High streamflows, including increased peak flows, volumes, and/or durations of stormflows,
- Coarse-sediment supply, including sharp curtailment of sediment entering the river following completion of Castaic (1974) and Santa Felicia-Piru (1958) Dams.
- Mature riparian vegetation, with interpenetrating roots, which can stabilize the banks and maintain the channel pattern.

We consider the 'pre-urban' condition to be the form and functions of the river during the 1950s and 1960s, prior to significant urban growth and modification of the flow and sediment regimes due to the construction of the Castaic and Santa Felicia-Piru Dams. Historic deviations from the pre-urban condition can be evaluated using the geomorphic evidence left by a period of floods and high flows from 1938 to about 1945. The effects of sediment supply can be evaluated by quantifying effects of eliminating coarse-sediment delivery from Castaic Creek (with a drainage area of 155 square miles, approximately 25 percent of the Santa Clara watershed at the L.A./Ventura County line. Supporting evidence can also be obtained similarly at Piru Creek (approximately 40 percent of the watershed at its confluence with the Santa Clara River at Piru).

1.3 Report organization

The analysis begins with an overview of the factors affecting the form and geomorphic history of the Santa Clara River (Chapter 2). The larger events and fluctuations, and manner in which they may have affected the river, are considered in Chapter 3. The fourth chapter explains the source materials and methods used to quantify the river's response to these perturbations, which are summarized in Chapter 5. Chapter 6 is a discussion of what we have learned from this study, and Chapter 7 draws conclusions as to how these findings relate to potential hydromodification effects in response to anticipated future watershed urbanization.

2. GEOMORPHIC SETTING

2.1 Channel pattern influences

Several previous reports have described the overall and geomorphic histories of the Santa Clara River (c.f., Schwarzberg and Moore, 1995; SCREMP 2005). In each case, authors have noted that the forms and functions of the river have varied with climatic cycles and with episodes such as floods and fires. It is this variability that is characteristic of the river. In the this report, we utilize the study of historic influences of some of the more pronounced events and cycles to better understand the impacts of drainage changes, if any, that can be expected to result from the anticipated future development in the Santa Clarita Valley, including Newhall Ranch.

2.1.1 Physiography

The Santa Clara River flows through a complex, tectonically-active trough generally bounded by reverse faults on the San Cayetano Mountain and South Mountain fronts. Some of the most rapid rates of geologically-current uplift in the world are reported from the Ventura anticline and San Gabriel Mountains, just to the northwest and southeast, respectively, of the river. Slopes are very steep, with local relief of 3000 to 4000 feet being common. These faults bring harder, more resistant sedimentary rocks over softer and younger sedimentary formations, but all formations are fundamentally soft and erodible. On either side of the faults, sandstone (generally multi-cyclic and fine-grained) and mudstones prevail. The northeastern and southeastern corners of the watershed are underlain by deeply-weathered granitic and schistose rocks, which produce sands that are coarser than those of other rock units when they weather and erode. The San Gabriel fault crosses the valley near the county line, bringing slightly more resistant rock to the surface and creating a local base level reflected as a slight rise or 'bump' on the river's longitudinal profile.

Most geologic materials in the watershed decompose mainly to silts and clays and to sand, with some coarser materials. Rhea Williams and his colleagues at the U. S. Geological Survey found that most sediment moved by the Santa Clara River and its main tributaries are quite fine, with less than 5 percent bedload-sized material (>0.25 mm, or about 0.01 inches in diameter). Some gravels and cobbles do occur within the beds of the streams and in their alluvium. Nonetheless, both the bed and the sediment transported by the river tend to be finer than in most Southern California watersheds (c.f., Knudsen and others, 1992).

The Santa Clara River watershed drains a watershed of 1,600 square miles, of which 625 square miles are within Los Angeles County, upstream of the "county-line gage" (USGS No. 11108500), near the western edge of the Newhall Ranch Specific Plan area.

2.1.2 Climate

Much of the watershed upstream of the Newhall Ranch Specific Plan area receives rainfall averaging about 18 to 25 inches per year (NOAA). As throughout Southern California, rainfall in the Santa Clara watershed alternates between wet and dry periods, a variation that is central to understanding the cultural and geomorphic histories of the upper watershed (Schwarzberg and Moore, 1995; Lynch, 1931; Reichard, 1981). Wet cycles tend to persist for several years, sometimes for periods of 6 or 8 years, during which rainfall, although variable, may average about 140 to 150 percent of the long-term average. For the woody riparian vegetation along the banks and on islands in the braided channels, these are crucial periods for establishment and growth. During dry cycles, the roots of the riparian vegetation must grow downward to the water table or perched zones, and where it cannot do so, this band of vegetation will die back.

2.1.3 Flows

Flows in the Santa Clara River, as in most southern California streams, are highly episodic. For the gaged period between 1953 and 1996 annual flow at the Los Angeles/Ventura County line gage ranged between 253,000 acre-feet (1969) and 561 acre-feet (1961). In general, however, streamflow, and especially dry-season streamflow, has increased over the past few decades primarily due to discharges from two wastewater treatment plants. Mean annual flow at the County Line increased from 25,700 acre-feet in 1972 (averaged over a 20-year record) to 35,360 acre-feet in 1988 (36-year record), with a significant decrease in the number of very low years over that period (UWCD and CLWA, 1996). Downstream of the County line, however, the Santa Clara River flows through the Piru groundwater basin, which represents a "Dry Gap" where dry-season streamflow is lost to groundwater.

Annual peak flows at the County line between 1953 and 1996 ranged from 68,800 cfs (1969) to 109 cfs (1960). Of note is that the second highest annual peak, 32,000 cfs in 1966, was less than half of the highest peak (68,800 in 1969). Both of these events occurred in the late pre-urban to early-urbanization stages within the Santa Clarita Basin and no consistent increase in peak flow is evidence since this time. Flow data for the 2005 flood event are not yet available, however the peak flow at the County line may have approached the flow observed in 1969. As discussed below these large episodic events have a significant impact on the geomorphic characteristics of the Santa Clara River mainstem.

2.1.4 Ground-water supported riparian vegetation

The Santa Clara River is underlain by several distinct alluvial ground-water basins—the Piru, Fillmore, and Santa Paula Basins (Reichard and others, 1999; SCREMP 2005). These basins are divided longitudinally by sills or ridges of bedrock that support areas of locally-high ground water, including the area upstream from the County line (above the Piru Basin), and upstream from the mouth Sespe Creek (the transition between the Piru and Fillmore Basins). This locally-high ground water sustains summer baseflow and riparian vegetation within the Santa Clara River corridor even through relatively dry climatic cycles.

3. PERTURBATIONS

This section describes several major perturbations (those with the potential to affect channel- and floodplain-form) that occurred in the Santa Clara River watershed since the early 1900s (summarized in Figure 1). Aerial photographs were selected to bracket these events and analyzed, both qualitatively and quantitatively, to try to discern and quantify responses of the Santa Clara River channel to:

(1) changes in flow regime during wet and dry multi-year cycles,

(2) sediment supply, notably describing the channel's adjustments to construction of large dams, and

(3) development of mature riparian vegetation with interpenetrating roots.

3.1 Streamflow cycles and events

As described above, streamflow within the Santa Clara watershed is highly episodic, and can vary drastically from year to year. However, decade-scale patterns of wet and dry periods have been identified in the historic record—as early as the 1700s. Previous wet periods (with associated high flows) are reported from 1810 to 1817, 1831 to 1840, 1883 and 1893, and 1903 to 1916, during each of which periods the area received a total of an additional 60 to 80 inches above the mean annual rainfall over the duration of the wet cycle. Prolonged static or drying periods similar to that observed between 1945 and 1977 also occurred from 1780 to 1810, 1842 to 1882, and 1919 to 1935 (with associated reductions in streamflow). The river is likely to have remained most stable during the latter periods, with the notable exceptions of a few major storms of record, such as 1862 (c.f., Lynch, 1931; Reichard, 1981; Schwartzberg and Moore, 1995). The primary wet periods in this study occurred between 1938 and 1946, and 1978 to 1983 (Figures 1 and 2). Other large storm events occurred in 1966, 1969, 1972, 1983, 1998, and 2005. Notable dry periods occurred between 1946 and the late 1960s, and 1983 and 1991.

3.2 Dam construction

Castaic Dam was completed on Castaic Creek (a tributary of the Santa Clara River just upstream of the Newhall project) in 1974. The watershed area above the dam is approximately one-quarter of the watershed area of the Santa Clara River at the L.A./Ventura County line, downstream of the Castaic confluence, and therefore the dam effectively reduced the sediment contributing area by about 25 percent. For comparison purposes, we also considered the effects of the construction of the Santa Felicia Dam (Lake Piru), which resulted in an approximate 38 percent decrease in sediment contribution area below the confluence of Piru Creek and the Santa Clara River[1].

3.3 Urbanization

Settlement of the Los Angeles County portion of the watershed transitioned from rural to mixed-use suburban during the mid- to late-1960s. This change initiated a period of ongoing urban expansion, with associated increases in the area of impervious or compacted surfaces as homes, commercial and industrial centers, highways and diverse infrastructure have developed throughout the Santa Clarita Valley. Future General Plan urbanization within the upper watershed, inclusive of Newhall Ranch, will bring the percent of urban area west of the County line to about nine percent (GeoSyntec, 2005).

3.4 Treated effluent discharge

Since the 1960's, treated effluent from two water reclamation plants (Saugas and Valencia) has been released directly to the Santa Clara River. This, combined with an increase in applied, imported agricultural water, has led to increased summer baseflows in the Santa Clara River at the County line, which had only rarely occurred under pre-urban conditions. This led to an increase in available water to support woody riparian vegetation. The increase in baseflow is evident in the USGS gaging record at the county line (Figure 2). In some stream corridors, vegetation growth in response to increased baseflow can provide additional bank cohesiveness and reduce erosion; though in others heavy in-channel vegetation growth (riparian encroachment) can serve to destabilize the stream and induce lateral erosion by directing flows toward the banks.

Newhall Ranch has proposed an additional plant that would ultimately treat approximately 5.8 million gallons per day at project build-out. However discharge from the plant in the summer is not expected, as this water will be re-used for irrigation purposes, and we therefore do not expect further change in riparian vegetation growth as a result.

3.5 Saint Francis Dam Breach

On March 12, 1928 the Saint Francis Dam, located in San Francisquito Canyon upstream of the Newhall project, failed and released approximately 30,000 acre-feet of water over the course of a few hours, with an estimated peak discharge of up to 800,000 cubic feet per second (Newhall,

[1] Drainage area calculations were based on USGS gaging station watershed data at Piru and Castaic Dams, and gages on the Santa Clara River at the L.A./Ventura County line and near Piru.

1928; and SCREMP, 2005). This event had drastic effects on the stream reaches downstream, as the resulting flows were much higher than anticipated from any natural event. Aerial photograph coverage during this time period is limited, however, and therefore an assessment of this event was not feasible. In addition, because of the extreme size of the event, it is unlikely that an assessment would be beneficial for assessing hydromodification impacts.

4. METHODS

We analyzed aerial photographs from 1927, 1947, 1957, 1966/67, 1989, 2002, and 2005 to describe channel change in response to the major episodes described above. The main criteria described were the width of the active braiding area (or meander belt width if there was no braiding), bank vegetation, number of channels, and width of the active channel. Also described, where they could be identified, were the width and length of "islands" (vegetated mid-channel bars) within the stream. Islands were typically easier to identify where vegetation was heavy, as the color of the vegetation highlighted the differences between channel and meta-stable islands.

The aerial photographs were analyzed in two different ways. First, a qualitative comparison of the alluvial corridor shown in the different years' photos was made, describing general differences in channel pattern and vegetation on a reach-wide scale. Second, specific cross sections were defined and the above parameters measured for each year with photo coverage in that area to provide a quantitative comparison of channel change at these standard locations along the Santa Clara River (Figure 3).

4.1 Descriptions of analysis criteria

4.1.1 Width of active braiding corridor

For braided reaches, the active channel width was identified primarily by noting the extent of active channels or recent sediment deposition. In many cases the active corridor was bounded by a significant change in vegetation or sediment deposition characteristics.

4.1.2 Relict channel corridor

The relict channel corridor is the portion of the flood plain that does not appear to have been active in the recent past (within the last 5 years or so). Typically the relict corridor is identified by areas of heavy or scattered vegetation containing no or few distinct channels, or areas that do not appear to have experienced recent sediment deposition. Alternatively, identification was based on the width between farmed fields[2]. Measurements of this feature were made from outside bank to outside bank, and include the active corridor.

[2] The total width of the former channel migration corridor is difficult to identify in aerial photographs due to past and present agricultural field reclamation following major perturbations. Where necessary, we used the width between agricultural fields as a estimate of the relict corridor.

4.1.3 Channel width

Where a distinct channel or channels could be identified, the widths of the individual channels were measured. The number of individual channel threads was also recorded, where threads could be distinguished. In some cases, measurement of these features was complicated by poor photo resolution or contrast, and difficulty in distinguishing major channels from minor ones (where a full spectrum was present).

4.1.4 Vegetation

Vegetation was described qualitatively as bare, scattered, moderate, and heavy. The location of specific areas of vegetation, such as vegetated islands, vegetation within the relict corridor, or vegetation along banks, was also described. Where the resolution was adequate, the growth form of vegetation, or state of maturity, was also described (trees or shrubs).

4.1.5 Number of vegetated islands

The number of distinct vegetated islands (mid-channel bars) was also recorded at each cross-section, where the resolution of the photographs was adequate. Where islands could be identified, measurements of width and length were recorded.

5. RESULTS

5.1 Qualitative descriptions

Initial inspection of the series of aerial photographs showed that significant changes in channel planform have occurred throughout the 1900s, as would be expected in a large, braided stream in southern California. Vegetation within the relict corridor (see definition above) near the Newhall Ranch planning area appears to become progressively heavier through time, likely due to the increase in agricultural water and discharge of treated effluent to the channel through the summer months.

The photos show many areas of net deposition, and corresponding channel shifts in major depositional areas. Single-thread, dominant channel segments are rarely present, especially in years following large events. Even when there is one main channel, secondary channels are often present within the active channel corridor.

Portions of the stream have been altered for flood control purposes, including stabilization of banks bounded by orchards and fields, or construction of levees within the active corridor. These levees are most prominent in the 1989 photographs (upstream of the L.A./Ventura County line), where the substantial segments of the main channel are confined in a flood control channel approximately 225 feet wide. By 2002, however, little evidence can be discerned in the aerial photographs of these levees.

The 2005 flood events caused significant changes within the Santa Clara River. Vegetation within the channel was almost all completely washed out (compared to 2002 conditions), and many areas of significant bank-widening were identified, even in areas of heavy bank vegetation (Figure 4).

There appears to be little change in agricultural constriction of the Santa Clara River over the span of photographs reviewed. Through the Newhall reach, the agricultural areas appear to be well buffered by the relict channel and the vegetation supported there. There were only a few places identified where the active channel cut into agricultural areas rather than staying within the relict corridor. In contrast, within the Piru Basin (downstream of the Newhall reach), significant agricultural constriction and subsequent channel widening occurred over the time span of the photos reviewed.

Areas of shallow ground water between Piru and Sespe Canyon[3], which support denser riparian vegetation than typical for the river between Valencia and Fillmore, show little if any significant change for all years in the studied photo-sets. Both the density and extent of vegetation in these areas does not appear to change over time (despite significant differences in climate and other watershed factors) nor does the amount of vegetation appear to significantly affect channel planform, compared to upstream and downstream reaches (the braided channel does not shift to a single-threaded channel through the wetted reach).

5.2 Quantitative results

For the quantitative portion of the aerial photograph analysis we looked at four different types of criteria to identify physical changes to the Santa Clara River channel (Table 1; see also section 4.1.1 for descriptions of criteria). Because of difficulties in identifying and measuring the width/number of channels and number/dimensions of vegetated islands, because of the varying resolutions and contrasts of the photographs, we concluded that analysis of these two criteria were less meaningful for this study. In other words, there was more variation due to the ability to identify the features for the varying quality of the photos than there was actual variation in the system. While we believe that these criteria may be a valid indicator of channel change, more study would be needed to adequately quantify these features so they were used a supplementary qualitative metric.

For this study we found that measurement of the "active corridor" (see section 4.1.1) was the most useful and easiest to work with to identify channel changes. In most cases there is enough vegetation along the banks that the active braiding corridor is easily identified, and changes in the width of the corridor can be tracked from year-to-year.

Figure 5 summarizes the changes in active corridor width over the time span of the reviewed photos. Within the Newhall reach, the width of the "active corridor" at the four measured cross-sections varies from year-to-year by as much as 500 feet, though most of the variation is considerably less. One station, in the narrows above the Piru Basin, has a very consistent channel width, varying by less than about 50 feet from year to year.

To provide additional analysis, we looked at a series of recent photos (1994, 2000, and 2002-2005) at one cross section downstream of the Castaic confluence. For this photo set, the channel widened significantly between 1994 and 2000 (probably in response to the 1995 or 1998 large

[3] See Reichard and others (1999) for a discussion of the hydrogeology of these shallow ground water areas; although downstream from the Los Angeles County line, results are applicable to the upstream as well, as discussed later in this report.

storms), but showed almost no change between 2000 and 2004 (Figure 6). The channel then widened considerably again in response to the high-flow events in 2005.

As a secondary check of the numbers derived for the measured standardized cross sections, we also measured active channel widths at approximately twenty different locations through the Newhall Reach on three different photo sets—1967, 2004, and 2005. From these measurements an average active braiding corridor width was calculated and compared with the other years. In 1967, the average channel width was approximately 580 feet, which was significantly wider than the average width in 2002 (392 feet). However, after the 2005 storms, the active width was approximately 560 feet, similar to the 1967 conditions.

The "relict corridor" (see section 4.1.2 for definition) also proved useful as a secondary criterion, providing a measurement of potential changes due to agricultural encroachment or constriction of the flood corridor. Measurement of the "relict corridor" at the standard cross sections showed that while there was some variation between photos, there is no consistent trend of agricultural constriction to the Santa Clara River flood corridor. These measurements, along with qualitative observations that within the Newhall reach agricultural activities were generally restricted to outside the active corridor, suggest that agricultural encroachment has not historically affected the geomorphology of the Santa Clara River within the Newhall Reach.

6. DISCUSSION

The Santa Clara River is a dynamic, episodic system. The above analyses highlight the magnitude of geomorphic change over the course of recent history, in response to natural and human disturbances in the watershed. Understanding the magnitude of past response is a key factor in assessing the potential response to future urbanization within the watershed.

The construction of Castaic Dam in 1974, regulating approximately 25 percent of the watershed at the L.A./Ventura County line, cut off a significant supply of sediment to the Santa Clara River. This change, however, does not appear to have had an effect on the channel dimensions of the Santa Clara River mainstem. The width of the active corridor, as well as the general form of the channel, are generally consistent both before and after construction of the dam. It appears that the Santa Clara River adjusted without morphological expression to absorb this change. One factor contributing to the lack of change is the seemingly large volume of sediment stored in the tectonic basin above the county line—a result of bedrock control associated with movement along the San Gabriel fault, which supports the large extent of semi-consolidated and alluvial deposits adjoining the drainage net.

The amount of vegetation within the Santa Clara River corridor appears to have increased since the 1960s, likely due to the increased summer return flows from agricultural water and to year-round augmentation of baseflows due to treated effluent discharge to the river. However, this vegetation does not seem to provide enough erosion resistance to maintain a "stable" channel capable of withstanding regular 're-sets', which occur at intervals averaging about a decade – or much less than the expected lifetime of the riparian woodlands which do get established. Despite heavy vegetation on the active channel banks near Newhall ranch and in areas of shallow ground-water, the stream still responds to large events by a general widening and/or shift of the channel. The role of vegetation in large-channel stability and morphology in Southern and Central California does fundamentally differ from that of smaller streams and streams elsewhere in the country. The geomorophic and historical record shows that resets have been occurring throughout the recent geologic past in basins exceeding a certain size. One partial explanation may be that 're-set' flood events in these larger channels exert stresses beneath or around the riparian vegetation exceeding the vegetation's threshold of stability[4].

[4] Sedimentologists note that crossbeds in the alluvium of the Santa Clara River are often 8 to 12 feet high, equal or greater than the depth to which roots can interpenetrate in most riparian settings in the region.

As stated above, the Santa Clara River, as with many streams in semi-arid southern California, is highly episodic. Concepts of "normal" or "average" sediment-supply and flow conditions have limited value in this "flashy" environment where episodic storm and wildfire events have enormous influence on sediment and stormflow conditions. Many of these channels are actively adjusting to lower flows than the last major event, which may have occurred some years before[5] (Hecht, 1993). In these streams, a large portion of the sediment movement events can occur in a matter of hours or days. In many of these channels most sediment is moved—and most bed changes occur—during the large flow events resulting from storms that may be expected approximately every 5 to 15 years (c.f., Capelli and Keller, 1993; Hecht,1993; Inman and Jenkins, 1999; Knudsen and others, 1992; Kroll and Porterfield, 1969).

Evidence of episodic channel changes can be seen in the Newhall reach of the Santa Clara River. Based on aerial-photograph interpretation of a near-yearly sequence of aerial photographs from within the last decade, the channel appears to maintain a consistent planform during average or dry rainfall years (such as between 2000 and 2004). Large events, however, (such as that which occurred in February 1998 and January 2005) can significantly modify this channel form. This widened and/or shifted channel (like that which was present after the 1998 or 2005 stormflow events) then sets the geomorphic template for subsequent normal to dry years. This model, similar to that described for the Ventura River by Capelli and Keller (1993), suggests that the geomorphology of the Santa Clara River is primarily driven by these large events.

Other perturbations which potentially affect channel geometry appear to have transitory or minor manifestations. For example, effects on the channel width due to 1980s levee construction are barely discernible by the first few years of the 21st century, probably mostly due to morphologic compensation associated with the mid- to late-1990s storm events.

[5] Actively adjusting channels may be aggrading, incising, expanding or otherwise changing channel dimensions, depending on the magnitude, type, and various effects of the episodic event.

7. CONCLUSIONS

Based on the study of historic aerial photographs described above we conclude that:

- Major perturbations within the Santa Clara River watershed (dam construction, levee construction, changes in flows in response to decadal-scale climatic patterns, and increases in woody vegetation) do not appear to have had a significant impact on the geomorphic expression of the Santa Clara River, as quantified from measurements made from a series of historical aerial photographs flown during the years 1927 through 2005.

- Large events (those which are typically not as affected by increases in impervious area and associated increases in stormwater peaks and runoff volume) can completely alter the form of the Santa Clara River channel. We call these events "re-set" events. These events, perhaps occurring on average once every ten years, are a dominant force in defining channel characteristics.

- The geomorphic dominance of "re-set" events overwhelms geomorphic effects of hydromodification on smaller events. Due to these episodic "re-sets" we do not expect hydromodification feedback "unraveling" of the Santa Clara River mainstem, as is seen in many smaller southern California watersheds[6]. The "re-set" events appear to adequately buffer changes that may occur in short-term sediment transport.

- While there is no expected increase in summer flows due to additional treated effluent discharge to the Santa Clara River, even if summer baseflow do increase we would not expect a significant change within the channel. Additional growth in the extent or density of vegetation is not anticipated, as the reach near Newhall already appears to have enough flow to support summer vegetation, and the existing vegetation does not appear to affect channel form for durations longer than the "re-set" interval. Further, re-sets occur at intervals significantly shorter than the period required for maturation of riparian vegetation, such that full development of bank-holding properties is frequently interrupted.

- Given that the channel morphology of the Santa Clara River mainstem has not adjusted significantly to much larger perturbations in flow, sediment yield, and riparian

[6] In many smaller streams, hydromodification of moderate events can induce incision of the stream bed, which reduces the connection of the stream to the floodplain. This disconnect, in turn, increases the erosive forces of the flows (concentrating more flow in the channel) and causing further erosion, and thus a positive feedback response.

vegetation growth factors, within the Newhall reach, we do not expect a significant geomorphic impact to the Santa Clara River mainstem due to the anticipated increase in 'urban area' from four to nine percent.

8. LIMITATIONS

The analyses in this report were designed to help bracket the range of likely effects on the geomorphology of the Santa Clara River due to proposed urban expansion under the General Plan, inclusive of the Newhall Ranch Specific Plan projects. It does not consider specific elements of the project or of evolving mitigation measures; rather, it focuses upon the susceptibility to perturbation of the Santa Clara River corridor as a whole. We believe that it conforms with the standard of care applicable to reconnaissance studies of this nature; no other warranty, expressed or implied, is made.

The above analyses and discussion were intended to assess the potential cumulative impacts to the Santa Clara River *mainstem* (not tributaries) due to the anticipated urban expansion in the watershed. While we conclude that urban expansion from approximately four- to nine-percent urbanized (not 'impervious') will not significantly affect the channel geomorphology of the Santa Clara River, we do expect that there might be a response to urbanization on a larger scale. However, further study would be required to define what the likely threshold and magnitude of response might be.

We ask readers to note that this is a reconnaissance report. It is intended to bracket likely future conditions, to identify factors which must be better known, and to help guide initial planning. This report should *not* be used to site or design individual facilities without further site-specific investigations. Similarly, it is *not* intended to serve as basis for flood management or detailed floodplain planning, both of which should be conducted by well-defined and site-specific procedures, and which frequently require multiple lines of evidence.

The application of geomorphic history to inferring future channel and corridor change has a long and respected record in the earth sciences. As with all history or archival analysis, the better the record is known and understood, the more relevant and predictive the analysis can be. We do encourage readers who have knowledge of other events or processes which may have affected the river to let the authors know at the first available opportunity. The authors and their contacts via several different media are given on the signature page of this report.

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TABLES

Table 1. Aerial photograph cross section data at selected locations near Newhall Ranch, Los Angeles County, CA. See text for explanation and interpretation of data. Locations of cross section are labeled on Figure 2. Photo sources are listed in Appendix A.

Cross section	location description	photo date	width of active braiding corridor (feet)	width of relict braiding corridor (feet)	is there one primary channel visible?	width of main channel (feet)	number of identifiable channels	total width of channels (including main) (feet)	number of islands	length of islands encountered (feet)	width of islands (feet)	vegetation	other descriptions
X1	downstream of Castaic	8/16/1947	570	1247	yes?	71	3?	107	can't define	n/a	n/a	moderately vegetated with some portions of relict corridor heavily vegetated	Just downstream a heavily vegetated bar is cut by a very distinct secondary channel
		7/20/1966	729	1173	yes	27	1	27	1	497	86	almost no vegetation within primary corridor except two areas near the primary channel and scattered small patches, only scattered vegetation on relict corridor	while there is only one main channel the rest of the primary corridor is section is almost deltaic in planform, spreading out from constriction upstream (possibly high sediment load coming in from Castaic)
		5/26/1989	173	1171	yes, but small	43	1	43	0	n/a	n/a	banks of meander corridor have scattered vegetation (less than 2000) with very little within braiding corridor	meander corridor is very distinct and straight, could be from flood control dredging;
		6/1/1994	337	1167	yes	72	2	97	1	551	171	light to moderate vegetation on braiding corridor banks	very little vegetation within braiding corridor
		2/1/2002	505	984	yes	42	2	50	poorly defined	n/a	n/a	relict braiding corridor is well-vegetated; meander belt/bar is lightly to moderately vegetated; at least one main channel bank is well-vegetated (alternates w/ meanders)	secondary channel essentially cuts off meander
		4/1/2004	505	978	no	n/a	3	87	2	929, 251	248, 56	heavy vegetation along former primary channel; relict corridor also heavily vegetated	there are two distinct channels, approximately the same size
		3/1/2003	510	965	yes	75	1	45	0	n/a	n/a	heavy vegetation on northern bank; some scattered vegetation within active corridor and surrounding low-flow channel	channel branches just downstream of cross section; very similar to 2002 and 2004 photos
		2/1/2005	601	999	no	n/a	3	106	poorly defined	n/a	n/a	no vegetation in main portion of channel; right bank has heavy tree cover, left bank has few trees	the main channel is about 340 feet wide with an obvious overbank deposition area (with very little vegetation)
X2	Upstream of County line	8/16/1947	532	1197	yes	89	2	133	1	355	133	vegetation is heavy (probably trees) on relict corridor; moderate (probably scrub) within active corridor (difficult to distinguish)	very distinguishable difference between active and relict corridor within this reach
		3/6/1963	491	1352	no	n/a	difficult to define	n/a	6	252, 283, 82, 441, 94, 410	44, 57, 52, 76, 38,63	several well-defined islands behind established vegetation (individual shrubs or small trees); relict corridor has moderate to heavy tree cover	very braided planform; switches to predominately single-thread channel just downstream
		5/26/1989	651	651	yes	43	3	108	1	2385	477	relict corridor has scattered trees with moderate to heavy shrub or grass cover; central island (along levee) has similar vegetation	well-defined flood control channel, but has been breached and there is a significant secondary channel to the north of the levees; included a portion of the island between the flood control channel and the secondary channel in the relict channel (no sign of recent deposition)

Cross section	location description	photo date	width of active braiding corridor (feet)	width of relict braiding corridor (feet)	is there one primary channel visible?	width of main channel (feet)	number of identifiable channels	total width of channels (including main) (feet)	number of islands	length of islands encountered (feet)	width of islands (feet)	vegetation	other descriptions
		6/1/2002	608	1258	yes	131	1	131	0	n/a	n/a	relict corridor on north bank has heavy tree cover; meander bends are eroding tree bank vegetation in places	stream has meandering planform, though meander belt (400' wide) has high sediment deposition and little vegetation; no evidence of flood control levees (meanders have widened to erode levees); active channel includes meander belt and area of significant recent sediment deposition to the north of the meander belt
		2/1/2005	674	1240	yes	97	3	192	1	475	155	almost no vegetation within active channel; relict corridor on both banks has moderate tree cover; much vegetation eroded away since 2002	numerous very small channels present as well
X3	downstream of county line	8/16/1947	362	805	yes, at this xs	80	2	121	can't define	n/a	n/a	outer banks of braiding corridor seem heavily vegetated	there seems to be one main channel through this reach, with extensive deposition of sediment outside of the channel
		7/20/1966	140	714	yes	51	2	77	0	n/a	n/a	banks of braiding corridor are heavily vegetated	
		5/26/1989	273	864	yes	91	2	114	1	136	23	only scattered vegetation on banks of braiding corridor	braiding corridor looks as though it may be a leveed flood control channel
		2/1/2002	249	1466	yes	41	3	79	2	344, 219	66, 36	scattered vegetation on u/s ends of islands; some recent deposition of sediment within relict braiding corridor (which is predominately heavily vegetated	
		2/1/2005	587	1472	yes	97	3	145	1	543	110	no vegetation in active corridor; right bank has heavy shrub cover with some trees, left bank has light shrub cover	
X4	upstream of Piru Basin	8/16/1947	282	885	yes	121	1	121	can't define	n/a	n/a	little to no vegetation within braiding corridor; relict braiding corridor has heavy tree/shrub cover	
		7/20/1966	281	383	no	n/a	3	26	poorly defined	n/a	n/a		
		5/26/1989	318	591	yes	68	1	68	1	91	23	meander belt banks lined with trees; meander belt itself covered with shrubs	"braiding corridor" is actually the meander belt; meander belt outside of channel is heavily vegetated
		2/1/2002	266	426	yes	35	3	45	1	340	36		secondary channels may be present in other photos, but resolution is poor, esp. 1948
		2/1/2005	281	495	yes	44	1	44	0	n/a	n/a	vegetation on right bank of main channel has diverted some flow over the relict corridor, though conditions are similar in 2002; moderate to heavy trees and shrubs on both banks	conditions are very similar to 2002, but with slightly wider and much clearer channel

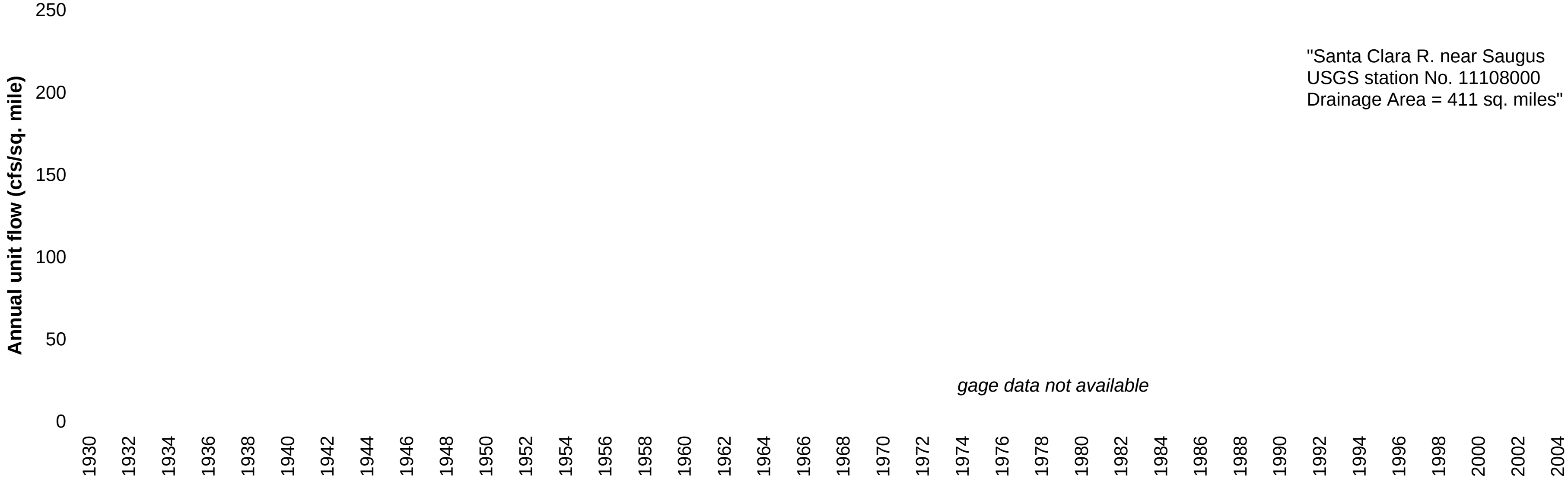
Cross section	location description	photo date	width of active braiding corridor (feet)	width of relict braiding corridor (feet)	is there one primary channel visible?	width of main channel (feet)	number of identifiable channels	total width of channels (including main) (feet)	number of islands	length of islands encountered (feet)	width of islands (feet)	vegetation	other descriptions
X5	upstream of Piru confluence	4/1/1927	1834	3191	no	n/a	many	n/a	3	3060, 1170, 468	540, 450, 90	sparse scrub vegetation within active corridor, but enough to define the complex channel pattern; only slightly more vegetation (or possibly just less recent sediment deposition) in relict corridor	relict channel is mainly an artifact of flow deflection by several long levees just upstream; typical braided stream with channels of varying widths and scales (can not define number of channels due to complexity and scale variation of channels); only measured large islands
		8/16/1947	1449	3066	no	n/a	0	n/a	1	1282	279	island appears heavily vegetated; relict channel has moderate vegetation, possibly some farming	active channel is very burnt in; no evidence of levees, but would be difficult to see
		11/10/1966	957	3051	no	n/a	complex channel pattern	n/a	too complex to define	n/a	n/a	no vegetation within active corridor; sparse scrub vegetation within relict corridor, but very patchy (may be due to clearing)	flood control channel is present down middle of active corridor (196' wide); stream has complex braiding pattern, even with flood control channel present
		6/20/1989	1796	2993	no	n/a	complex channel pattern	n/a	too complex to define	n/a	n/a	light scrub vegetation within active corridor; vegetation is obviously stabilizing small islands, at least until the next big event; relict corridor is sparsely vegetated	little evidence of flood control channel but may have been some excavation in middle of active corridor (~300' wide);
		6/1/2002	1730	2452	no	n/a	5	1000	3	1200, 1085, 1520	384, 406, 400	moderate scrub vegetation on islands within active channel, similar to 1989 but slightly heavier	channels were relatively easy to pick out due to moderate scrub vegetation; channel width does not necessarily correlate to other measurements (where the only measurable parameter was wetted width)
X6	downstream of Piru confluence	4/1/1927	1713	1983	yes	18	1	18	0	n/a	n/a	no vegetation within braiding corridor; only scattered vegetation on relict corridor; heavy trees along portions of the south bank of relict corridor	very wide braided corridor with little definition (too burnt-in to define secondary channels)
		8/16/1947	1767	1983	no	n/a	0	n/a	0	n/a	n/a	looks similar to 1927 conditions	
		9/1/1957	1220	1449	yes	25	3	51	2	875, 1750	325, 425	very sparse scrub vegetation in active corridor; some small trees on relict corridor (where corridor is present)	well-defined flood control channel through this reach (136' wide), but there are several secondary channels outside the levees; diversion ponds present near the north bank; larger island cut by flood control channel
		11/10/1966	1132	1563	yes	32	4	388	2	2125, 750	850, 250	large island is moderately vegetated with scrub and one line of heavy vegetation; relict braiding corridor is similarly vegetated	braiding corridor has been confined on both sides by levees (especially on the northern portion); looks like the southern levee was recently overtopped (that area was included in the relict corridor); main channel divides in two in some areas
		6/20/1989	1082	1082	no	n/a	n/a	n/a	1	685	180	sparse scrub vegetation growing on poorly-defined islands within channel and near piers	lots of recent grading within the channel, several levees in the middle of the corridor and a series of piers on the southern bank
		6/1/2002	1050	1245	no	n/a	none	n/a	0	n/a	n/a	very little vegetation in this portion of the stream; some scattered scrub on relict corridor, even less within active channel	217-foot wide flood control channel begins just d/s of xs (poorly defined, though)

Cross section	location description	photo date	width of active braiding corridor (feet)	width of relict braiding corridor (feet)	is there one primary channel visible?	width of main channel (feet)	number of identifiable channels	total width of channels (including main) (feet)	number of islands	length of islands encountered (feet)	width of islands (feet)	vegetation	other descriptions
X7	between Piru and Sespe (ground-water upwelling)	8/16/1947	1694	2472	no	n/a	4	difficult to define the widths	can't define	n/a	n/a	this area is heavily vegetated; difficult to distinguish active braiding corridor from relict corridor	looks like there has been some flood control work in this area, two very straight channels through here, but masked some by vegetation
		9/1/1957	1446	2253	yes	168	4	370	2	4624, 8500	272, 408	northern portion of the corridor (including flood control channels) have heavy vegetation outside of the channels; the southern portion of the corridor has sparse vegetation	the main channel, and possibly the secondary channel, have been altered for flood control
		6/20/1989	749	2697	yes	37	2	150	1	1386	449	thick vegetation (with trees) along main channel; very little vegetation otherwise within active braiding corridor; moderate vegetation in northern portion of relict corridor, but only scattered brush in southern	no evidence of flood control alteration; downstream the corridor has been severely constrained by encroaching agriculture
		6/1/2002	551	2767	yes	42	2	65	1	396	108	heavy vegetation (trees) along secondary channel along north bank; scattered shrub (with some trees) vegetation within active corridor, some defining the edges of bars; heavy scrub vegetation on south relict corridor with scattered trees; heavy trees and scrub on northern relict corridor	just upstream there is a distinct main active corridor and an overbank area of deposition; the main active corridor has portions lined with heavy trees, but becomes less distinct further upstream (no vegetation)
X8	just downstream of Sespe Creek	8/20/1947	2003	2003	no	n/a	6	601	can't define	n/a	n/a	limited, if any	photo very burnt in, but channels less well-defined than in other photos
		8/13/1967	701	2203	yes	100	3	250	1	2804	401	limited, if any	one single-thread channel with one minor channel
		6/20/1989	1532	1723	yes, but less so than 1967	153	5	306	poorly defined; small and well-vegetated	n/a	n/a	islands are more heavily vegetated away from main channel; main channel bank is ~75 vegetated w/ thin vegetation line; more vegetation than in other photos	
		6/1/2002	670	1820	no	n/a	3	170	1	801	216	islands are moderately well-vegetated; relict corridor has scattered vegetation, Sespe mainstem has heavy vegetation along low-flow channels	interpretation complicated by Sespe confluence, but looks very similar to 1989 photo

FIGURES

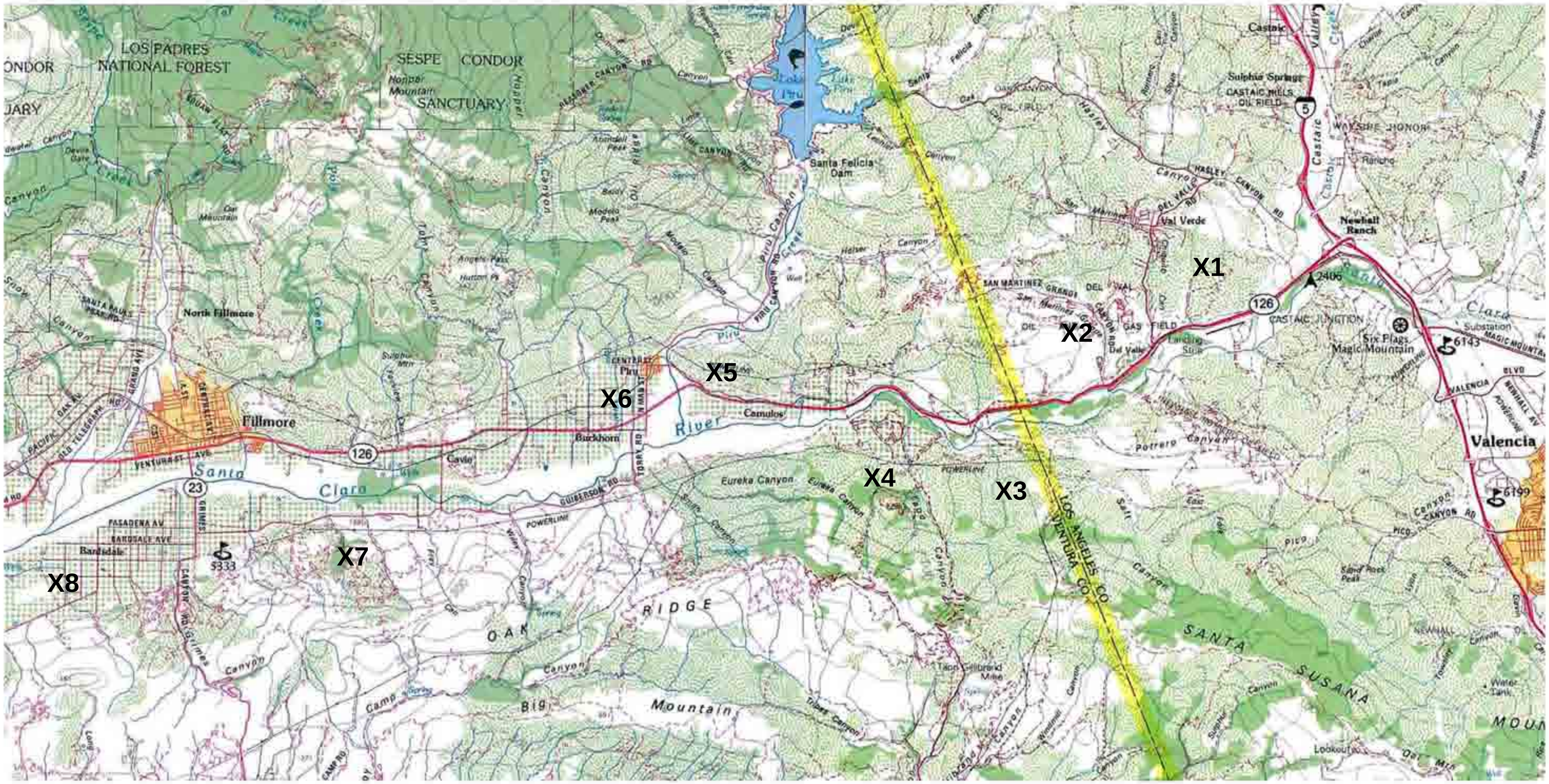
Balance Hydrologics, Inc.

Figure 1. Timeline of selected major events in the upper Santa Clara River, California. Also shown (at top) are the years for which aerial photographs were analyzed.



Balance Hydrologics, Inc.

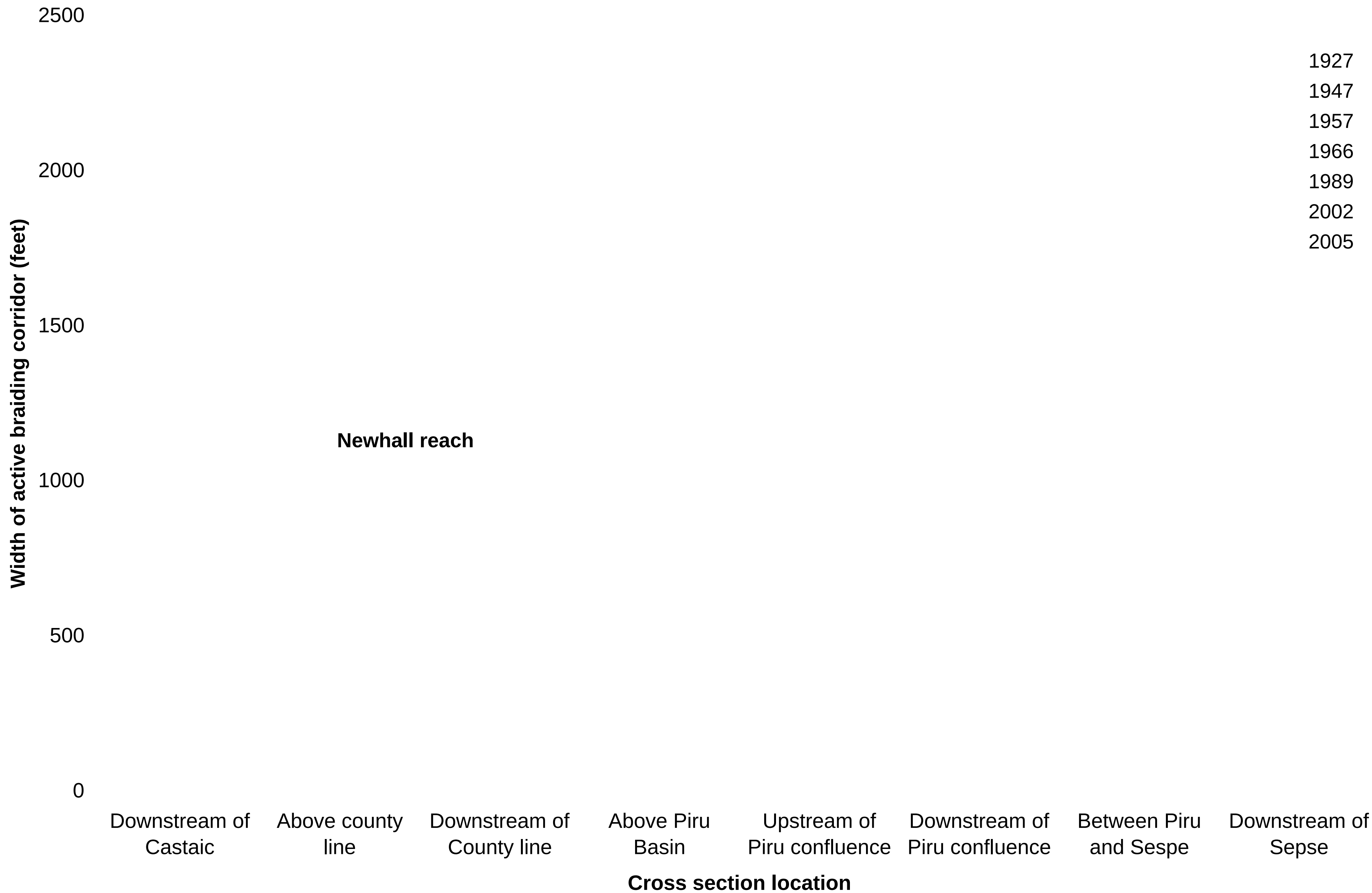
Figure 2. Annual unit runoff (annual flow per square mile) for the Santa Clara River near Newhall at two separate gaging stations. Note that flow in drier years has increased since the 1960s, most likely due to release of treated effluent to the River.



Balance Hydrologics, Inc.

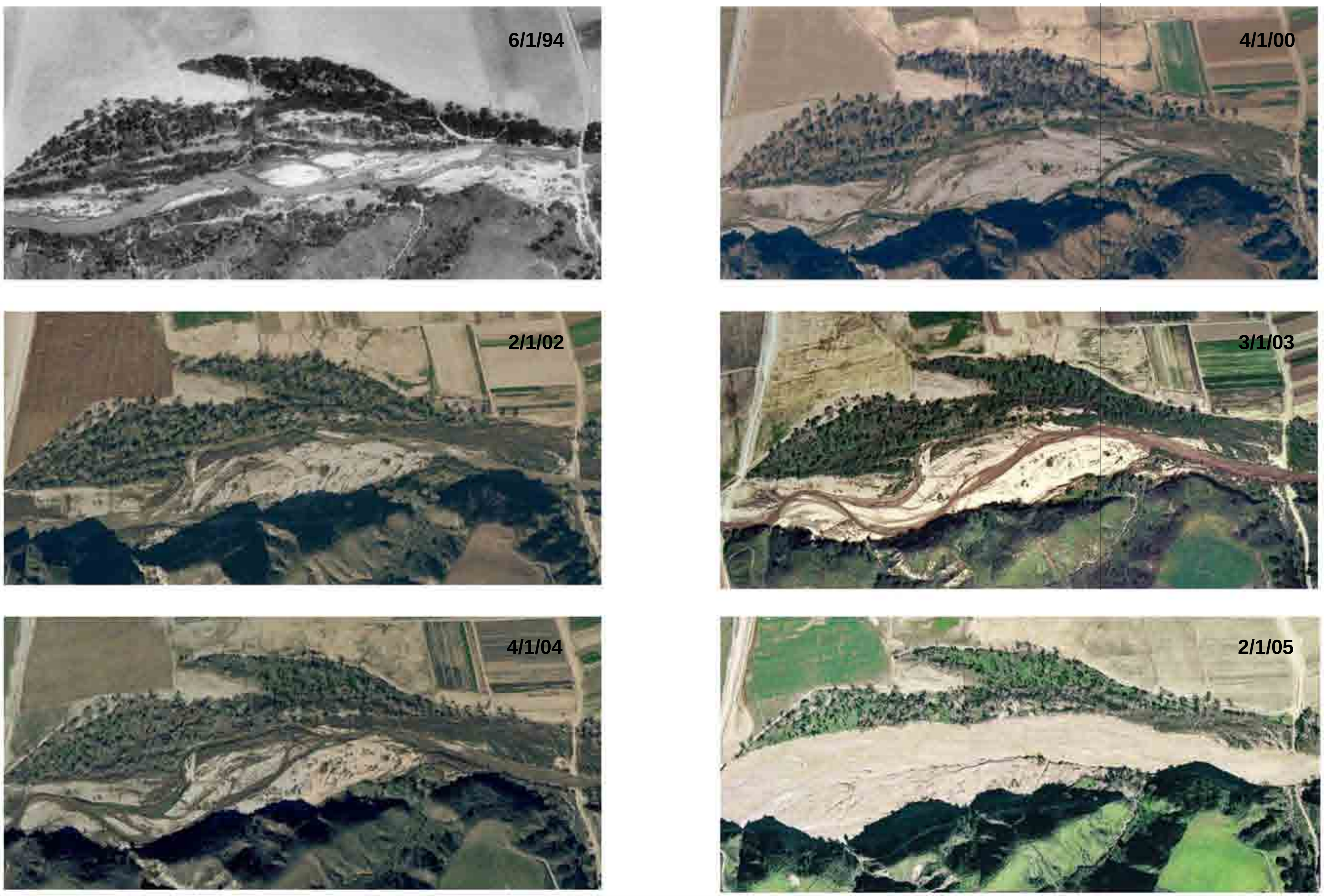
Figure 3. Location of channel cross sections on the Santa Clara River, measured on aerial photographs.

Figure 4. Comparison of 2004 and 2005 conditions on the Santa Clara River, just downstream of the L.A./Ventura County line. Note that significant channel widening occurred in response to the 2005 events, even in heavily vegetated areas. See appendix A for photo sources.



Balance Hydrologics, Inc.

Figure 5. Measurements of active braiding corridor width from aerial photographs, for cross sections on the Santa Clara River.



Balance Hydrologics, Inc.

Figure 6. Progression of aerial photographs downstream of Castaic Canyon, showing channel change between 1993 and 2005. Note that there was little change between 2000 and 2004, but the active corridor widened significantly in response to the 2005 events, and that channel traces within the active corridor were effectively erased. See appendix A for photo sources.

APPENDICES

Appendix A: Summary of aerial photographs used for assessment of potential hydromodification effects on the Santa Clara River, Newhall, California.

Date	Number of photos	Nominal Scale	Hard Copy?	Electronic copy?	Image Type	Source/Vendor	Remarks
1927	6	2000	yes	yes	b/w	Whittier College: 80, 82, 84, F27, F28, F31	Only available photography prior to the March 1928 collapse of the Saint Francis Dam. Photos show area near Piru confluence
August 16, 1947	34	24000	no	yes	b/w - Vert Cart	USGS_GS-EM, Rolls 3, 5, 7	Previews downloaded already are sufficient.
1957	2	2000	yes	yes	b/w	Whittier College: 109, 123	1957 photos are for justdownstream of Piru Creek. Piru Dam was closed in 1957.
March 6, 1963	1 (2)	21670	no	yes	b/w - Vert Recon	USGS_ARMC630001L0049 a,b	high resolution scans
July 20, 1966	2 (4)	21670	no	yes	b/w - Vert Recon	USGS_ARM6625001L1362 a,b USGS_ARM6625001R1357 a,b	high resolution scans
August 19, 1966	1 (2)	21670	no	yes	b/w - Vert Recon	USGS_ARM6628502L1314 a,b	high resolution scans
September 13, 1966	1 (2)	21670	no	yes	b/w - Vert Recon	USGS_ARM6631405R1165 a,b	high resolution scans
November 10, 1966	2 (4)	21670	no	yes	b/w - Vert Recon	USGS_ARM6638605L1238 a,b USGS_ARM6638605L1242 a,b	high resolution scans
August 13, 1967	1	30000	no	yes	b/w - Vert Cart	USGS_AR1VBUK00010110	Preview already obtained. Downstream of Sespe Creek
May 26, 1989	5	31680	yes	yes	b/w	WAC-89CA, 27-42	LA County
						WAC-89CA, 27-62	LA County
						WAC-89CA, 27-84	LA County
						WAC-89CA, 27-109	LA County
						WAC-89CA, 27-135	LA County
May 1, 1989	6	2000	yes	yes	Color	PAS_89 06-20 PW VEN 7-229	Ventura County
						PAS_89 06-20 PW VEN 7-231	Ventura County
						PAS_89 06-20 PW VEN 7-233	Ventura County
						PAS_89 06-20 PW VEN 7-235	Ventura County
						PAS_89 06-20 PW VEN 7-269	Ventura County
						PAS_89 06-20 PW VEN 7-237	Ventura County
June 1, 1994	n/a	unknown			b/w, georeferenced	GlobeXplorer	downloaded select sections from LA and Ventura County
April 1, 2000	n/a	unknown	no	yes	color, georeferenced	GlobeXplorer	downloaded select sections from LA and Ventura County
February 1, 2002	4	Unknown	no	yes	Color, georeferenced	AirPhotoUSA (from GeoSyntec)	Covers all of Newhall project area

Date	Number of photos	Nominal Scale	Hard Copy?	Electronic copy?	Image Type	Source/Vendor	Remarks
July 23, 2002	n/a	unknown	no	yes	Color, georeferenced	GlobeXplorer	downloaded select sections from LA and Ventura County
March 1, 2003	n/a	unknown	no	yes	Color, georeferenced	GlobeXplorer	downloaded select sections from LA and Ventura County
April 1, 2004	n/a	unknown	no	yes	Color, georeferenced	GlobeXplorer	downloaded select sections from LA and Ventura County
October 13, 2004	n/a	unknown	no	yes	Color, georeferenced	GlobeXplorer	downloaded select sections from LA and Ventura County
February 1, 2005	n/a	unknown	no	yes	Color, georeferenced	GlobeXplorer	only avaialable for LA County

APPENDIX G

NEWHALL RANCH HYDROMODIFICATION ANALYSIS

NEWHALL RANCH
HYDROMODIFICATION CONTROL

Prepared for

Newhall Land
Valencia, California

Prepared by

Geosyntec Consultants
Oakland, California
Los Angeles, California

January 2008

Table of Contents

List of Figures

1. INTRODUCTION

The purpose of this report is to summarize hydrograph modification (hydromodification) control alternatives for the Newhall Ranch project areas tributary to the Santa Clara River tributaries: Lion, Long, Potrero, Chiquito, and San Martinez Grande Canyons (herein referred to as "the tributaries"). Geosyntec Consultants has developed and used in this report a state-of-the-art analytical technique to evaluate and address hydromodification impacts that result from watershed development. This unique approach has been developed to provide a more accurate assessment of the changes that take place in stormwater runoff, stream flows, and sediment transport characteristics due to watershed development than traditional hydrologic analysis methodologies. It is intended to allow for development of more effective long-term solutions to protect the receiving channels from excessive erosion and degradation.

Three basic hydromodification control alternatives are available:

1. Hydromodification control using flow duration control basins only (called "on-site control") to mimic the natural hydrologic characteristics (flow rates, volumes, and duration) of the project area.

2. Hydromodification control using geomorphically-referenced natural channel design, such as incorporating in-stream grade control structures to provide an equilibrium slope that maintains the existing sediment transport capacity (called "in-stream control"). This option can also be used to restore already degraded stream channels.

3. Hydromodification control using a combination of flow duration control basins and in-stream grade control (called the "mixed control alternative").

Additional alternatives that were not investigated for this report include "bypass" and storage of excess runoff volumes for irrigation reuse. The bypass alternative consists of piping excess stormwater runoff flows directly to the Santa Clara River instead of to a tributary canyon. The Santa Clara River is capable of withstanding excess flows from the Newhall Land development projects without hydromodification impacts (see further Appendix F, Balance Hydrologics, 2005). This alternative may be feasible for portions of the Homestead and Potrero Valley Projects that are in close proximity to the Santa Clara River. In the irrigation reuse alternative, excess surface runoff could be directed to storage tanks or above ground water features located in parks or a golf course for irrigation reuse, or alternatively, to blend excess stormwater runoff with reclaimed water from the proposed Newhall Water Reclamation Plant for reuse. These additional alternatives may be investigated at the project level.

This report is organized as follows:

Section 2 summarizes hydromodification and its effects on the fluvial geomorphology of the receiving waters, and describes the computational steps used in our analysis. This section also summarizes the hydromodification control options that will be implemented on the Newhall Ranch projects.

Section 3 presents normalized sizing charts for hydromodification (flow duration) control basins for the on-site control alternative and describes the methodology used to produce the charts. These charts provide unit volume and area requirements that are applicable the Newhall Ranch Specific Plan area.

A technical memorandum prepared by Phillip Williams and Associates, Attachment A to this report, provides the basis of design for in-stream control in the Newhall Ranch tributary drainages (Lion Canyon, Long Canyon, Potrero Canyon, Chiquito Canyon, and San Martinez Grande Canyon). Appendix A also describes the existing geomorphic and hydrologic setting within these tributaries.

The evaluation contained in this report was based on preliminary project land use plans and the following assumptions:

- The hydrologic model assumes that the proposed water quality treatment BMPs will infiltrate and/or evapotranspire a minimum of 20% of the captured runoff volume. The water quality treatment BMPs will be sized to capture 80 percent of the average annual runoff volume.

- Existing channel geometry and longitudinal slope are as specified by PACE in the tributary reports for Chiquito, Lion, Long, and Potrero Canyons (PACE 2005).

- The critical shear stress values were primarily based on NRCS soil type data and measured data provided in the Hydraulic, Sediment Yield and Sediment Transport Study conducted by URS (2002) for Chiquito Canyon. Critical shear stress values for Long, Lion and Potrero were determined from bed grain size distributions and channel hydraulics.

- The channel material in the post-developed condition was assumed to be the same as that used for the existing condition. In other words, the material type and critical shear stresses were held constant from pre-development to post-development.

- The amount of bed material (sediment) transported under existing conditions in the stable reaches of each canyon represents the baseline condition used in tributary design to be maintained in the post-development condition.

- Reductions in sediment supply were provided by PWA using the proposed project developing area. Changes in sediment supply (in percent) is accounted for by reducing the sediment transport capacity (in percent) by an equivalent amount in the post-developed condition.

2. HYDROLOGIC MODELING

Geosyntec modeled the pre- and post-development hydrology, hydraulics, and sediment transport capacity of flows in the tributaries. Two land use scenarios were analyzed: 1) existing conditions and 2) developed conditions with water quality treatment BMPs. Developed conditions include the proposed natural channel designs developed by others.

The existing condition represents pre-development for the NRSP projects. Existing land uses in the NRSP area consist of open space, agriculture, and oil and gas extraction wells with associated access roads. Before human disturbances, channels generally evolved over time to balance watershed characteristics (e.g., rainfall patterns, surface runoff, and infiltration rates) and sediment load (e.g., soil type and erodibility) with channel planform, slope, cross sectional dimensions, and boundary material resilience. The currently stable reaches in the existing condition are the baseline conditions to be maintained after development, as opposed to channel conditions prior to human disturbance

Proposed conditions represent post-development with water quality treatment BMPs in place for each tributary watershed consistent with those proposed in the NRSP Subregional SWMP and the Project Water Quality Technical Reports. Proposed conditions are compared to the existing conditions to evaluate changes in sediment transport capacity created by the proposed project. Project Design Features (PDFs) will be designed to avoid, reduce and/or manage stormwater runoff in a way that reduces potential impacts to less than significant when compared to existing conditions. Reductions in sediment supply caused by covering the landscape is accounted for by reducing the sediment transport capacity in the proposed channel by the same percentage.

2.1. <u>Hydromodification</u>

2.1.1. Hydrologic Processes

It is well documented that urbanization modifies the natural watershed and stream hydrologic and geomorphic processes by altering the landscape, modifying vegetation and soil characteristics, and introducing impervious surfaces and drainage infrastructure. The resulting increases in the volume, frequency, and cumulative duration of runoff from development are known as hydromodification. Changes to the rainfall-runoff regime resulting from development intensifies sediment transport and erosion processes, and often leads to channel degradation and adjustment in channel morphology.

Research over the last decade has concluded that assessment of stream channel stability should address the long-term cumulative effects of all sediment-transporting and erosive flows. As a result, continuous hydrologic modeling and analysis is required to fully address changes in the full range of geomorphically significant flows and the long-term cumulative effects of watershed development.

Continuous hydrologic modeling incorporates the full distribution of all rainfall events and uses flow duration as a basis for work and sediment transport computations. This approach assesses all of the “geomorphically significant flows” regardless of their magnitude. No assumption is necessary regarding which storm (or storms) adequately characterizes all the important hydrologic conditions. This approach utilizes the entire rainfall record, thereby incorporating small and large storms, frequent sediment transporting flows, wet years and droughts, back-to-back storms, and antecedent conditions.

2.1.2. Geomorphic Processes

Stream channel size and form are established through a balance between the imposed flow energy, sediment type and supply, and the ability of the channel boundary to resist erosion, which is influenced by the presence and density of vegetation. A stable channel is loosely defined as one that neither aggrades nor degrades, but instead maintains its average cross-section, planform, and profile features over time and within a range of variance. In high sediment load systems, channel alignment and profile change frequently within limits. Pulse loads of sediment from episodic events, such as landslides, often result in a slug of sediment migrating downstream through the system. This slug causes aggradation of sediment followed by degradation as the slug is dispersed and transported downstream. This system may not appear stable, creating and destroying channel forms, but all this activity usually stays within the defined flood banks and is a natural condition in Southern California watersheds.

A stable channel system can tolerate short-term disturbances without significant change; e.g., El Nino winters or burned watershed. A disturbance of sufficient magnitude and duration that exceeds the system’s ability to self-regulate, such as watershed development, causes the channel to begin a permanent evolutionary change. Persistent changes in watershed hydrology and sediment supply can cause the system to adjust and not return to its previous form, but instead to evolve to a new one.

Research has shown that the frequency and duration of geomorphically significant flows control channel form and the sediment transport processes. Stream restoration professionals typically select a 1.5, 2-, or 5-year peak flow as the design flow for natural channel design. Common terminology refers to this as “bankfull flow”, “dominant”, or “most effective discharge.” However, research has also showed that urbanization changes the most effective discharge from its natural state to a much more frequently occurring flow. The continuous modeling approach explicitly incorporates the geomorphically significant flows under both existing and developed conditions, including changes in frequency of occurrence and magnitude.

2.1.3. Runoff Computational Methodology

The hydromodification analysis uses the USEPA Storm Water Management Model (SWMM) to generate a long-term stormwater flow rate and duration data for each of the canyons. SWMM was selected as it is capable of modeling stormwater treatment devices in addition to drainage areas and pipe and channel networks. SWMM is a public domain model that is widely used for modeling hydrologic and hydraulic processes affecting runoff from urban and natural drainages. The model can simulate all aspects of the urban hydrologic cycle, including rainfall, surface and subsurface runoff, flow routing through the drainage network, storage, and treatment. The model is particularly appropriate for analyzing both pre- and post-development flow duration because the model takes into account the effects of precipitation, topography, land use (accounting for any change in impervious cover), soils, and storage and treatment by Best Management Practices (BMPs) on surface runoff, infiltration, and evapotranspiration.

The SWMM model is designed to run in continuous simulation mode such that longer-term, more realistic hydrologic and hydraulic analyses could be performed. The continuous simulations allow for a direct frequency and duration analysis of flows in individual sub-watersheds and main-stem hydraulics. The continuous hourly rainfall record used for the analysis extends for 31 years, from 1972 through 2002.

Each canyon sub-watershed is divided into catchments to account for differences in topography, soils, and post-development land use. SWMM subdivides each catchment (drainage area) into two inclined planes, one for impervious areas, and one for pervious areas. A non-linear reservoir algorithm, coupling Manning's equation and the continuity equation, is applied to estimate runoff, taking into account rainfall intensity, initial losses, evapotranspiration, and infiltration (for pervious areas). The width and length of each plane is selected based on the drainage area configuration and existing and proposed drainage features. Thus, in addition to rainfall, input data characterizes imperviousness, soils, topography, and losses associated with evapotranspiration, infiltration, and initial losses. Flows are then routed to BMPs (where present) and then to the main/collector channels and pipes. SWMM uses dynamic routing of stormwater flows through natural channels or constructed channels and pipes to the outfalls to the receiving water. Outputs of continuous stream flow hydrographs are then used in the hydromodification computations described below.

Runoff volumes and flows are predicted for two scenarios:

- the pre-development (existing) condition, and
- the post-development with BMPs condition.

Further detail on the SWMM analysis used for this report is provided in Appendix B of the NRSP Sub-Regional SWMP.

2.1.4. Hydromodification Computational Methodology

The basis of the hydromodification analysis method is to compare the total amount of work that would be expected to move sediment and contribute to the erosion and deposition processes between pre- and post-development conditions. The total amount of work done can be thought of as equivalent to the total sediment load transported over a long period of time. The comparison is accomplished by considering the relative changes between pre and post project conditions as a ratio called the Erosion Potential (Ep). This approach does not presume the accuracy of sediment transport equations, but rather looks at the magnitude of change in work imposed on the channel by watershed development and looks at the magnitude of change in the transport of bed material. Comparing changes in terms of ratios is preferred because it reduces the affects of inaccuracies and uncertainty in the methodology and calculations.

Episodic events of fire, debris flows and/or landslides contribute slugs of sediment that migrate through the canyons as large scale sediment waves. At any given location, local channel dimensions and slope can change in response to episodic events. Although this methodology may consider several cross sections along the tributary alignment, it does not draw conclusions regarding the transport capacity between reaches. The dynamic nature and frequency of change during large flow events makes comparisons between reaches a short-term academic exercise. Instead, we look at the change in work between pre- and post-development continuously over a long rainfall record at representative cross-sections along the length of the channel.

Channel Hydraulics: Hydraulic calculations convert modeled flow rates to depth, velocity, and shear stress based on cross-section geometry, roughness, and slope. Shear stress is the force applied to the channel boundary during any given flow rate. Shear stress, depth, and velocity are taken from the central channel as opposed to the cross sectional average. The computations are completed following the Army Corps of Engineers HEC-2 method, where conveyance (K) is computed and summed between individual elevation points. Channel hydraulics are computed using normal flow[2] assumptions.

Work Index: The direction of current research is to use indices[3] to distinguish between eroding and non-eroding, or stable and unstable channel conditions (Booth, 1990; Bledsoe, 2001; MacRae, 1996; and SCVURPPP, 2005). Indices are attractive because they are simple to use and less expensive to apply compared to full scale sediment transport modeling. Sediment transport equations are only approximate and should be verified with field measurements. An un-calibrated sediment transport model is essentially an index method.

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[2] "Normal flow" assumptions mean that the slope of the water surface is the same as the slope of the channel bed, and no backwater conditions occur.

[3] "Indices" are metrics, such as the output from the Work Index or selected Sediment Transport equations, that can estimate, within several order of magnitude, parameters of interest. Indices are not intended as precise estimates.

Three forms of work indices are applied in this analysis:

Work Index	Description	No.
$W = \sum_{i=1}^{n} k \cdot (\tau_i - \tau_c)^a \cdot \Delta t_i$	Total Work Done (arbitrary units) Andrew Simon's bank stability model (2002)	(1)
$W = \sum_{i=1}^{n} (\tau_i - \tau_c) \cdot V \cdot \Delta t_i$	Total Work Done (ft-lbs/sq-ft) Effective stream power integrated over time.	(2)
$W = \sum_{i=1}^{n} \left(\tau_i / \tau_{ri} \right)^a \cdot \Delta t_i$	Wilcock-Crowe dimensionless sediment transport function. Incorporates grain size distribution and sand fraction (2003).	(3)

Where τ_c = critical shear stress that initiates bed mobility or erodes the weakest bank layer, τ_i = applied hydraulic shear stress, τ_{ri} = reference critical shear stress, V = mid-channel velocity (ft/sec), Δt_i = duration of flows (in hours), k = an erodibility coefficient, a = exponent and n = length of flow record.

The application of these indices requires some discussion. During the initial development of this methodology, Equations 1 and 2 were used to evaluate changes in work done on both the toe channel banks as well as the stream beds (SCVURPPP 2005, MacRae 1996). A recent advancement is the addition of Equation 3, which applies to the transport of bed material (sands and fine gravel). Another improvement is the use of Equation 1 as a model to predict the failure of *consolidated bank materials*. Andrew Simon, USDA Agricultural Research Service (2002), is using this equation with field measurements to determine the erodibility of consolidated bank materials. Therefore, Equations 1 and 2 are applied to represent changes in work done on consolidated bank materials, and Equation 3 is applied to represent changes in amount of *unconsolidated bed material* transported downstream.

The approach is to compare the Work Index between pre- and post- development scenarios. The relative change is represented as the *Erosion Potential* (Ep). The Erosion Potential, expressed as a ratio, is defined as:

$$Ep = \frac{W_{post}}{W_{pre}} \qquad (4)$$

Where W_{post} = work index estimated for proposed development, and W_{pre} = work index measured for the baseline condition.

MacRae (1993, 1996) recommended that the Erosion Potential remain the same under both developed and undeveloped conditions over the range of geomorphically significant flows. Management strategies that balance the future sediment transport characteristics (at baseline or below to account for reductions in supplies) are considered effective at achieving stable conditions and are the basis of the recommended hydromodification management approach.

For each drainage area upstream from a cross section of interest, a target Ep value must be defined. The goal is to match the long-term cumulative sediment load transported in the post-development condition to that of the pre-condition. Given the variety of factors that affect stream channel response, it is not necessary to achieve an Ep of exactly 1.0 in all cases. Therefore, the target is considered a mean value within an allowable range of tolerance or uncertainty. Although MacRae does not explicitly state a criterion, evaluation of his conclusion suggest MacRae is using a value of 20% as a decision criterion. Soar and Thorne (USACE, 2001) define a sediment transport capacity/sediment supply ratio (CSR) and suggests a value of 10% as a criteria for preserving channel stability. Geosyntec (SCVURPPP, 2005) correlated Ep to observed field conditions (stable and unstable) to empirically relate the likelihood of stream channel instabilities to the erosion potential. On the basis of this correlation, a 20% range about the target Ep has been selected as an acceptable criterion. Impacts analysis and control effectiveness including in-stream modifications are evaluated for their ability to maintain the target Ep = 1 ± 20%. To account for reductions in sediment supply, a lower target must be established in order to prevent stream erosion. For example, if an area experiences a 40% decrease in sediment supply due to development, the baseline Ep of 1.0 must be reduced by 40%, giving a target Ep value of 0.60. In other words, our goal for management is to reduce the post-project sediment transport capacity to 60% of the pre-project condition. Under these conditions, impacts analysis and control effectiveness are evaluated for their ability to maintain the target Ep at 0.6 ± 20%.

2.2. Management Strategies

2.2.1. Flow Duration Control – On-Site Control Alternative

Stream erosion/deposition and sediment transport processes are functions of the long-term cumulative effects of geomorphically significant flows. Maintaining the long-term cumulative duration of geomorphically significant flows maintains the existing capacity to transport sediment and promotes long-term stability. Flow duration control was first discussed in the literature by Derek Booth (1990), of the University of Washington. The flow duration method is essentially an analysis of distributions of all flows as opposed to using a design storm event. A distribution of hourly rainfall is transformed to a distribution of hourly runoff using the hydrologic model. The distribution of runoff is then converted to a long-term cumulative flow duration series.

Flow duration control is a design methodology to maintain the existing distribution of in-stream flows above the critical flow for bed mobility and as a result maintains the existing capacity to transport sediment.

2.2.2. Changes in Channel Geometry & Slope – In-Stream Control Alternative

Where on-site flow duration controls cannot be implemented or are insufficient to achieve the target Ep ± 20%, in-stream controls can be implemented. In-stream controls involve modifying the receiving stream channel slope and geometry so that it can convey the new urban flow regime while reducing the potential for erosion aggradation and damage to habitat. Modifications must ultimately be designed according to fluvial geomorphic principles and must meet the hydromodification management objective (the target Ep ± 20%). Key principles include:

a) Reduce the applied shear forces by reducing the longitudinal slope, and modifying the cross sectional geometry such as by reducing the depth.

b) Reduce longitudinal slope by using environmentally sensitive grade control measures and natural materials.

c) Maintain or increase flow energy dissipation along the stream channel by installing, or leaving in place, features that add roughness (e.g., dense vegetation planting).

d) Implement biotechnical engineering solutions to increase the resistance of the stream channel to the increased flow energy.

e) Maintain hydrologic connectivity between streams and floodplains. Use floodplains for flood storage, riparian habitat, recreation, and water quality.

The analysis compares the pre- and post-development longitudinal channel profiles over the length of tributary channel to identify a new longitudinal profile that maintains the existing sediment transport capacity given the new imposed flow regime. Appendix A to this report provides the basis of design for in-stream control in the Newhall Ranch tributary drainages (Lion Canyon, Long Canyon, Potrero Canyon, Chiquito Canyon, and San Martinez Grande Canyon).

2.2.3. Mixed Control Alternative

A mixed control alternative is defined as a combination of on-site control and in-stream control. Mixed control alternatives may be investigated at the project level for the Legacy Village, Homestead, and Potrero Valley Projects.

3. ON-SITE CONTROL ALTERNATIVE

This section discusses the development of normalized design and sizing charts for flow duration control basins designed according to flow duration criteria for the on-site control alternative. The design charts are based on matching the flow duration curves from undeveloped land using local soil and geologic information including infiltration rates and stream channel resiliency (i.e., critical shear stress values). These design charts provide the volume and area requirements for flow duration control basins. On-site flow duration control basins, or other types of BMPs that can provide storage, that are designed to match the pre-project flow duration condition are considered to meet the hydromodification control management objective.

3.1. Flow Duration Control Basins

A flow duration control basin is essentially a dry extended detention basin that is designed to provide hydromodification control. As shown in Figure 1 below, the flow duration control facility is conceptualized as having two pools, a low flow pool (Zone A) and a high flow pool (Zone B). The low flow pool is designed to capture the difference in runoff volume between the pre- and post-development conditions. It will capture small storms that typically do not produce runoff from undeveloped land, the initial portions of larger storms, and dry weather flows. The increase in runoff volume must be either released to the ground via infiltration, released to surface water at a fraction of the receiving stream's threshold for bed mobility (i.e., Qcp), diverted to a safe discharge location such as the Santa Clara River, and/or stored for irrigation reuse. The high flow pool is designed to detain and release higher flows to maintain the pre-development flow regime. The flow duration control basin can also serve as a water quality treatment facility by assuring that the water quality basin design criteria are met.

The flow duration control basin is sized using an iterative process of adjusting basin storage as well as selecting and adjusting the outlet structure. A stage-storage-discharge relationship is defined for the design under consideration. The 31-year time series (January 1972 to December 2002) of post-development runoff predicted by the SWMM model is routed through the facility and the stored volume and discharges are computed for each time step (i.e., In-Out = Δ Storage), according to the routing methodology defined in Hydraulics, A Guide to the EXTRAN, Transport and Storage Modules of the USEPA SWMM 4 (1988). Outflow can take the form of infiltration, evapotranspiration, flows less than Qcp, diversions, weir flow, and overflow. A wide range of outlet design styles are possible, such as weirs, orifices, sand filters, and risers.

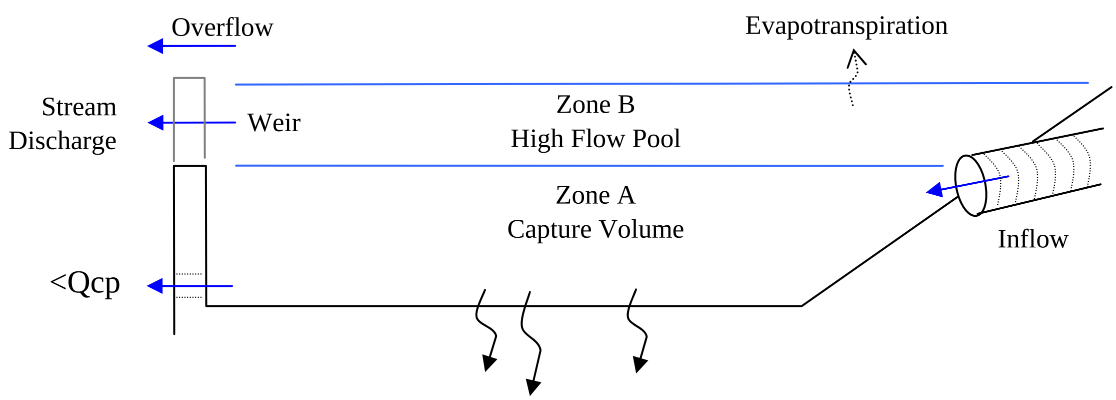


Figure 1. Conceptualized Configuration of Flow Duration Basin

3.2. Selection of Critical Shear Stress & Low Flow Discharge Rate (Qcp)

The critical flow for bed mobility (Qc) is the threshold flow that creates an applied hydraulic shear stress equal to the defined critical shear stress for the channel boundary. The critical shear stress is based on either bed material or bank material, which ever is least resistant, and can be adjusted depending on the density of vegetation. Qcp is the fraction of Qc that is apportioned to the flow duration control basin discharge if there is more than one basin in the watershed. For the watersheds analyzed for this report, the critical flow for bed mobility ranges from 1 cfs to 35 cfs, depending on boundary material, channel geometry, roughness, and longitudinal slope.

With the exception of Chiquito Canyon, no field samples of bed and bank material were collected in the canyons at the time of this analysis, and thus information on boundary material (e.g., wetted perimeter of stream) properties was obtained from NRCS soils data (NRCS, 2005). In Chiquito Canyon, where bed material was measured by URS (2002), the median grain size is 0.9 mm. The selected critical shear stress for this grain size is 0.06 lbs/sq-ft (ASCE Manual No. 77, Figure 9.5, pg 334) On the basis of this information, the following boundary material properties were selected for analysis and used throughout this report:

1. Chiquito Canyon: Bed material D_{50} = 0.9 mm, τ_c = 0.06 lbs/sq-ft.

2. Lion Canyon (soil type: Metz, MtC) = loamy-sand. τ_c = 0.055 lbs/sq-ft.

3. Long Canyon (soil type: Castaic, CnG3) = silty-clay-loam. τ_c = 0.05 lbs/sq-ft.

4. Potrero Canyon (soil type: Yolo, YoA) = loam. τ_c = 0.05 lbs/sq-ft.

The values assume little compaction and generally loose bed and bank material. If a moderate amount of compaction was present, the critical shear stress values could be increased to 0.10 lbs/sq-ft, which would result in a 15% to 20% reduction in computed Ep values. Bed and bank material sampling is recommended to more accurately estimate the critical shear stress for future refinements of this analysis.

Given the estimated critical flow values computed in this analysis and the uncertainties in boundary material, and based on an average or representative channel geometry, a value of 2 cfs was selected as the Qcp for a 100 acre tributary area. The 100 acre size was chosen because it is close to the typical catchment size that would drain to a single water quality or flow duration control basin. Qcp is important when local soils are low infiltrating, clayey soils. Because Qcp and infiltration are the only means of discharging the increased runoff volume, their relative values determine which is the controlling factor. Both infiltration and Qcp are applied in the sizing charts herein.

3.3. <u>Flow Duration Control Basin Configuration</u>

Flow duration control basins discussed herein do not provide flood control per the requirements of the Los Angeles County Hydrology Manual. If flood control is desired in these facilities, they would ultimately be designed to meet the Los Angeles County requirements for both flood control and hydromodification control. Stormwater treatment can also be accomplished in such facilities.

Due to the large number of possible basin configurations, some design features were held constant in the preparation of the sizing charts. Basin depths were limited to six feet to avoid triggering dam safety requirements. The outlet structure was limited in type and size, and held constant as much as possible.

Figure 2 presents a conceptual illustration of a flow duration basin. The basin has 2:1 side slopes and a depth of 6 feet for the purposes of this report; the basin length and width would vary by drainage catchment size and percent imperviousness. Infiltration occurs everywhere the surface is inundated. The bottom four feet of the basin represents Zone A, the capture volume; whereas the top two feet represents Zone B, the flow duration matching volume.

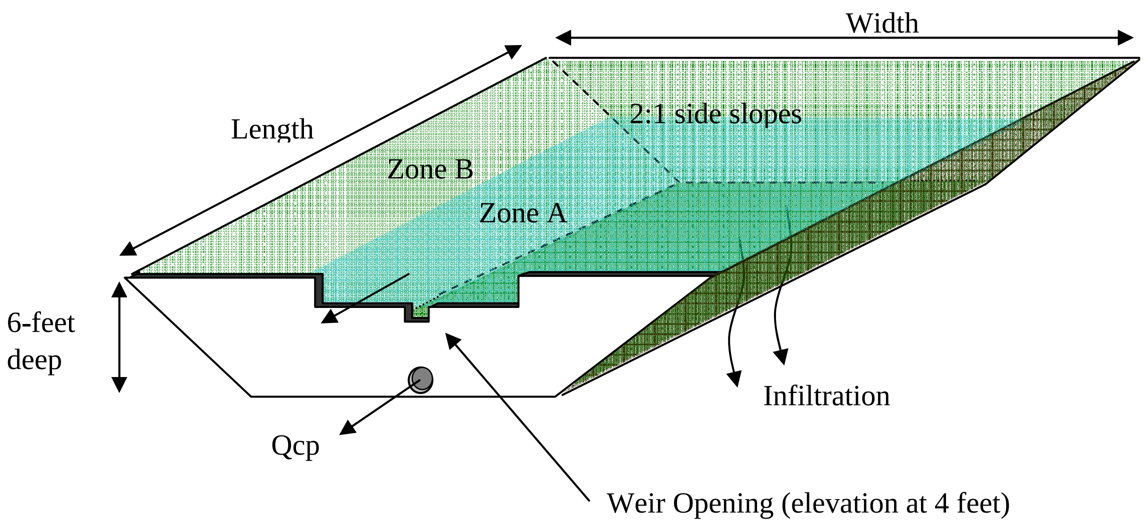


Figure 2. Conceptual Illustration of a Flow Duration Basin

Various outlet configurations and basin size combinations could be developed to meet the flow duration matching criteria. The sizing charts were developed using a constant outlet configuration, as much as possible, to provide consistency. In order to achieve the correct flow control using the sizing charts, this standard outlet design must be used in the design of the basin.

The low flow discharge (Qcp) can be controlled by an orifice hole in a headwall or by using a sand filter/buried perforated outlet pipe design. Any other design that controls the low flow discharge to below Qcp would also be acceptable. The orifice is sized so that it discharges Qcp just at the overflow weir elevation; i.e., six feet in these examples. Experience from similar projects has found that the size of the orifice hole is acceptable (> 4 inches) for approximately 20 acre tributary areas and greater. Orifice holes that are less than four inches have a tendency to plug with small debris, and therefore should be avoided for maintenance reasons. For tributary areas less than 20 acres in size, or a tributary area that results in an orifice size less than four inches, a sand filter/buried perforated outlet pipe can be used as an outlet structure. This type of outlet is sized so that the discharge into the perforated pipe is equal to Qcp. The weir outlet is designed so that its crest occurs at the top of Zone A, the capture volume, and is used to discharge the high flow pool (Zone B).

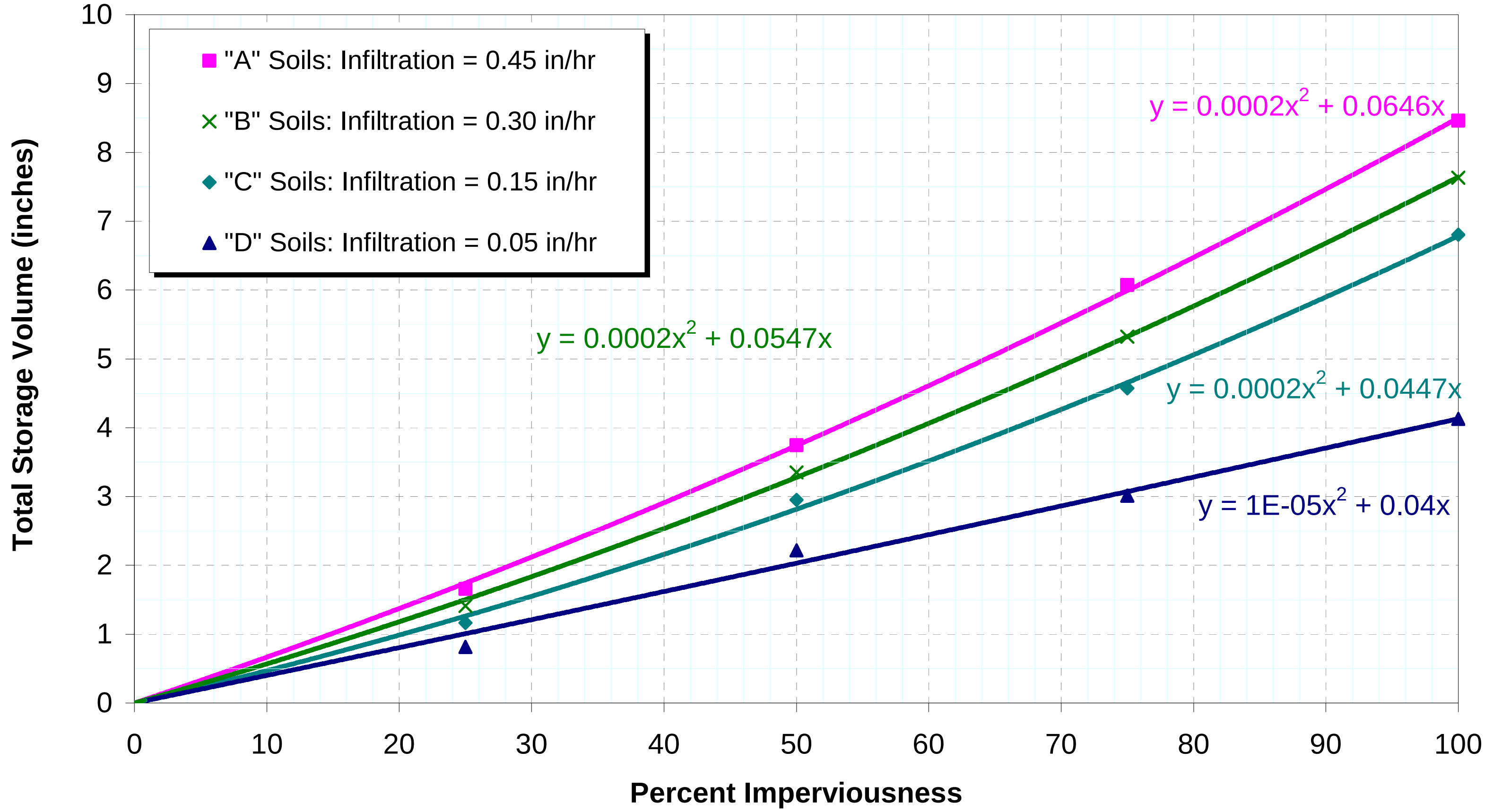
3.4. <u>Normalized Sizing Charts</u>

Figures 3 through 5 present the normalized sizing charts developed for the Newhall Ranch watersheds. Figure 3 and 4 provide the total volume (Zone A and B in Figure 2 above) and the capture volume (Zone A in Figure 2 above) requirements, respectively, and Figure 5 provides the surface area requirements assuming a 6-foot deep storage basin with 2:1 side slopes. Note that these charts are specific to the assumptions of 2:1 side slopes, a 6-foot depth, and a specified outlet design. Alternative sizing charts could be prepared for alternative design assumptions. The sizing charts are based on runoff from a 100 acre area. Sizing curves are provided for four tributary area soil types (Hydrologic Groups A, B, C and D) assuming the following infiltration rates in saturated soil conditions:

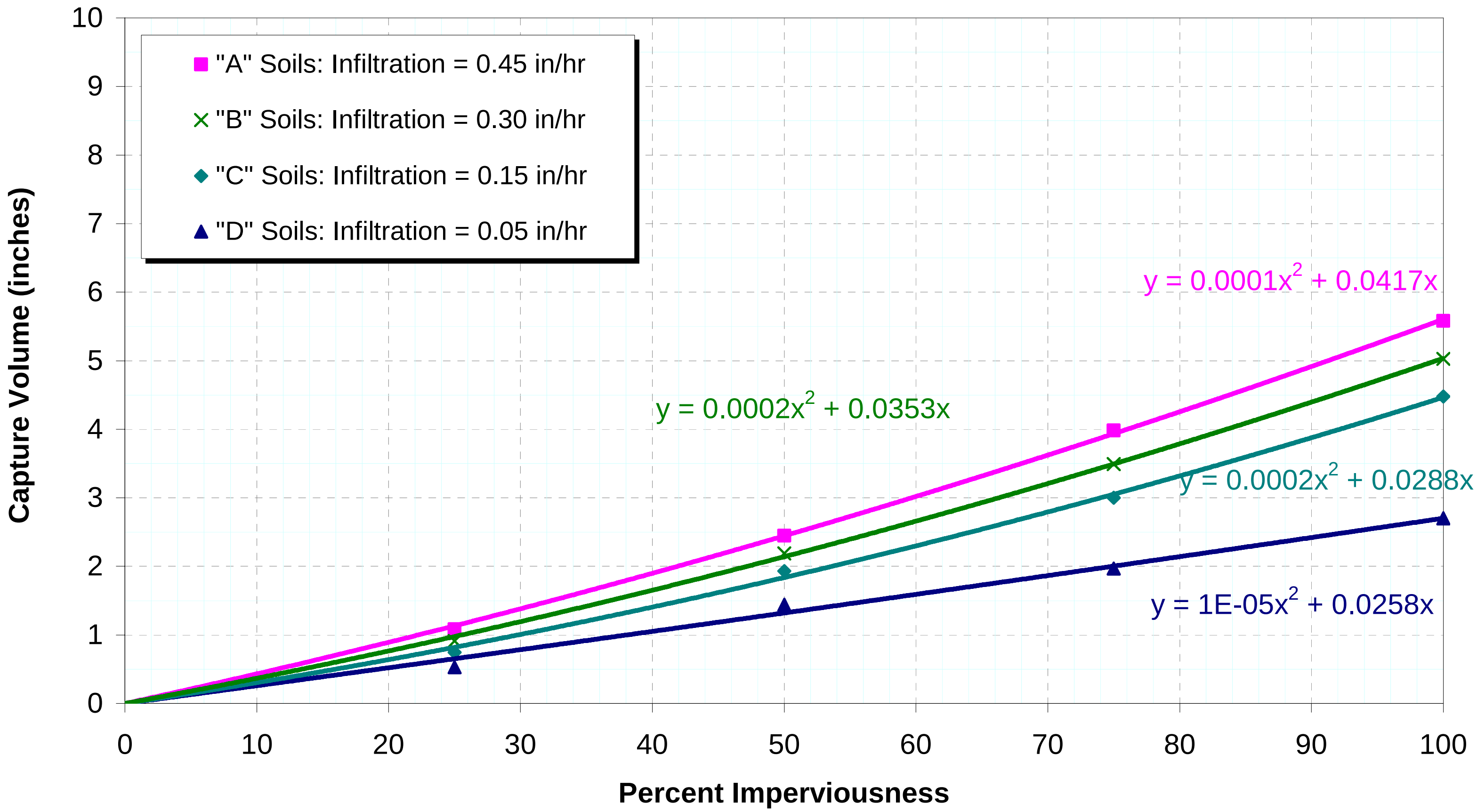
- Soil type “A” with 0.45 in/hr infiltration.
- Soil type “B” with 0.30 in/hr infiltration.
- Soil type “C” with 0.15 in/hr infiltration.
- Soil type “D” with 0.05 in/hr infiltration.

Unit total storage volume and capture volume (acre-inches per acre of tributary area) can be determined from Figures 3 and 4 based on the imperviousness of the flow duration basin’s tributary catchment area and the tributary area soil type (or infiltration rate). For example, a tributary area with 50 percent imperviousness and soils with an infiltration rate of 0.15 in/hr requires 1.8 acre-inch per tributary acre of capture volume and 2.8 acre-inch per tributary acre of total stormwater storage.

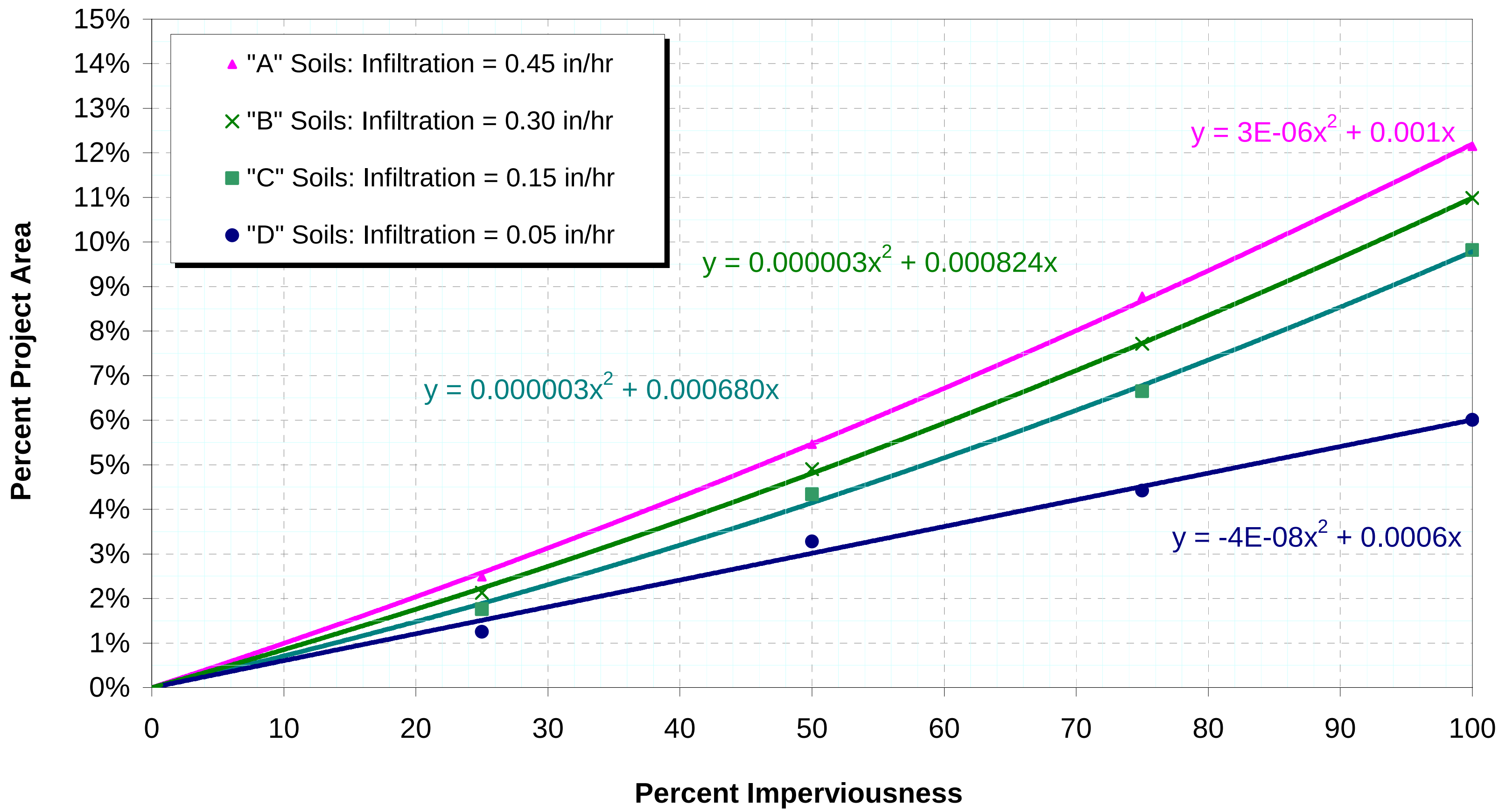
Figure 5 presents a flow duration control basin surface area sizing chart. A deeper basin will result in smaller surface area requirements. Surface area can be adjusted according to depth between three and eight feet as long as the capture volume and total volume remain as specified in the sizing charts presented in Figures 3 and 4. The use of the sizing chart beyond these limits would require further verification that the basin design is achieving the desired hydromodification control objectives. Using the tributary area’s estimated percent imperviousness, the *Unit Area* requirement from Figure 5 is multiplied by the total tributary area to derive the total required land area to meet the flow duration criteria. For example, a tributary area with 50% imperviousness and an infiltration rate of 0.15 in/hr requires the equivalent of 4.1% of the tributary area for a flow duration control basin that is six feet deep with 2:1 side slopes and a weir crest at four feet.



Required Flow Duration Control Basin Total Volume	**Figure 3**
Newhall Precipitation; Qcp = 2 cfs/100 acres	GeoSyntec Consultants



Required Flow Duration Control Capture Volume	**Figure 4**
Newhall Precipitation; Qcp = 2 cfs/100 acres	GeoSyntec Consultants



Required Flow Duration Control Basin Area	**Figure 5**
6-foot deep basin, Weir Crest at 4 feet	GeoSyntec Consultants

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APPENDIX G
ATTACHMENT A
BASIS OF DESIGN: NEWHALL RANCH TRIBUTARIES

PHILIP WILLIAMS & ASSOCIATES, LTD
ENVIRONMENTAL HYDROLOGY
720 California St., Suite 600
San Francisco, California 94108-2404
TEL 415.262.2300 FAX 415.262.2303
www.pwa-ltd.com

M E M O R A N D U M

Date:	April 14, 2008
To:	Newhall Land Company
Organization:	Philip Williams and Associates, Ltd.
From:	Andrew Collison, Adam Parris, Jeffrey Haltiner, and Vince Geronimo
PWA Project #:	1820
PWA Project Name:	Newhall Ranch
Subject:	**Basis of Design: Newhall Ranch Tributaries**

1. INTRODUCTION AND OVERVIEW

This document describes the existing geomorphic and hydrologic setting and provides the basis of design for a restored stable channel and floodplain for the tributary drainages in the Newhall Ranch area (Lion Canyon, Long Canyon, Potrero Canyon, Chiquito Canyon, and San Martinez Grande Canyon; herein referred to as "the tributaries"). Channel and floodplain stabilization are required for a variety of purposes: to mitigate for historic watershed disturbances (primarily increased runoff due to ranching, oil and gas extraction, and the construction of unimproved roads); to accommodate proposed future increases in runoff and reduction in sediment delivery resulting from land development; to support a diversity of native vegetation and wildlife habitat; and to provide a visual amenity to the Newhall Ranch Specific Plan (NRSP) development projects.

The present channel systems include combinations of stable and unstable reaches, with substantial sediment production from hillside slope failures and channel/bank erosion. From a channel stability perspective, the construction of housing and associated urban infrastructure within the NRSP area will result in increased peaks and duration of runoff (hydrograph modification) and a reduction in sediment supply. To be stable under future conditions, the stream channels will require a lower than existing gradient and somewhat increased flow capacity (width and depth). The tributaries will be designed to convey sediment under future conditions with a "dynamically stable channel" (neither long-term erosion nor deposition) and to support the proposed native re-vegetation program. This memo describes the tributary channel design and analysis approach. Design elements include channel gradient, width and depth, as well as planform sinuosity and riparian corridor width.

1.1 DESIGN CRITERIA

The channel and floodplain will meet the following design criteria:

- Geomorphic stability – the channel will not aggrade with sediment or erode its banks or bed excessively. The bankfull channel will be sized for the dominant (channel forming) discharge.
- Hydraulic/Flood conveyance – the floodplain will convey the capital flood (Qcap) with a minimum of 3 feet of freeboard, and meet LA County standards for flood channels.
- Ecological function – the channel and floodplain will provide for the proposed ecological function, supporting a combination of riparian habitat, coastal sage scrub, oak woodland, etc., as appropriate. Grade control structures, culverts, and other hydraulic structures will be designed to accommodate wildlife requirements.
- Hydromodification – The combined urban runoff management program, in conjunction with the channel design, will address potential "hydromodification" impacts. The channel will not aggrade or generate excess sediment from erosion or create a larger than natural downstream impact from sedimentation associated with hydrograph modification.
- Low maintenance – the channel and associated structures will require minimum maintenance. The channel and floodplain will not require sediment removal or vegetation clearance. Drop structures will require monitoring annually during the initial establishment period. Once the system is established and revegetated, there will be no regular maintenance required. A program for periodic checking/monitoring of the channel corridor will be established. Infrequent access may be required following extreme flow events.

The designs will represent an optimization of the above project goals. To minimize long-term maintenance and possible impacts to the restored habitat, a more active initial restoration design will be developed. A relatively conservative equilibrium channel slope will be assumed for the initial design, based on the assumption that some minor channel aggradation is preferable to erosion. Potential aggradation will be evaluated and accounted for in the channel hydraulic design and freeboard analysis. Because the focus of the design of the majority of the channel length is to create a "natural" channel system, with high riparian and habitat value, the tributary designs will require very infrequent maintenance or access by heavy equipment. However, the maintenance access system will accommodate easy/frequent access to those elements likely to require more frequent monitoring and maintenance (water quality basins, culverts, bridge crossings). In addition, the channel design will have adequate capacity, freeboard, and setbacks from the development that the need for direct channel access will likely not be required during the wet/rainy season. Monitoring and possible channel maintenance can be accomplished during the dry season.

1.2 REGULATORY FRAMEWORK

The channel designs must meet a variety of regulatory requirements. Channels must be designed to meet Los Angeles County Department of Public Works (LACDPW) guidelines while meeting the hydromodification control requirements of the Los Angeles County municipal separate storm sewer (MS4) Permit established by the Los Angeles Regional Water Quality Control Board (LARWQCB). In some cases, these regulatory requirements require specific design approaches using different analysis methodologies. For example, LACDPW requires event-based designs that are focused on stability during low frequency-high magnitude events, while the LARWQCB appears likely to adopt a continuous simulation method that incorporates all geomorphically significant flows in the design for hydromodification control. These approaches may produce slightly conflicting channel dimensions. The goal of the tributary design is to comply with the requirements and the objectives of all of the agencies. Where there are differences between the agency methods, we describe these and provide our recommendations on the preferred design parameters. Some of the methodologies are still developing, as traditional flood and channel management strategies are evolving to integrate habitat, public access, aesthetic goals, and agency requirements.

The tributary design goals, which are to design a stable channel corridor that provides flood protection, habitat values, aesthetics, and appropriate access, are consistent with both the goals and requirements of all of the various regulatory agencies.

1.3 DESIGN APPROACH

The available approaches to stable channel design can be grouped into three categories:

- *Field reference reach approach* – channel design based on field measurements made at stable reference reaches in local watersheds with similar sizes, runoff regimes and sediment characteristics.
- *Empirical methods* – channel design is based on observed correlations between inputs (watershed area, discharge, sediment yield) and outputs (channel width, depth and slope) for a similar physiographic and climatic region.
- *Analytical methods* – channel design is based on physically-based numerical modeling such as sediment transport modeling.

Each of these methods has benefits and limitations. Of the channel parameters, estimating "equilibrium channel gradient" is the first and most important parameter. Considering the complexity of actual channel morphology, a combination of several different methods will be used, including local reference conditions, empirical and analytical approaches. This provides a "sensitivity analysis" and allows the design to select an optimal design slope that balances the analysis uncertainty with the tributary design goals. This may suggest using an average of the gradients from these methods, or a value that is supported by a preponderance of evidence based on the specific site conditions and risks. Safety features will be designed into channel structures to accommodate the level of uncertainty in final equilibrium slope without structural damage. Three different methods of calculating channel width, depth and slope that fulfill the LACDPW and LARWQCB requirements will be used that are based on performance of channel designs in a variety of settings.

Channel width, depth and slope are interdependent. In keeping with standard river restoration design practices, a "slope first" design approach will be used in which channel equilibrium gradient is determined, followed by width and depth. In this approach, the stable channel gradient is estimated first. The difference between the existing and future (stable) slope then determines the amount of the total gradient that must be stabilized using grade control structures (GCSs), which will be designed as a sequence of step-pools, drop structures, armored channel sections, or other suitable alternative hydraulic structures. These hydraulic structures are then designed to be hydraulically-stable during the design flow (capital flood or "Q_{cap}").

2. PROJECT HYDROLOGY: DEVELOPMENT OF DESIGN DISCHARGES

The dominant discharge will be used as the design basis for the main low flow channel, in keeping with standard geomorphic practices. Dominant discharge is the flow that cumulatively transports the majority of sediment over a long period of time. This analysis approach assumes dominant discharge is equivalent to bankfull flow for purposes of channel design. Using continuous rainfall-runoff simulation for the Newhall Ranch watersheds, Geosyntec calculated the dominant discharge; this corresponded closely with the 2-year recurrence interval storms as determined using a continuous flow model for the post-developed condition. Based on our review, the 2-year recurrence interval storms as determined using a continuous flow model for the post-developed condition will be used as the design event for the low flow channel, insuring that these designs are also consistent with the LACDPW approaches.

3. CHANNEL SLOPE DESIGN

The design channel slope will be dynamically stable (should neither erode nor accumulate excess sediment over the long-term). Small amounts of cyclical erosion and deposition are expected, and accounted for, in any channel composed of soft materials in the short term, but the long term patterns should be of equilibrium between erosion and deposition. The tributary channel slopes will be designed using LA County methods. The resulting slope will then be verified using the erosion potential method (Ep) and field geomorphic data and adjusted if necessary. We will verify the reasonableness of the design slopes using actual channel slopes measured from a variety of developed and undeveloped watersheds in the region.

These methods are described below.

3.1 METHOD 1. LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS METHODS

LACDPW has developed two methods of calculating equilibrium channel gradient (Table 2). The first is an empirical method that is suitable for rapid analyses of small channels. The second is an analytical method, using sediment transport equations, that is more complex. We include analyses using both methods as appropriate.

Table 2. Summary of LA County Methodologies

	Method 1a – LACDPW empirical method	**Method 1b - LACDPW analytical method**
Inputs	Existing conditions flow velocity Proposed conditions flow velocity Existing conditions channel slope Proposed conditions reduction in sediment supply	Upstream water and sediment inputs
Events Assessed	Qcap and 0.25Qcap	0.25Qcap
Approach	Nomograph based on empirical relationships for LA County. Use nomograph to identify slope reduction for both events and use the lower of the two slopes	Use sediment transport modeling to size channel to convey water and sediment at design flows without erosion and use the lower of the two slopes
Output	Reduction in existing slope required to achieve equilibrium	Equilibrium width, depth and slope of channel

3.1.1 Method 1a: LACDPW Empirical Method

The LACDPW empirical method involves comparing pre- and post-project channel velocity and sediment availability for Qcap and 0.25 Qcap. Equilibrium slope is estimated from the nomograph (Figure 2) based on changes in velocity and sediment supply. PWA developed a spreadsheet to automate interpolation from the nomograph and calculate the resulting stable channel slope.

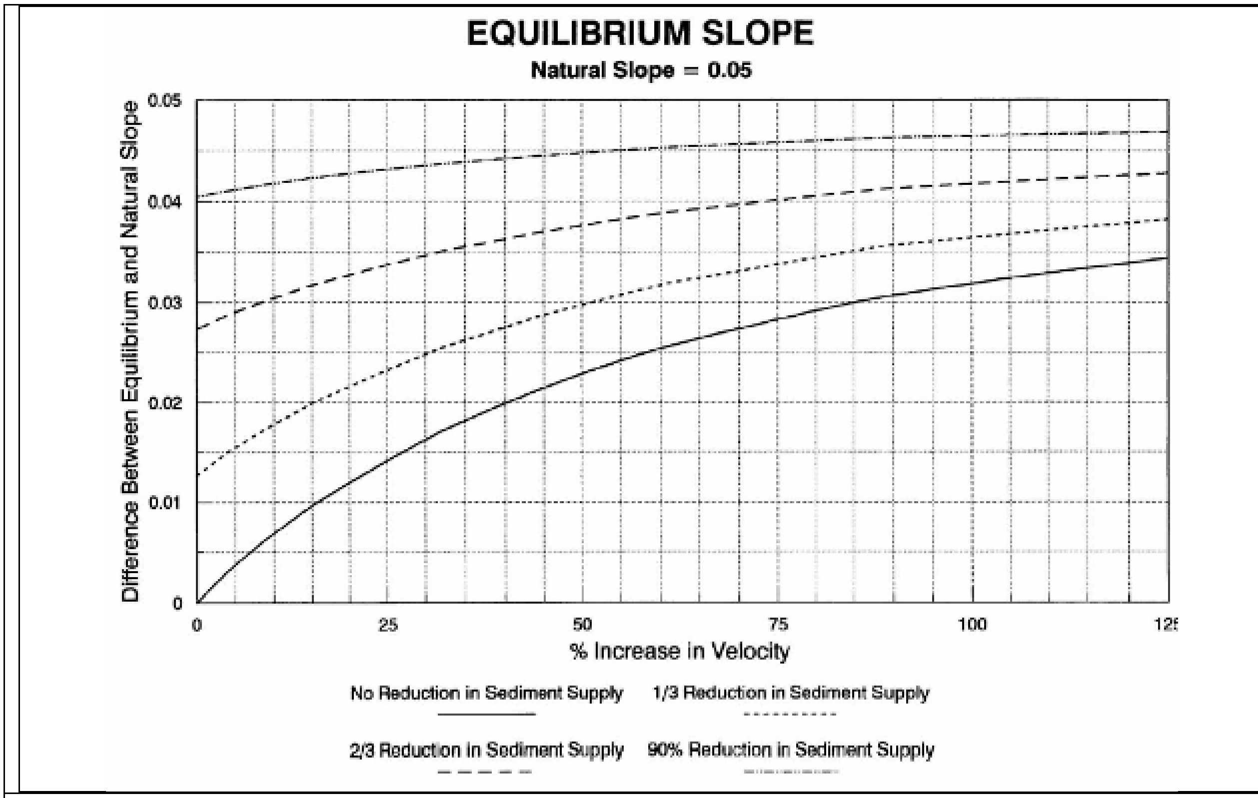


Figure 2. Nomograph for estimating equilibrium slope.
Source: LA County Dept of Public Works, 2006. Appendix C.

3.1.2 Method 1b: LACDPW Analytical Method

This method is specified for soft bottomed channels with levees. The approach is based on applying a sediment transport equation for pre- and post-project conditions and iteratively adjusting channel slope until post-project sediment transport is equal to pre-project. The method requires selection of the most appropriate of the following sediment transport equations:

1. Meyer-Peter, Muller equation
2. Einstein bed load equation
3. Einstein suspended load methodology
4. Colby methodology

Reid and Dunne (1996) review a large number of sediment transport equations for suitability based on the number and accuracy of field verifications on different types of channel. They recommend the following applications (Table 11, p.100):

Meyer-Peter/Muller model: gravel bedded and braided channels, and small sand bedded streams
Einstein and Colby: medium and large sand bedded channels

3.2 VERIFICATION USING EROSION POTENTIAL METHOD

Erosion potential (Ep) is a measure of the change in the long-term, cumulative effective work done on the channel by hydraulic forces between a pre-project and post-project condition, which represents the change in sediment transport capacity. 'Effective work' is calculated based on the difference between the applied boundary shear stress and the critical shear stress of the boundary materials or bed sediments represented by the complete grain size distribution. The ratio between existing and proposed effective work or sediment transport capacity (Ep) is used to evaluate whether the designed channels will be stable under proposed flow conditions. Ep calculations are made using continuous rainfall-runoff simulations in the EPA Storm Water Management Model (SWMM) for 31 years of available record. The resulting flow time series are applied to a sediment transport model to calculate Ep for a series of existing and proposed cross sections.

Proposed conditions are typically compared to the existing condition; however, for channel design where the existing condition is unstable, the baseline used for comparison is based on stable reference reach(es). When reduction in sediment supply is an important physical element in stable channel conditions, the target Ep is adjusted accordingly. When post-developed flows are increased and reductions in sediment supply are not important, the target ratio of existing and proposed Ep is set to 1.0. That is, the proposed design attempts to match the baseline conditions (i.e., the future sediment transport condition is equal to the existing sediment transport condition).

When reduction in sediment supply is important, an equivalent reduction in the transport capacity is needed. For example, a project that reduces sediment supply to 30% of its baseline level requires the transport capacity to also be reduced to 30% of its baseline condition; i.e., Ep = 0.30. A correlation between observed field conditions (channel stability) and predicted erosion potential for 49 cross-sections within four separate California watersheds showed that as the erosion potential begins to exceed the target by 20 to 30 percent, the probability of stream channel instabilities begins to increase rapidly (SCVURPPP, 2005). The Ep verification methodology therefore incorporates a risk-based approach that limits the variance in erosion potential to ±20% of the target, as the risk of hydromodification impacts is low in this range.

Table 1. Description of Ep Verification Method

	Verification Method - Geosyntec Application of the Erosion Potential Model
Inputs	Runoff from continuous rainfall-runoff model (SWMM) Reduction in sediment supply Bed particle size distribution, bank material type, vegetation density Existing and proposed channel geometry and longitudinal slope
Events Assessed	Continuous range of geomorphically significant flows

	Verification Method - Geosyntec Application of the Erosion Potential Model
Approach	1. Compute work done and sediment load transported for existing geometry and flow conditions using range of sediment transport and work equations. Identify stable and unstable sections. 2. Scale target Ep based on reduction in sediment delivery (e.g., 40% reduction in sediment requires 40% reduction in E_p). Identify the appropriate baseline condition for comparison. 3. Calculate Ep for the proposed channel design at several cross sections. 4. Refine slope until future Ep does not deviate from the target Ep by more than ±20%.
Output	Width, depth and slope of channel that is within 20% of target Ep, adjusted for sediment reduction.

3.3 VERIFICATION USING FIELD DATA AND SAM SIMULATIONS

3.3.1 In addition to verification using the Ep method, we assess the proposed channel design using field data from the Newhall Ranch area. This check is performed to assess the geomorphic stability of the creek. Data on equilibrium slope were collected in Newhall Ranch by measuring channel gradient in stable channel reaches. These are often located immediately upstream of grade control structures. These were compared with watershed area, (used as a surrogate of annual discharge). The resulting plot is shown in Figure 3. A measure of stable channel gradient under post-development conditions can be determined by looking at the channel gradient of watersheds with the same runoff as the post development watershed. For example, a 1-square mile watershed in which post-development runoff is doubled will lead channel slopes to adjust to a gradient appropriate to a 2-square mile watershed, assuming the same sediment delivery.

3.3.2 To compensate for reductions in sediment supply we performed a sensitivity analysis using the USACE Stable Channel Design Model SAM to determine the degree to which reductions in sediment supply affected equilibrium slope. We used this method as a check to ensure the channel designs were geomorphically-appropriate to the site.

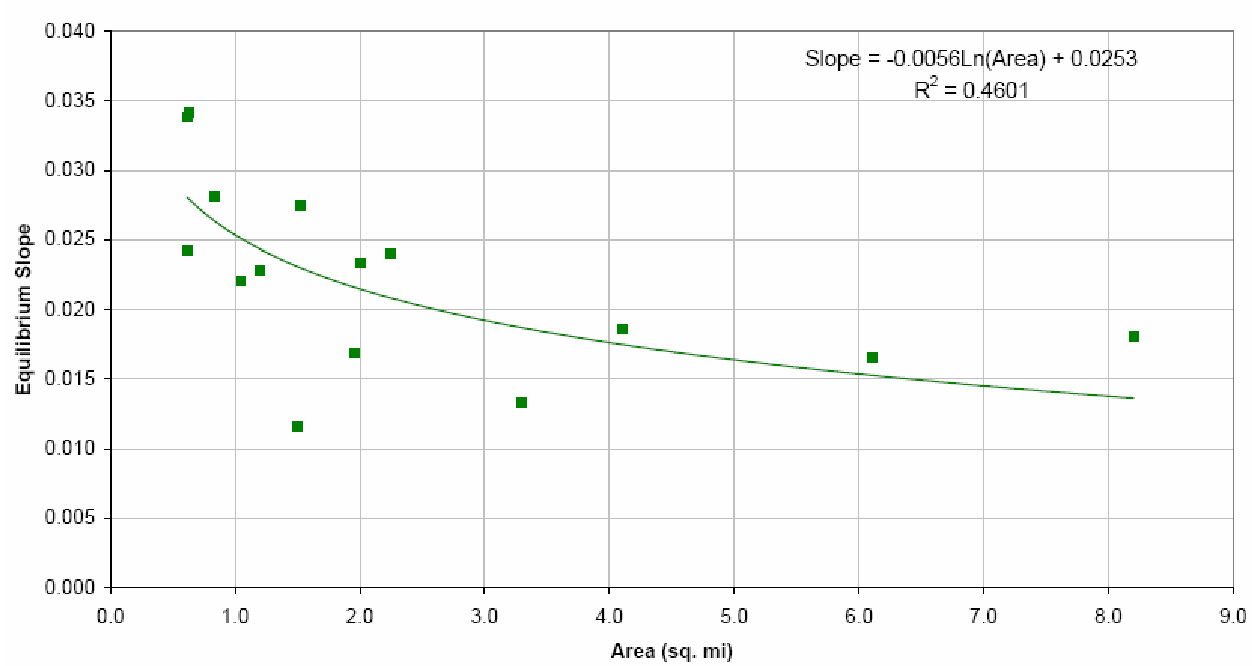


Figure 3. Equilibrium Slope for Rural Reference Reaches

3.4 SELECTION OF DESIGN CHANNEL SLOPE

Each of the above three design approaches (LA County, Ep, and reference reach/field data methods) produces a slightly different estimate of stable slope. Based on these estimates, we will select a design slope that falls between the high and low end of the estimates, based on the preponderance of evidence for the most likely stable slope. In general, this approach produces a relatively conservative estimate of the stable channel slope, to insure that stabilization structures are not undermined. In order to anticipate possible aggradation impacts, the selected slope for flood control performance will be assessed, using the highest of the previously estimated design slopes as an estimate of the maximum aggradational condition.

3.5 DESIGN SLOPE IMPLEMENTATION

Where extensive development will take place in the watershed and plans call for channel re-grading (Long Canyon and Potrero Canyon), or where the existing channel is degraded and some development will take place in the watershed (Lion Canyon), step-pool design structures (described in Section 5) will be designed and located to create a channel gradient with the selected slope.

Where channels are not degraded and less extensive development will take place in the watershed (San Martinez Grande Canyon and San Martinez Chiquito Canyon), grade control structures will be used to maintain the existing slope.

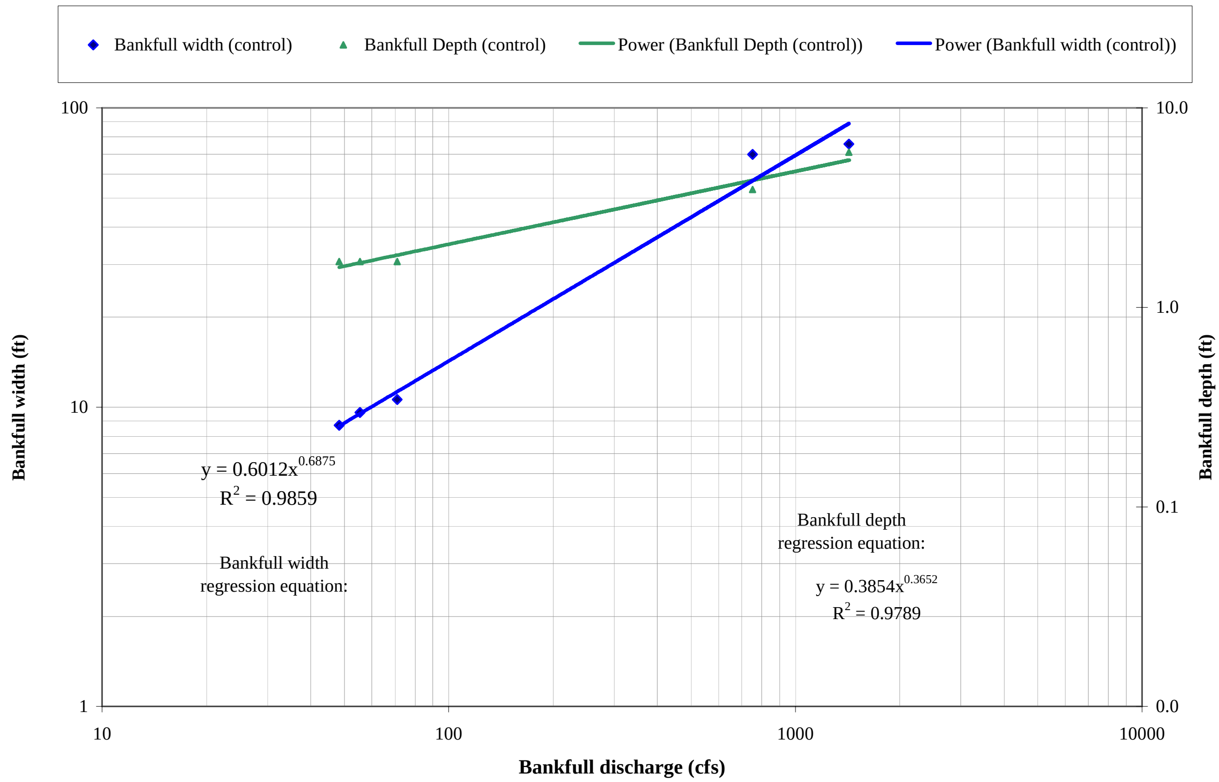
4. CHANNEL WIDTH AND DEPTH

Channel width and depth are calculated using an empirical approach using local reference reaches (Coleman et. al. 2005), verified by an erosion potential assessment to ensure that the design meets the appropriate target erosion potential within the 20 percent threshold.

4.1 SOUTHERN CALIFORNIA FIELD REGRESSIONS

The Stormwater Monitoring Coalition (SMC) (Coleman et al., 2005) performed a geomorphic assessment of streams in disturbed and un-disturbed watersheds of Southern California. This study provides regional regressions between dominant discharge and channel geometry for Southern California stream channels, and identifies predictive relationships between changes in impervious cover and stream channel enlargement for use in stream management. Eleven watersheds in Southern California, including five canyons in LA and Ventura counties near the Newhall Ranch, were selected based on detailed guidelines including watershed size, natural channel bed and banks, and development covering five to ten percent of the watershed area. Based on geomorphic assessment, historic analysis of development conditions, and ground survey, the SMC developed predictive relationships between dominant discharge and bankfull channel width as well as dominant discharge and cross sectional area (shown in Figure 4). We integrate the results from these channel systems with the estimates produced by other methods.

Figure 1. Southern California Stream Morphology Relationships



Note: Plots derived from Coleman et al. (2005) Table 5.6. Data are only from control (undeveloped) sites

4.2 SELECTION OF A DESIGN CHANNEL WIDTH AND DEPTH

Following estimation of design parameters with the different methods, a proposed channel cross-section is selected which is likely to be most stable (falls between the high and low end of the estimates). The selected combinations of width, depth and slope are evaluated hydraulically to ensure that flow velocities are reasonable and unlikely to erode over the longer term.

4.3 SELECTION OF A DESIGN CHANNEL WIDTH AND DEPTH

Following estimation of design parameters with the three methods, a proposed channel slope is selected which is likely to be most stable (falls between the high and low end of the estimates). The selected combinations of width, depth and slope are evaluated hydraulically to ensure that flow velocities are reasonable (bankfull flow velocities of typically less than 6 ft/sec where feasible (based on estimated channel roughness values) unlikely to erode over the longer term.

5. STEP-POOL DESIGN

Where the three methods utilized predict that the bankfull channel gradient will be considerably flatter than the existing gradient, drop structures or armored channels will be required to take up the elevation difference between the existing and proposed stable slopes. To maximize vegetation, aquatic, and wildlife habitat and maintain a natural channel appearance, a range of types of step-pool structures and armored riffles will be used to accommodate the drops in channel elevation. Construction of these structures will likely include large boulders, rip rap, Armorflex, soil cement, or concrete and will mimic natural step-pool function and morphology (as identified in reference reaches) in appearance and hydraulic function.

5.1 SELECTION OF MULTIPLE SMALL STEPS OR FEWER LARGE STEPS

Two approaches have been taken to controlling channel grade, to be used in different settings. Where the existing stream course and valley is going to be significantly altered by mass grading we consolidate drops in a smaller number of larger drops, to allow for greater lengths of non-armored channel between drops. Where the goal is preservation of existing channel habitat and little mass grading is proposed for the channel and floodplain area we use larger numbers of smaller drops (approx. height 3 feet) to control grade. Selection of these approaches is made based on the habitat value of the existing creek corridor and the infrastructure and mass grading needs of the surrounding development.

5.2 DESIGN PROCEDURE

The approximate initial step-pool dimensions are determined using the approach of Thomas et. al. (2000). Once the approximate structure dimensions are determined, this initial dimension is then tested using HEC-RAS to optimize the height of the step, gradient of the ramp, depth and width of pool and elevation of the apron/tail water. HEC-RAS flow estimates are also used to develop flow discharge per unit width for sizing rock to be used in the grade control structures or for bank protection. The detailed analysis and final design for the step-pool structures will be described in final design technical memorandums.

5.3 GRADE CONTROL CONCEPTS

Some of the potential types of step-pool structures and armored riffles that could be used to accommodate drops in channel elevation are described below and illustrated in Attachment A. Final design will be dependent upon the analysis of the individual channel reach conditions, constraints, and requirements.

5.3.1 <u>Grouted Sloping Boulder (GSB) Drop</u>

Boulders, typically 24-inch minimum in all directions, would be placed on the face of the grade control structure, the crest, the lower part of the side slopes, and the stilling basin. Twelve inches of grout would be placed at the bottom 30-50% depth of the boulders to lock them together. Typical vertical drop heights for this type of grade control structure can be greater than 3 feet and are proposed at up to 15 vertical feet. The structure length and width varies depending on the design flow; typical structure dimensions may be 100 feet long by 60 feet wide. Planted riprap would be placed along the approach, in the upper voids of the boulders, along the upper banks, and downstream of the stilling basin (lay down toe). Seepage control would consist of a metal or vinyl sheet pile across the width of the structure and weep drains that daylight through the grouted boulders.

5.3.2 Soil Cement Grade Control Structure

On-site sandy soils will be combined with adequate cement to form a soil cement mixture that when placed mimics the sandstone outcrops in the area. Facings and lateral protection will be built by constructing the soil cement slope protection in successive horizontal layers (6-10 inches thick). Facing slopes can be steeper than GSB Drops with the steepest recommendation at nearly 1.5:1 (H:V); constructed by setting back subsequent lifts. Typical vertical drop heights for this type of grade control structure can be greater than 3 feet and are proposed at up to 15 vertical feet. The structure length and width varies depending on the design flow; typical structure dimensions may be 80 feet long by 80 feet wide. Planted riprap may be placed along the approach, in the approach at the crest, along the upper banks, and downstream of the stilling basin (lay down toe). Soil cement could be mixed on-site, placed, compacted, finished and cured resulting in a strong durable, erosion-resistant material with low permeability. If required, seepage control would consist of a metal or vinyl sheet pile synthetic liner or other impermeable material across the width of the structure and weep drains that daylight through the soil-cement lifts.

5.3.3 Sculpted Concrete Drop Structure

Colored, poured and shaped concrete will be molded to form an aesthetic modification to the grouted sloping boulder style of drop. Design of for these drops will be conducted individually but similar to the GSB Drop. Construction is typically conducted with a single monolithic full-depth pour or using a two pour system over steel reinforcement then contoured and textured to finish. Planting wells may be considered to help revegetated and conceal the structure. Facing slopes are roughly similar to GSB Drops with the steepest recommendation at nearly 3.0:1 (H:V). Typical vertical drop heights for this type of grade control structure can be greater than 3 feet and are proposed at up to 10 vertical feet. The structure length and width varies depending on the design flow; typical structure dimensions may be 100 feet long by 80 feet wide. Planted riprap would be placed along the approach, in the approach at the crest, along the upper banks, and downstream of the stilling basin (lay down toe). Seepage control could consist of a metal or vinyl sheet pile synthetic liner or other impermeable material across the width of the structure and weep drains that daylight through the poured grout mixture.

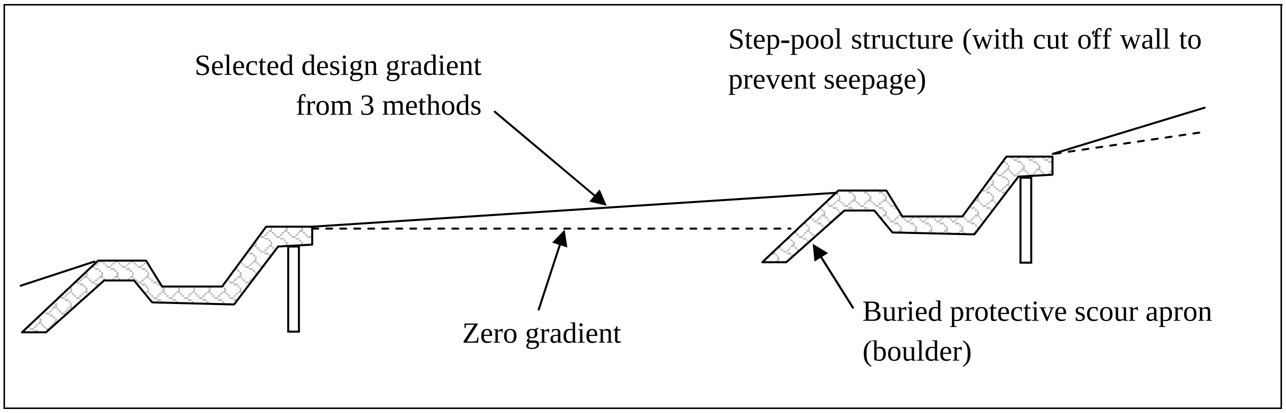
5.3.4 Non-Grouted Boulder Step Pool

Boulders, comprised of various sizes between 24-inch and 36-inch minimum in all directions, would be placed on the face of the step-pool structure, the crest, the lower part of the side slopes, and pool. The sub-base of the structure will be adequately designed using a mixture of compacted soil and riprap. The boulders would be individually placed and chinked to lock them together. Plants will also be used to prevent boulders from dislodging. The crest boulders would be placed on top of a metal or vinyl sheet pile wall and grouted to the buried check wall to form the crest. The check wall would extend to the width of the floodplain corridor and will be notched at the step-pool structure. The non-grouted boulder step-pool will be designed for less than Qcap and have typical dimensions of roughly 50 feet by 50 feet. Planted riprap would be placed along the approach, in the upper voids of the boulders, along the upper banks, and downstream of the pool.

5.3.5 Grade Control Scour Apron

Grade control structures would include a buried toe scour apron made of appropriately sized rock on the downstream end of the step-pool structure to accommodate the most conservative slope assumptions (i.e., assume that a completely flat slope develops) to insure that the structures will still have integrity and channel downcutting will be prevented (see Figure 2 below). The designs will also include intermittent buried rock sills across the floodplain to protect from erosion or outflanking of the step pools. For a typical design of 1% channel gradient and structures every 100 feet, the worst case scenario (adjustment of the channel to zero gradient) would be 12 inches of toe erosion on each structure.

Figure 2. Conceptual Sketch of Step-pool Structures Showing Relationship Between Design Gradient and Lowest Predicted Gradient



6. EXISTING GEOMORPHIC CONDITIONS ASSESSMENTS

PWA conducted reconnaissance-level geomorphic assessments and collected sediment samples from the beds and banks of the tributaries to support sediment transport modeling, geomorphic and channel design activities.

6.1 DATA COLLECTION

Fieldwork was carried out between February 7 and 9, 2006, with repeat visits to selected sites in summer of 2006. The channels were walked for their entire length within the Newhall Ranch project area. Sediment samples were collected approximately every 1,000 feet along the channels. Sites were selected by pre-programming GPS coordinates along the streambed at fixed intervals and then identifying geomorphically-typical reaches close to the site. At each sampling point the nearest mid–channel or point bar was selected and a sample taken from a position one third from the upstream edge of the bar, in accordance with sediment sampling protocols outlined by Reid and Dunne (1996) and Thomas and Gee (2005). Sediment taken from this location is believed to be representative of average-sized sediment that is in transport through the system. Samples were collected by digging a 6 inch pit in the bed and transferring the entire sample to a polythene bag. Bank samples were taken from actively eroding banks where they appeared to be the main source of sediment in the channel. Typically in all creeks studied the bed samples had a thin veneer of gravel but were dominated by sand beneath that. Samples were transferred to Cooper Testing Laboratory for particle size distribution. Most samples were clearly non-cohesive and were analyzed by wet sieving. A few appeared to be cohesive and were sampled using the hydrometer method to differentiate silt and clay from coarser sediment.

A reconnaissance-level geomorphic assessment was conducted, primarily focused on the degree of channel incision (disconnection between the bankfull channel and floodplain). This was assessed by running a HEC-RAS model with the 5-year flow (model and data supplied by PACE) to determine the extent to which the 5-year flow was confined in a well defined bankfull channel or not. This was based on the observation of SCCWRP (Coleman et. al. 2005) that stable channels in this area contain the 5-year flow. Where the 5-year flow did not fill what appeared to be the bankfull channel and qualitative geomorphic evidence supported the assessment the channel was classified as incised or widening.

6.2 LION CANYON

The sample locations and particle size distribution curves are shown in Attachment B, with typical sediment sizes and channel geomorphic assessment for context.

6.2.1 Summary of Sediment Characteristics

7 samples were classified as sand with 1 gravel.

6.2.2 Summary of Geomorphic Assessment

Lion Canyon has steep headwaters (above the project boundary) that supply large amounts of sediment into the aggrading upper reach producing an undersized channel (Attachment B, Images #1 – 6) with local erosion on outside bends. (All images hereafter referenced for Lion Canyon are in Attachment B). Primarily aggradational conditions continue downstream producing a well connected and vegetated floodplain (Images 7-9). This incorporates a reach with mature oaks (Images 10-13) and an additional aggraded reach with a well connected floodplain downstream (Image 14). There is a very sharp transition from aggrading to deeply incised, eroding conditions at the road crossing, which acts as a grade control protecting the upper reaches from incision. The source of the incision is likely uncontrolled drainage from the unimproved road surface. Downstream of the grade control is a 12 foot high knickpoint (Image 15) and a reach of deeply incised channel with some failing banks (Images 16 and 17 near to more mature oaks). This reach opens up into a wider section (Images 18-20) that has historically experienced incision into what appears to be material derived from the right hillside (identified by the geotechnical assessment as a former quarry spoil deposit). This material has constrained the channel and deflected it over to the left bank terrace where it is actively eroding and causing slab failures (Image 19). Despite the longer-term appearance of incision (e.g. abandoned floodplain terraces), the bed in this reach appears to have recently aggraded (evidenced by very shallow channel and 'buried' appearance of channel features, e.g. Image 20). Downstream the channel remains historically incised with erosion on the outside bends but with local bed aggradation and the formation of a small new floodplain on the inner bends (Images 21-22). The right valley side looking downstream is undercut by the creek, creating a high unstable slope. This reach culminates in a 8 foot high knickpoint which suggests that the channel is now eroding the bed sediment deposited in the 2004-05 floods.

6.3 LONG CANYON

The sample locations and particle size distribution curves are shown in Attachment C, with typical sediment sizes and channel geomorphic assessment for context.

6.3.1 Summary of Sediment Characteristics

All 18 samples were classified as sand with most defined as 'poorly graded sand with gravel'.

6.3.2 Summary of Geomorphic Assessment

Long Canyon is characterized by a very steep, unstable headwaters reach (outside the project area) that becomes aggradational downstream. Most of the canyon is then aggradational with some sections of wide floodplain, before passing though a culvert and into a constructed earth channel that conveys it to the Santa Clara River.

The upstream headwaters reaches (Attachment C, Images 243a and 242a) are deeply incised and highly unstable, with actively eroding channels that generate a large volume of sediment. (All Long Canyon images referred to hereafter are in Attachment C.) Downstream the channel becomes complex with evidence of local cycles of erosion and deposition in sub reaches. For example, Image 242d shows an aggraded reach with a headcut that indicates more recent upstream-migrating incision. However, the net long term trend throughout most of Long Canyon between the headwaters and the culvert at the lower end of the Onion Field is aggradational, as evidenced by the high width to depth ratio of the channel, the presence of sand-buried bed and channel features, the well connected floodplain and the braided channel form. The channel passes through a locally slightly incised but undersized reach (Images 241c and b) before entering a slightly aggrading section (Images 240a and b). The channel then enters a locally confined reach (Images 239) with actively eroding relict terraces on the outside bend before emerging into another aggradational, unconfined reach with an extensive active floodplain (Images 238). Downstream the channel becomes aggradational but with active lateral erosion on the southwest bank by the road (Images 237). Further downstream the channel remains aggradational (Images 236) with laterally eroding outside bends where the channel has migrated against relict terraces (Images 235). The channel passes through a short, slightly entrenched reach (Images 234) before widening and aggrading (Images 233, 232). Downstream the channel becomes slightly confined with a higher floodplain, but still overall relatively stable conditions (Images 231). Below this point the creek enters a constructed trapezoidal flood channel that conveys it to the Santa Clara River.

6.4 CHIQUITO CANYON

The sample locations and particle size distribution curves are shown in Attachment D, with typical sediment sizes and channel geomorphic assessment for context.

6.4.1 Summary of Sediment Characteristics

All 7 samples were classified as 'sand'. Chiquito Canyon is a mixture of well and poorly graded sand and gravel.

6.4.2 Summary of Geomorphic Assessment

Chiquito Canyon enters the project area in a confined reach with very high, unstable banks (Attachment D, Images 449, 449b). (All Chiquito Canyon images referred to hereafter are in Attachment D.) Further downstream it exits its confined canyon and enters a long reach that is dominated by a series of large alluvial fans on the east bank (Images 450a through 452c). These fans are supplying abundant sand to the creek and the channel has formed low banks in the toe of the fan that have little erosion resistance, in part due to the arable land use and lack of woody vegetation. As a result this reach is aggrading and widening. Further downstream (Images 453 through 453b) the channel becomes slightly confined as it cuts through former terraces, leaving abandoned terraces on the banks that are actively eroded on outside bends. The channel however appears to be aggrading within this setting. Towards the downstream end of the tributary (Images 454 and beyond) the channel remains slightly confined and has been modified by a series of bridges, culverts and artificial channel sections. In places these appear to cause local backwaters and sediment deposition (e.g. Image 453-4b). Downstream of the transportation corridor the channel enters the alluvial fan of Chiquito Canyon near its confluence with the Santa Clara River. The channel is leveed here and has aggraded strongly, to the point where the channel is higher than the surrounding fan surface. There is a high potential for the channel to avulse at this point.

6.5 SAN MARTINEZ GRANDE CANYON

The sample locations and particle size distribution curves are shown in Attachment E, with typical sediment sizes and channel geomorphic assessment for context.

6.5.1 Summary of Sediment Characteristics

All five samples were classified as 'sand'. San Martinez Grande Canyon is mostly well graded sand with silt and gravel.

6.5.2 Summary of Geomorphic Assessment

Grande Canyon combines a series of reaches alternating between unconfined stable reaches with small inset floodplains and confined, slightly incised and unstable conditions with actively eroding outside bends. The upper reach has a well defined and relatively stable bankfull channel that contains the 5-year flow adjacent to a small inset floodplain (Attachment E, Images 345a-b). (All Grande Canyon images referred to hereafter are in Attachment E.) Downstream the channel is more confined and many outside bends are actively eroding into relict raised floodplain terraces, creating steep and failing banks (Images 354c, 346a, 346b, 346-7a, 3467b). Downstream of this reach the valley opens up and we again encounter more stable conditions (Images 347a, 347b) with small floodplains that persist towards the downstream end of the channel (Images 348b, 348c).

6.6 POTRERO CANYON

The sample locations and particle size distribution curves are shown in Attachment F, with typical sediment sizes and channel geomorphic assessment for context.

6.6.1 Summary of Sediment Characteristics

Of the total samples, 18 were classified as sand, 3 silt and 3 gravel. Sediment in the downstream reaches was classified as fines.

6.6.2 Summary of Geomorphic Assessment

Potrero Canyon has steep headwaters with incised, erosive channels (Image #1) that deliver a lot of coarse sediment to a downstream braided reach (Attachment F, Images #2-7). (All Potrero Canyon images referred to hereafter are in Attachment F.) The downstream reach is relatively stable with areas of slight incision some of slight aggradation (Images #8-10). There is a short reach where the channel is confined against the valley side and is deeply incised with highly unstable banks (Image #11). The channel then become more stable, though again with some fluctuations between slightly erosive and slightly aggradational sub reaches (Images #12, 23, 22). The channel then has a long and unusual reach of alkaline meadow much of which takes the form of a swale rather than a channel (Images 20, 19, 18). Towards the downstream end the channel becomes increasingly well defined, culminating in an unstable knickpoint that is migrating headwards. The channel transitions sharply into a steep, incised section with several knickpoints (Image #17c) before emptying into the Santa Clara River.

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ATTACHMENT A

Grouted Sloping Boulder Drop

Placed, stepped boulders with voids grouted

PWA

Grouted Sloping Boulder Drop

SOIL CEMENT DROP STRUCTURE

PWA

Sculpted Concrete Drop Structure

PWA

Non-Grouted Boulder Step Pool

PWA

ATTACHMENT B

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San Francisco, California 94108-2404
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Lion Canyon

Geomorphic Reconnaissance

Lion Canyon

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Source: USGS (images), PWA (Geomorph)

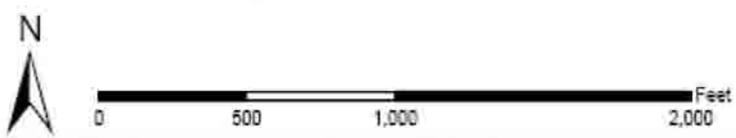


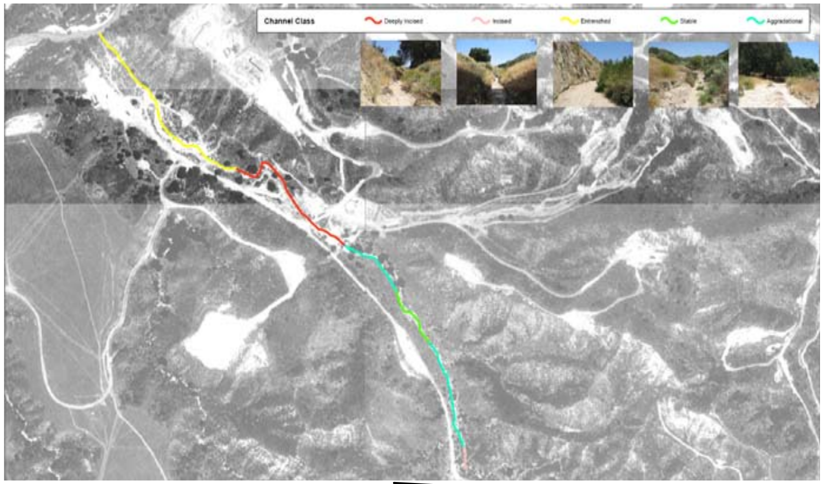
figure 1

Newhall Ranch

Geomorphic Stream Assessment Map - Lion Canyon

ref. 1820

PWA



Slightly eroded

Lion #1

Aggraded

Lion #2

Slightly eroding outside bends, aggrading channel

Lion #4

Aggrading

Lion #5

Aggrading

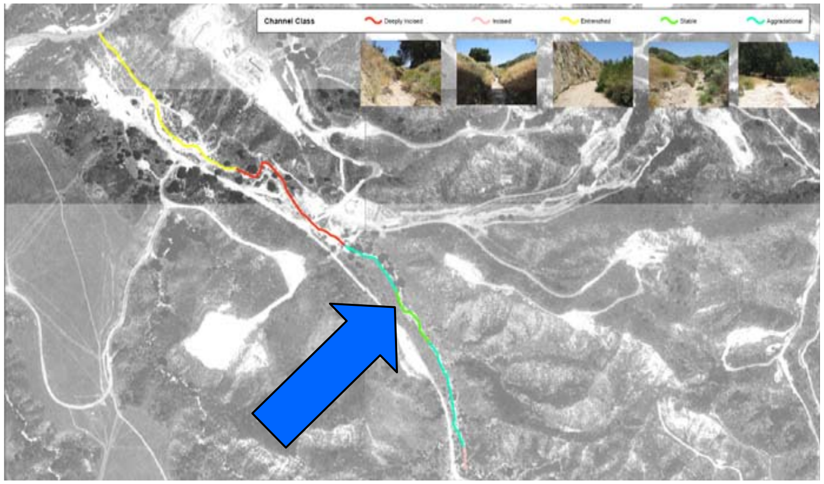
Lion #6

Stable – slightly aggrading

Lion #7

Stable

Lion #8



Stable – slightly aggrading

Lion #9

Aggrading

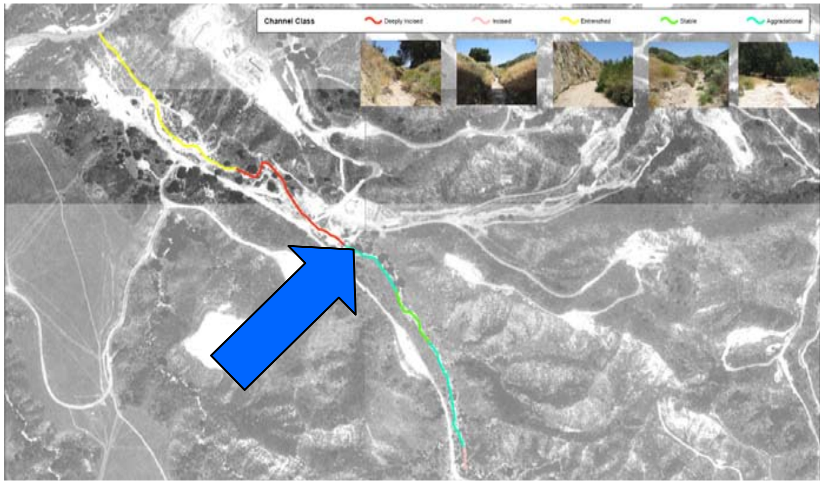
Lion #10

Heavily aggrading

Lion #11

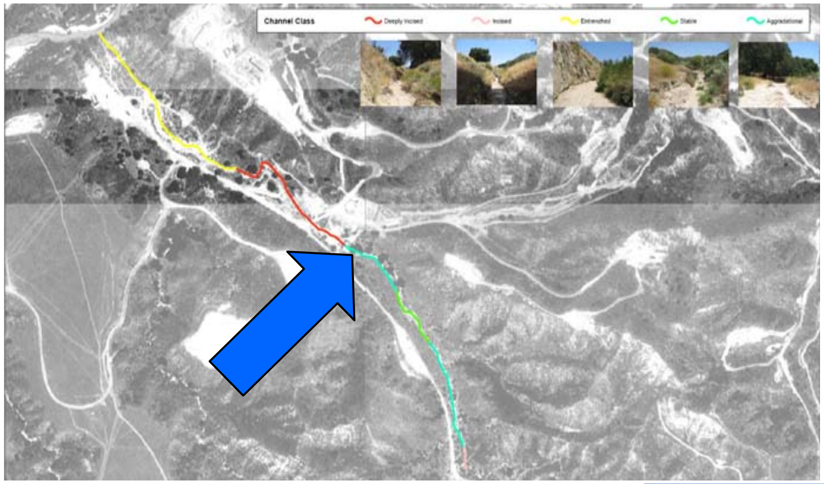
Aggrading

Lion #12



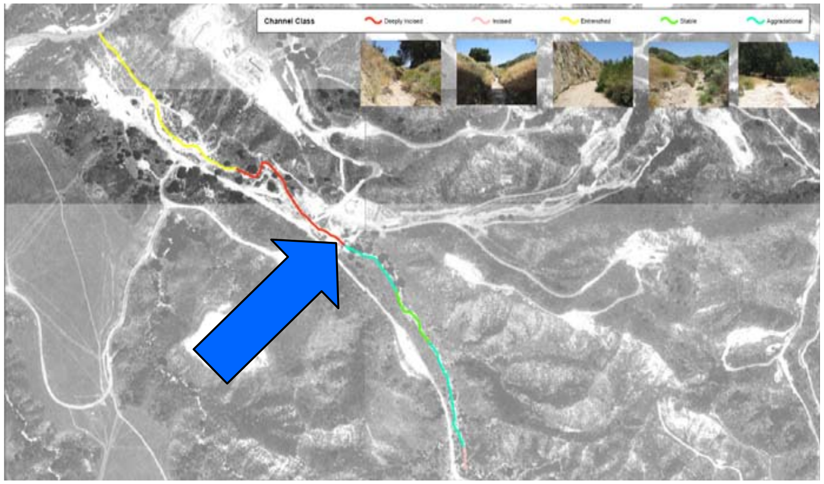
Heavily aggrading

Lion #13



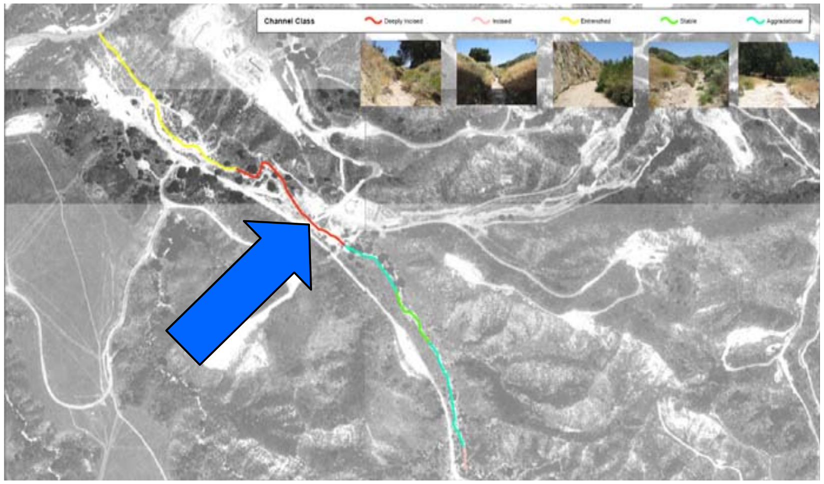
Slightly aggrading

Lion #14



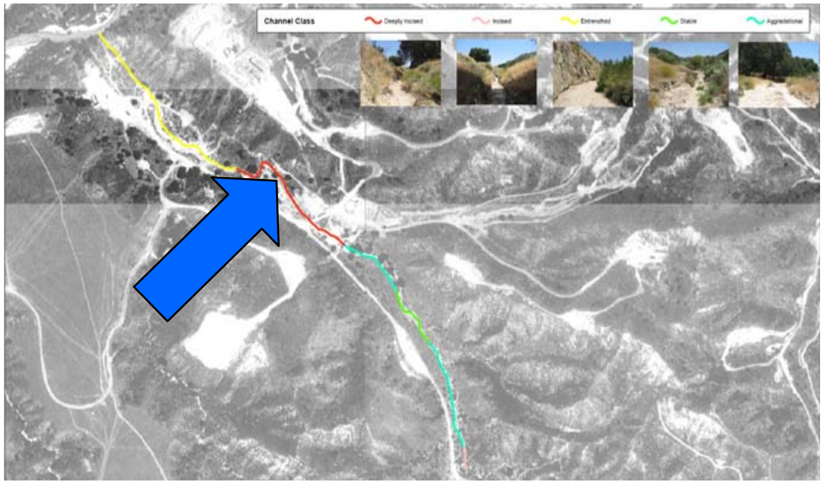
Deeply incised

Lion #15



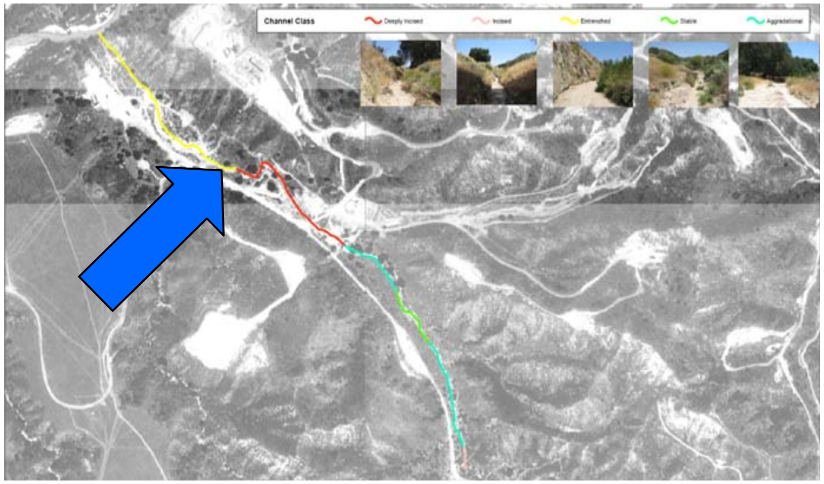
Deeply incised

Lion #16



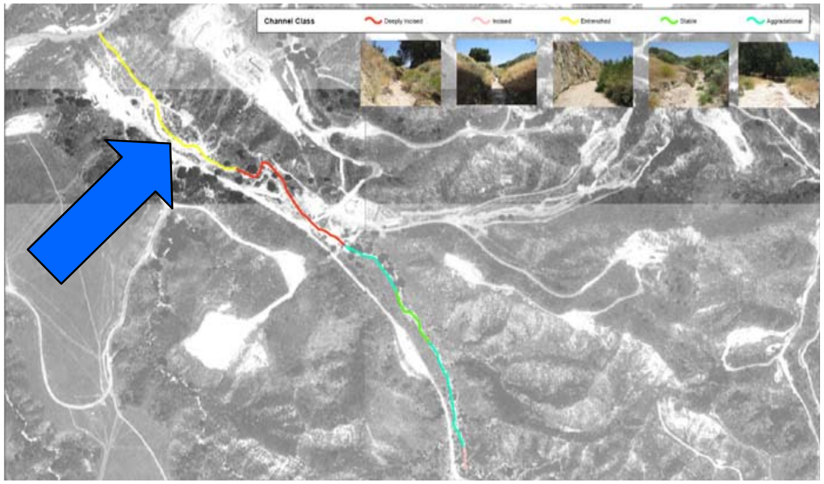
Deeply incised

Lion #17



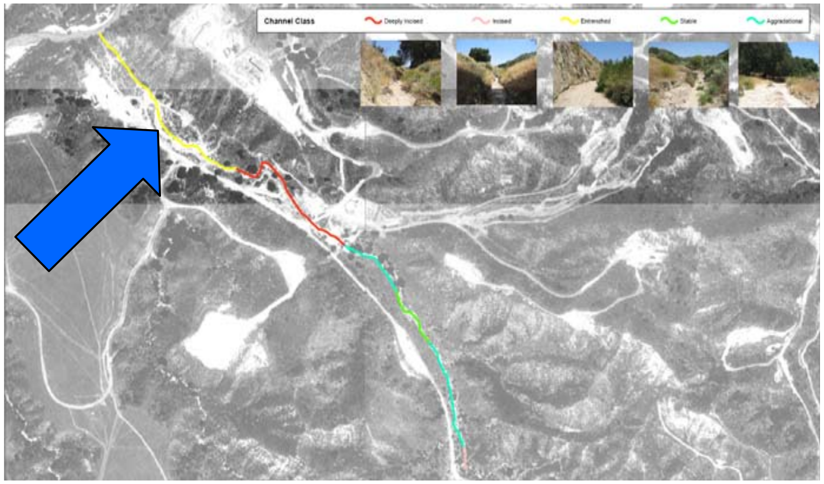
Historically incised but experiencing recent aggradation – relict terraces eroding on outside bends

Lion #18



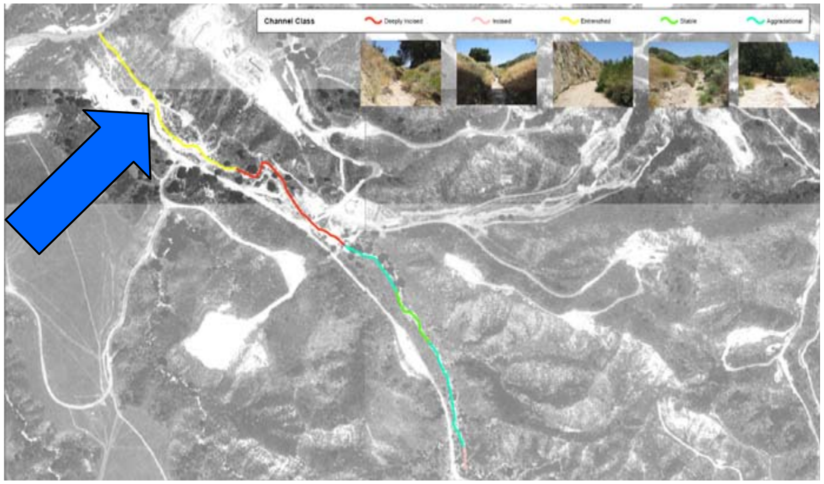
Historically incised but experiencing recent aggradation – relict terraces eroding on outside bends

Lion #19



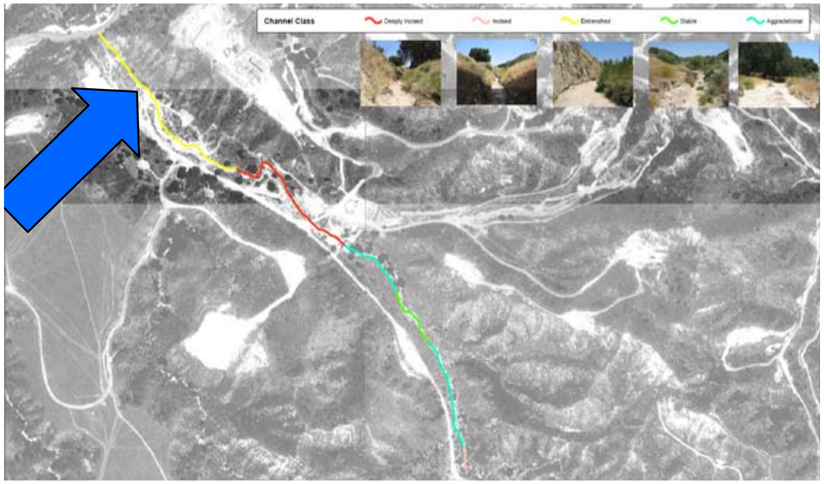
Historically incised but experiencing recent aggradation – relict terraces eroding on outside bends

Lion #20



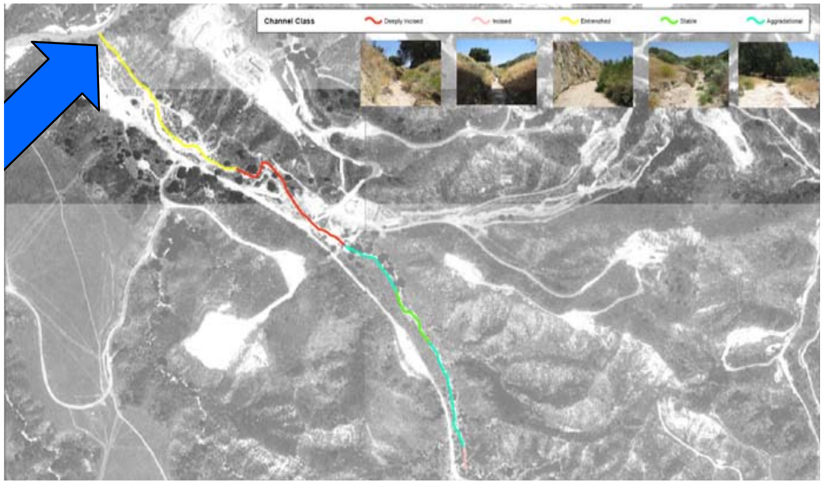
Historically incised but experiencing recent aggradation – relict terraces eroding on outside bends

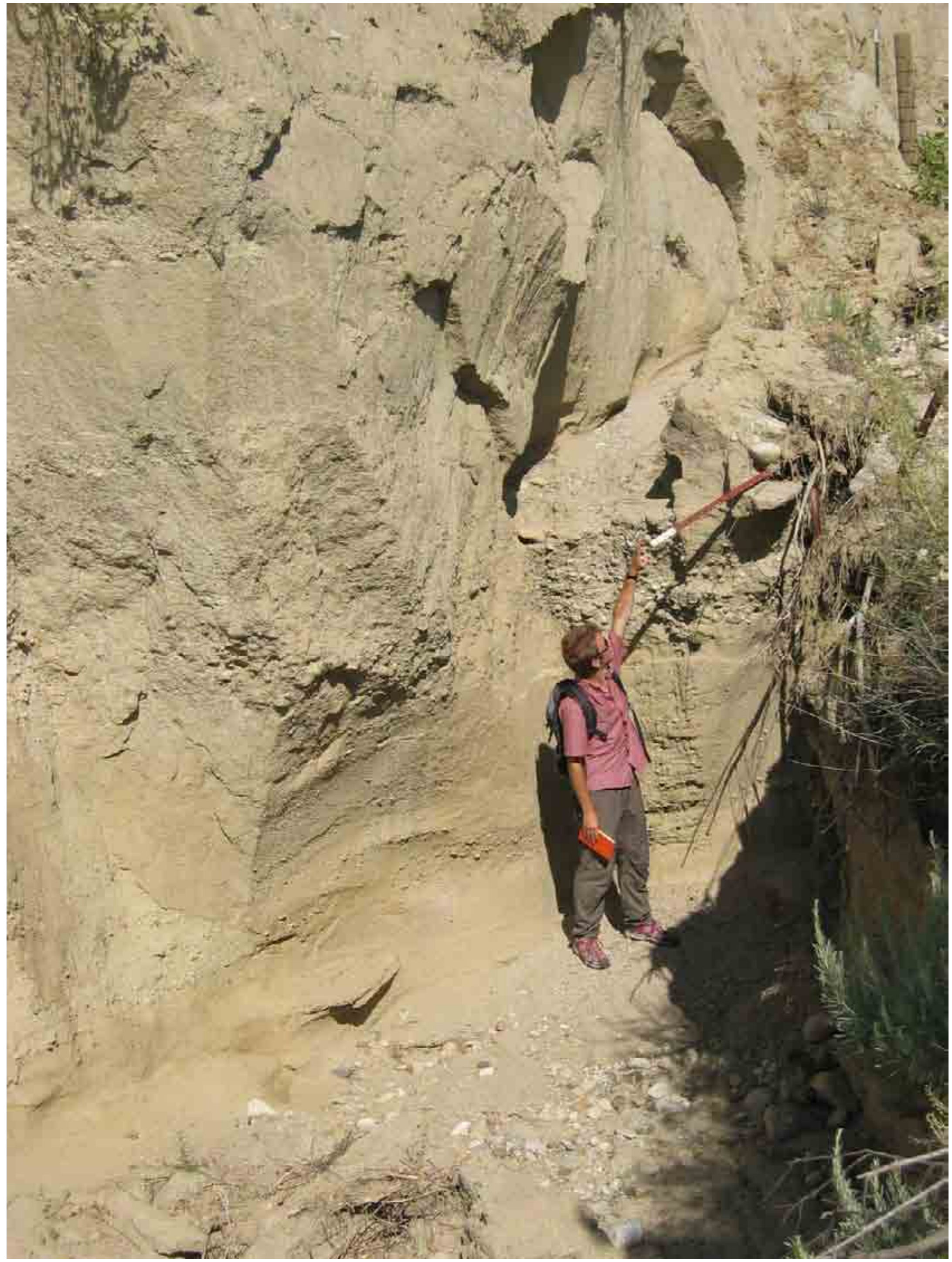
Lion #21



Historically incised but experiencing recent aggradation – relict terraces eroding on outside bends and large undercut valley side

Lion #22





Historically deeply incised with undercut valley side – knickpoint is incising recently deposited sediments

Lion #23

ATTACHMENT C

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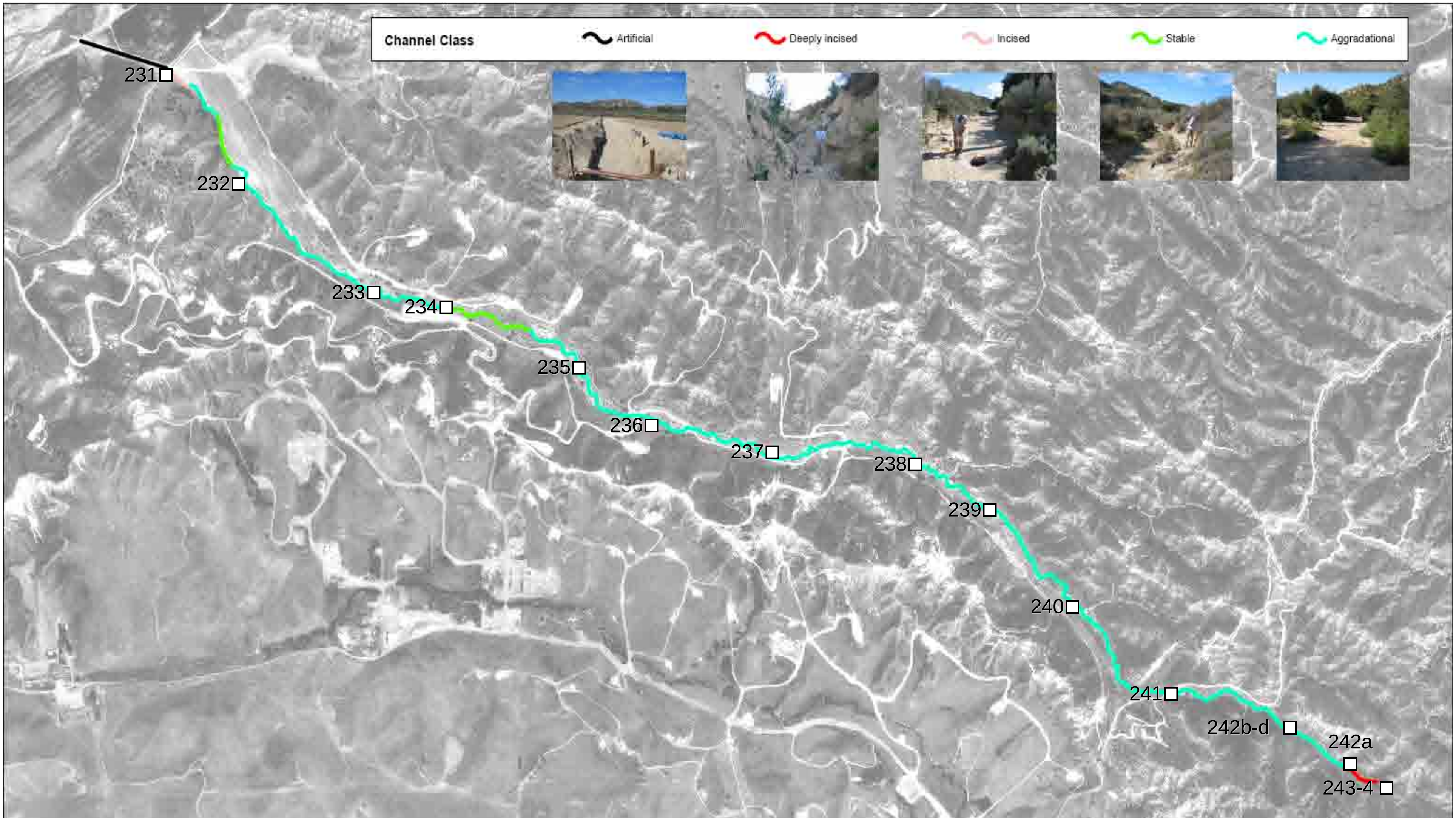
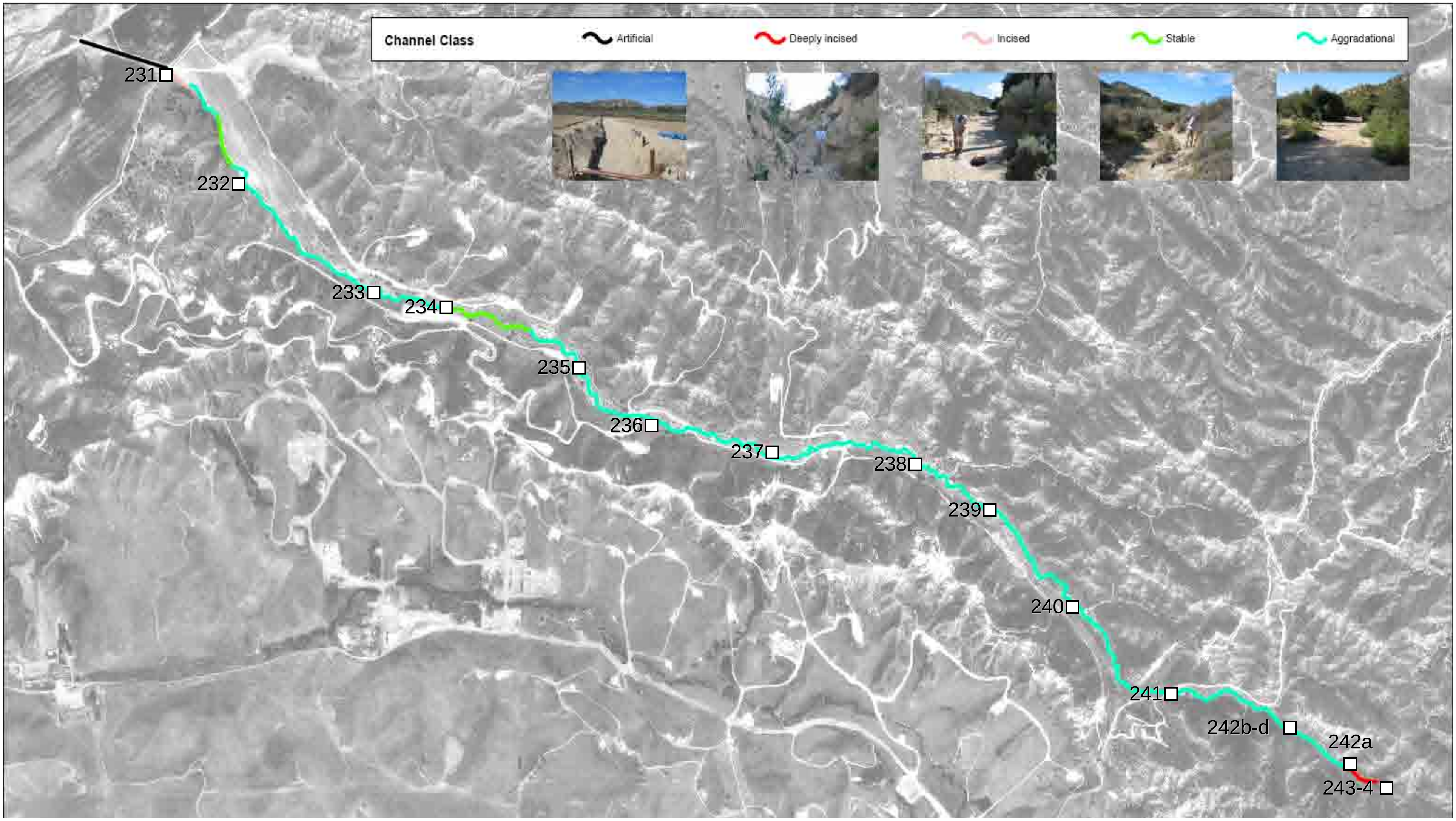


Reach Classification and Photo Points



Headwaters of canyon showing highly eroded slopes

Long #243a


Deeply incised headwaters reach
Long #242a


Sediment sample
LONG #244
BED
Long #244

Aggraded reach (upstream) with channel sediment being eroded by migrating headcut from downstream reach


Aggraded reach
Long #242d


Aggraded reach in historically entrenched section
Long #242c


Sediment sample
Long #242b


Narrow, slightly entrenched reach
showing recent aggradation
Long #241c


Narrow, slightly incised reach
showing recent aggradation
Long #241b

Sediment sample

Long #241


Highly aggradational reach
Long #240b


Highly aggradational reach
Long #240a


Sediment sample
LONG #240
BAR
Long #240


Entrenched reach with recent aggradation
Long #239b

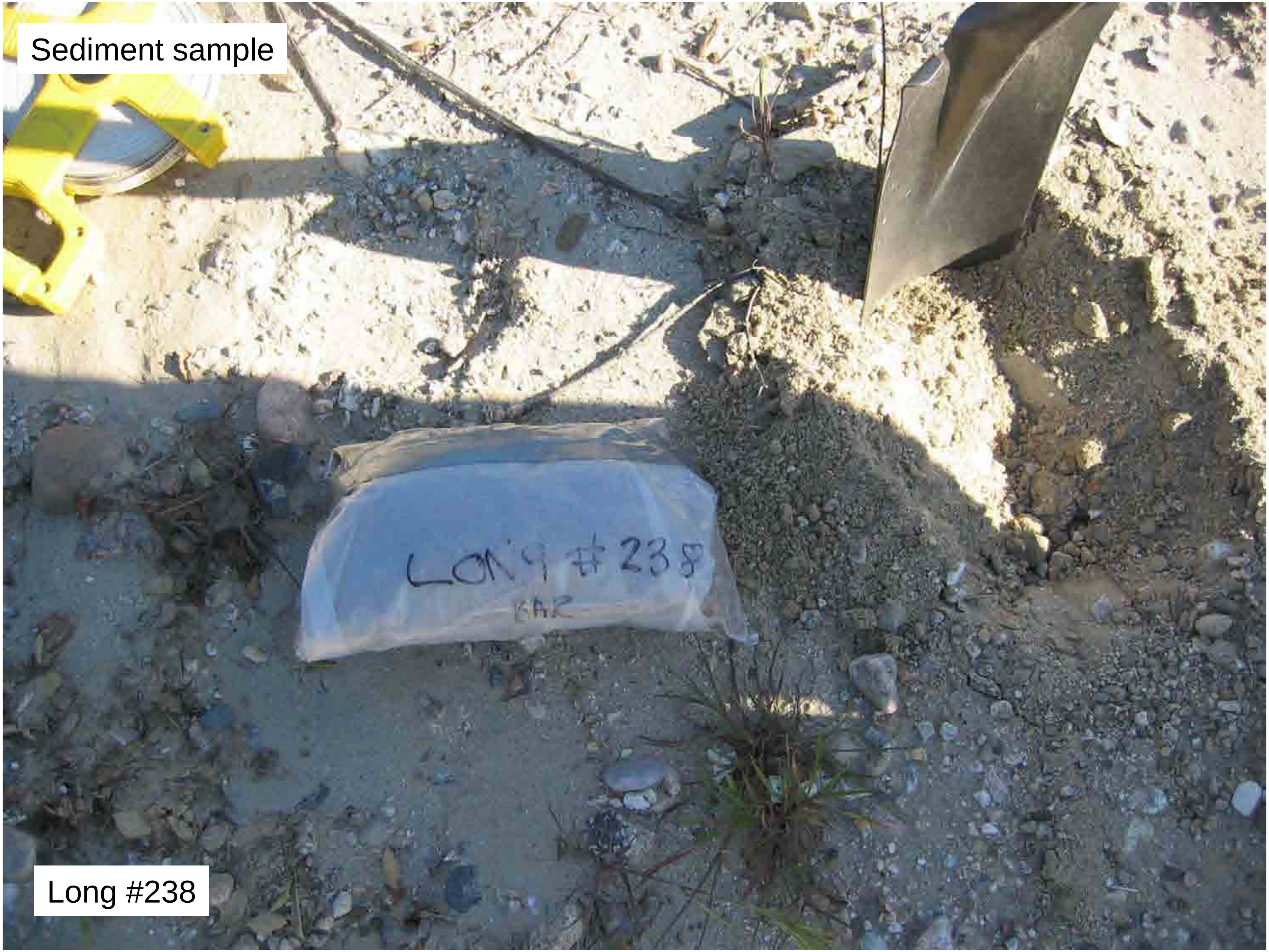

Entrenched reach with recent channel aggradation
Long #239a


Sediment sample
LONG #239
BAR
Long #239


Aggradational reach with low floodplain
Long #238c


Aggradational reach with low floodplain
Long #238b


Aggradational reach with low floodplain
Long #238a



Sediment sample

Long #238


Aggradational-widening reach with low floodplain on inside bend, eroding terrace on outside
Long #237b

Aggradational-widening reach with low floodplain on inside bend, eroding terrace on outside

Long #237a


Sediment sample
LONG
SITE 237
BAR
Long #237


Aggrading reach with low floodplain
Long #236b


Aggrading reach with low floodplain
Long #236a


Sediment sample
BAR
Long #236


Aggrading reach with low floodplain on inside bends, eroded terrace on outside
Long #235b


Aggrading reach with low floodplain on inside bends, eroded terrace on outside
Long #235a


Entrenched reach with recent channel aggradation,
low floodplain on inside bends, eroded terrace on outside
Long #234b


Entrenched reach with some channel aggradation,
low floodplain on inside bends, eroded terrace on outside
Long #234a


Aggrading reach with low floodplain on inside bends, eroded terrace on outside
Long #233a


Sediment sample
LONG #233
BAR
Long #233

Aggrading reach with low floodplain on inside bends, laterally eroded terrace on outside

Long #233b


Aggrading reach with low floodplain on inside bends, laterally eroded terrace on outside
Long #232a


Aggrading reach with low floodplain on inside bends, laterally eroded terrace on outside
Long #231d


Slightly entrenched reach with medium height floodplain terraces
Long #231


Slightly confined reach with medium height floodplain terraces
Long #231b


Constructed channel
Long #231c

ATTACHMENT D

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Chiquito Canyon

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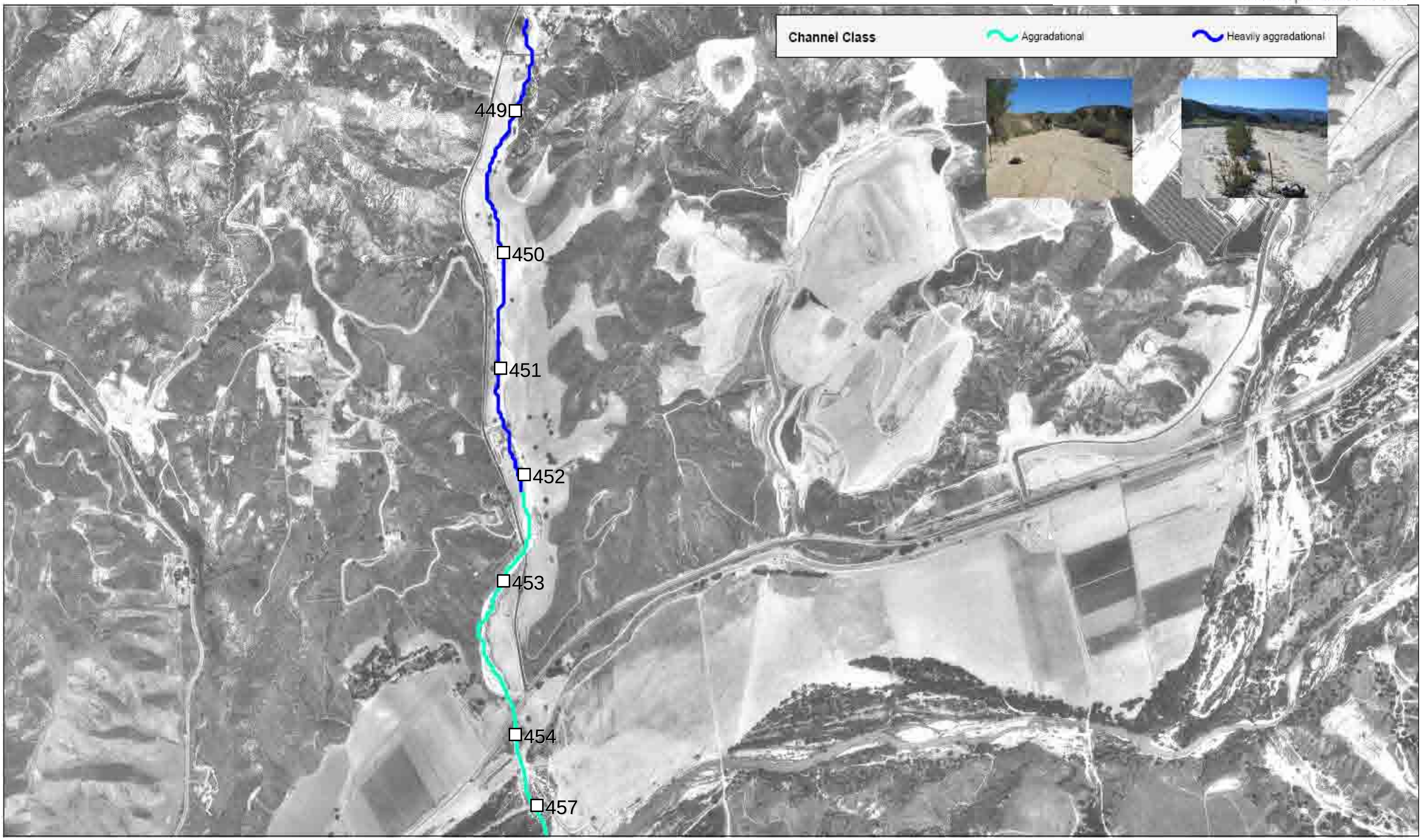


Reach Classifications and Photo Points

Chiquito #449

Bed sample

Chiquito #449


Slightly confined upper reach
Chiquito #449b

Chiquito #450

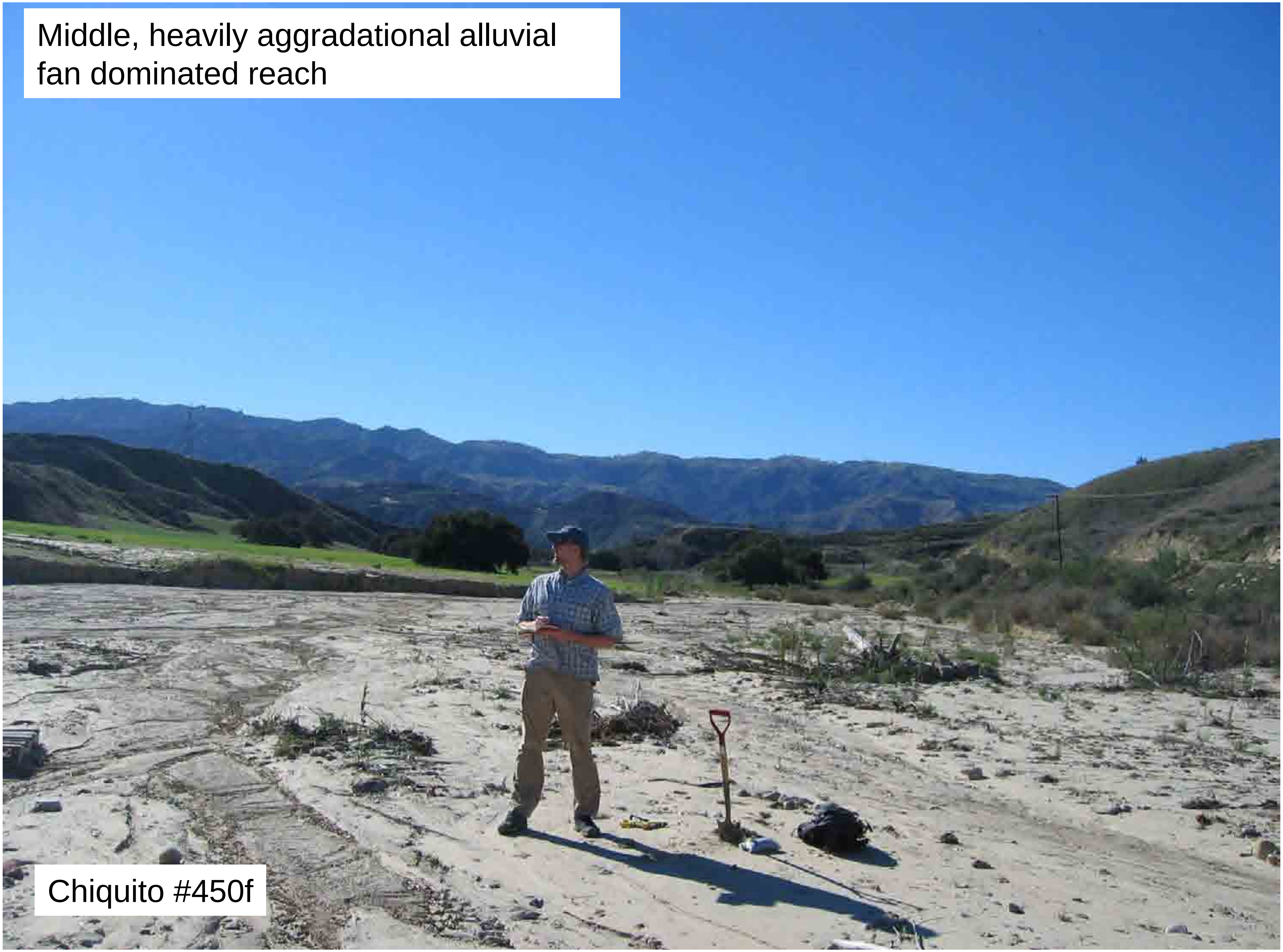
Middle, heavily aggradational alluvial fan dominated reach

Chiquito #450a


Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450b


Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450c


Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450d


Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450f

Middle, heavily aggradational alluvial fan dominated reach

Chiquito #450g


Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450h


Middle, heavily aggradational alluvial
fan dominated reach
Chiquito #450i


Middle, heavily aggradational alluvial fan dominated reach
Chiquito #450j


Middle, heavily aggradational alluvial fan dominated reach
Chiquito #451a


Middle, heavily aggradational alluvial fan dominated reach
Chiquito #451b

Chiquito #452


Middle, heavily aggradational alluvial fan dominated reach
Chiquito #452a


Middle, heavily aggradational alluvial
fan dominated reach
Chiquito #452b


Middle, heavily aggradational alluvial fan dominated reach
Chiquito #452c


CHIQ #453
BAR
Chiquito #453


Lower aggradational reach with actively eroding former terraces and new inset floodplain
Chiquito #453a


Lower aggradational reach with actively eroding former terraces and new inset floodplain
Chiquito #453b


CHIQ # 454
BAR
Chiquito #454


Lower aggradational reach with actively eroding former terraces and new inset floodplain
Chiquito #454a


Lower constructed reach
Chiquito #454b


Lower aggradational reach
Chiquito #453-4b


Lower constructed reach
Chiquito #453-4a

Chiquito #456


Lower aggradational
constructed reach
Chiquito #456a


Lower alluvial fan
Chiquito #457
© 2008 Europa Technologies
© 2008 Tele Atlas
Google
Pointer lat 34.416468° lon -118.656382° elev 900 ft Streaming |||||||||| 100%
Eye alt 2003 ft

ATTACHMENT E

PWA
PHILIP WILLIAMS & ASSOCIATES, LTD
ENVIRONMENTAL HYDROLOGY
550 Kearny Street, Suite 900
San Francisco, California 94108-2404
TEL 415.262.2300 FAX 415.262.2303
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Grande Canyon

Geomorphic Reconnaissance

Grande Canyon
Geomorphic Reconnaissance

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Reach Classification and Photo Points

Bed sample

Stable – aggrading channel with inset floodplain

Stable – aggrading channel with inset floodplain – some overwidening

Widening with active bank erosion on abandoned floodplain terraces

Sediment sample

Widening and aggrading with active bank erosion on abandoned floodplain terraces

Widening and aggrading with active bank erosion on abandoned floodplain terraces

Unstable – eroding outside bend condition

Unstable – eroding outside bend condition


Grande #346-7b

Sediment sample

Moderately stable condition with eroding upper terraces and stable new inset terraces

Moderately stable – slightly aggradational condition with eroding upper terraces and stable new inset terraces

Sediment sample

Moderately stable
– slightly aggradational condition

Moderately stable
– slightly aggradational condition

ATTACHMENT F

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Potrero Canyon

Geomorphic Reconnaissance

Potrero Canyon
Geomorphic Reconnaissance

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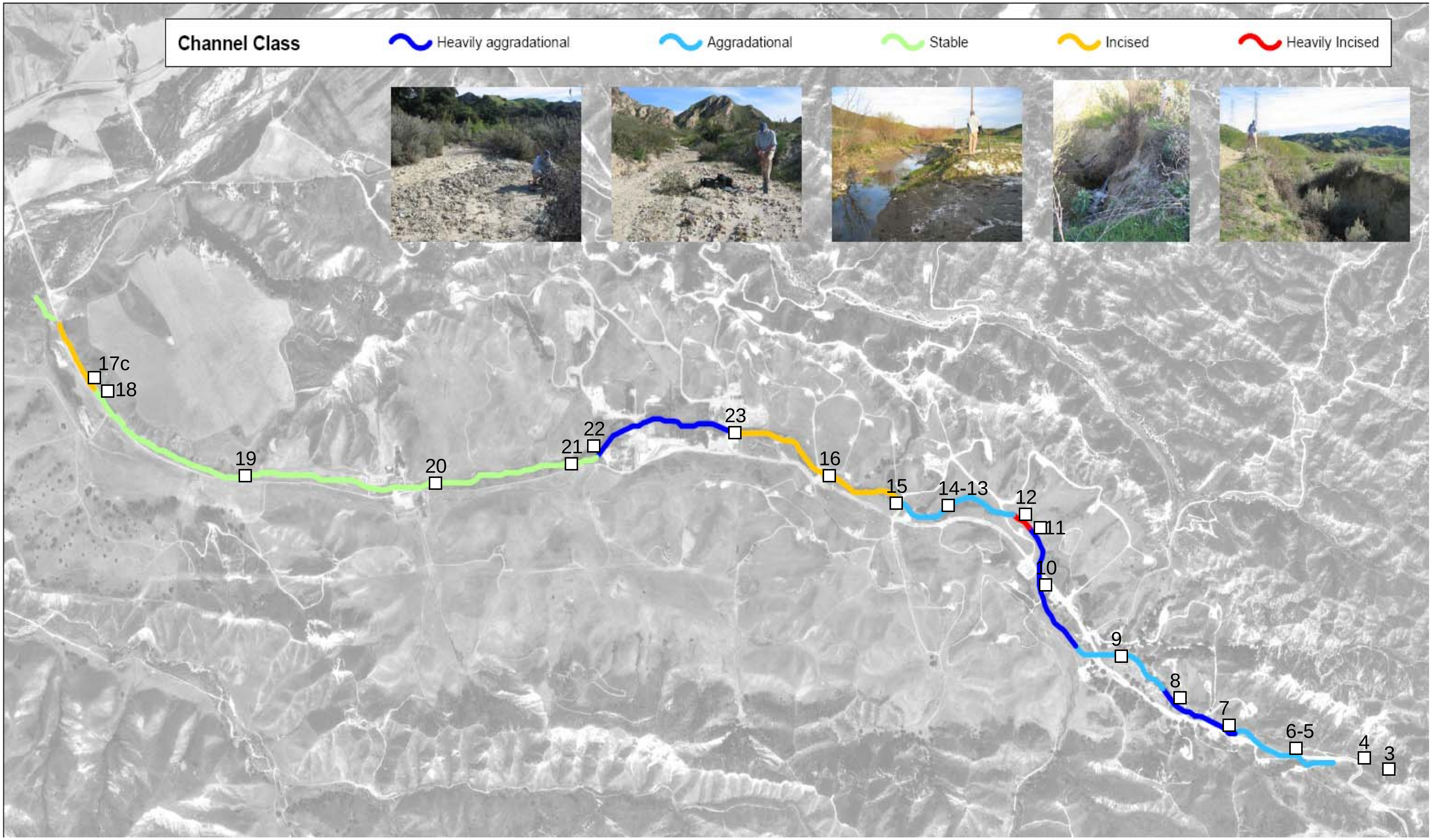
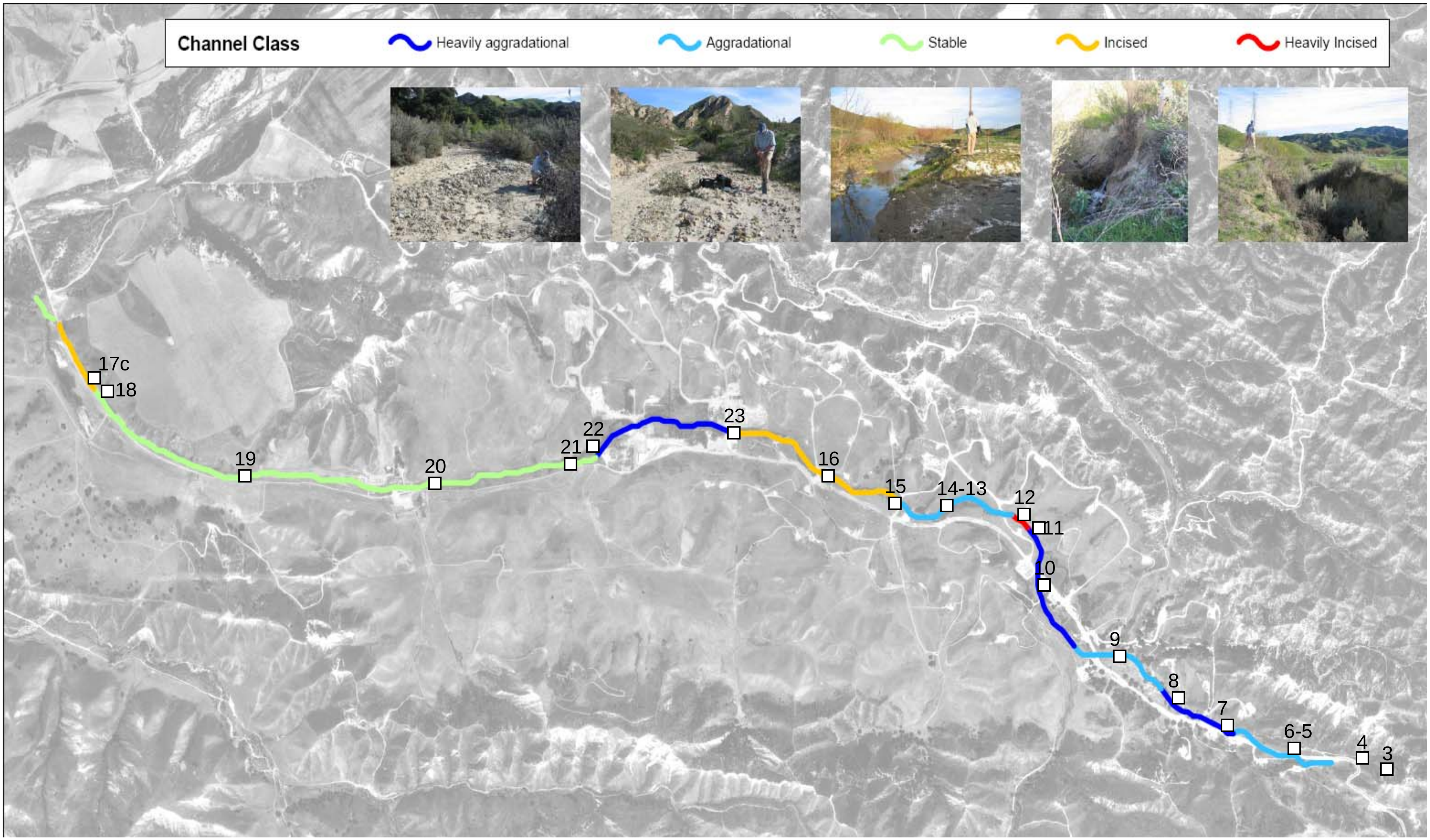


Reach distribution



Steep, incised headwaters channel

Potrero #1

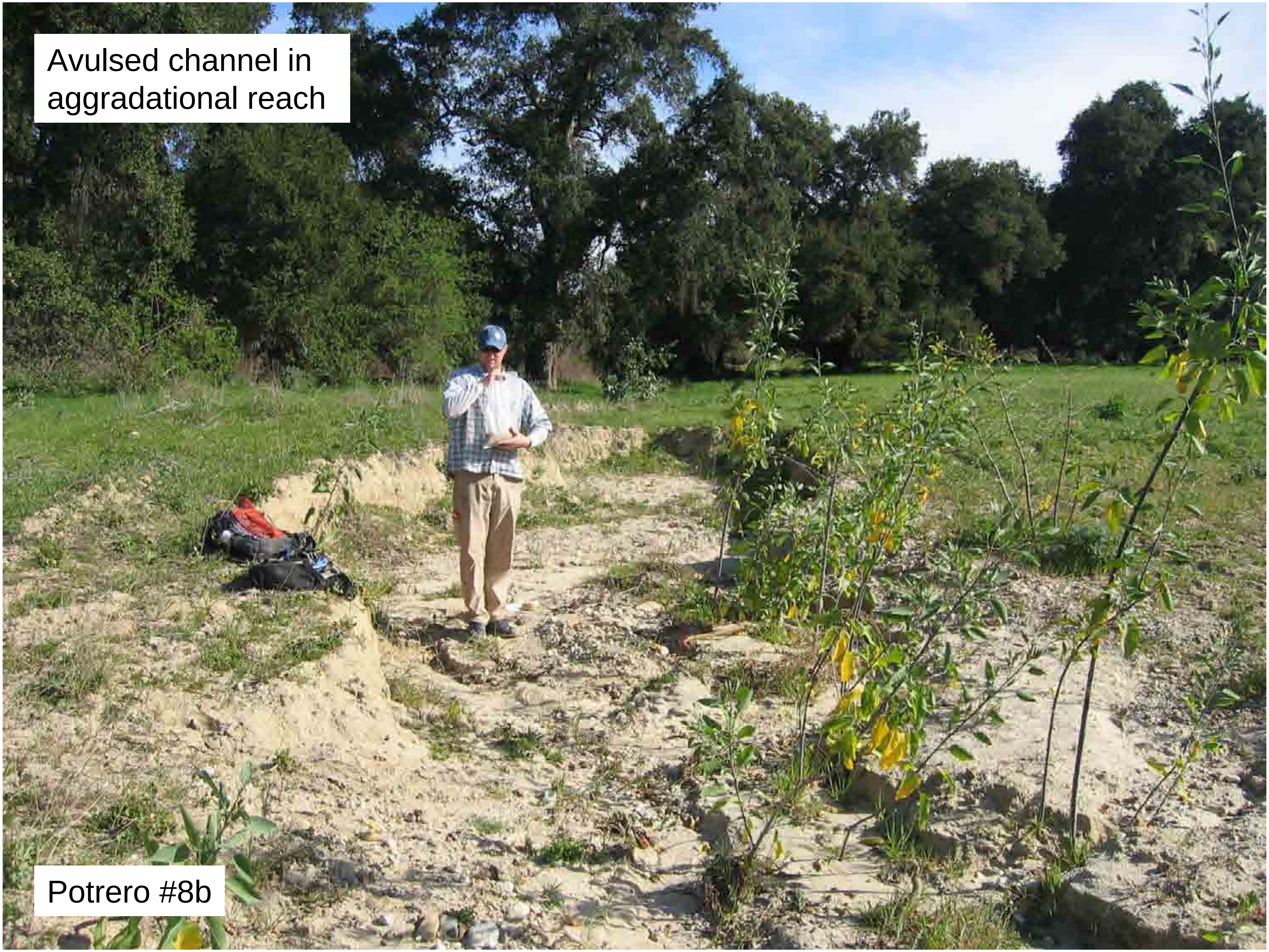

Steep braided
headwaters
channel -
aggradational
Potrero #3


Steep braided headwaters channel - aggradational
Potrero #4a


Steep braided headwaters channel – aggradational
Potrero #5


Steep braided headwaters channel - aggradational
Potrero #6a


Steep braided headwaters channel – strongly aggradational
Potrero #7


Avulsed channel in
aggradational reach
Potrero #8b


Strongly aggradational channel
Potrero #9

Strongly aggradational channel

Potrero #10


Deeply incised channel
Potrero #11


Aggradation in formerly
incised channel
Potrero #12-14


Incision into aggraded sediments
Potrero #23


Heavily aggradational channel
Potrero #22


Mesic meadow
stable swale
Potrero #20


Mesic meadow
stable channel
Potrero #19


Mesic meadow currently stable swale (unstable migrating knickpoint in foreground)
Potrero #18c

Steep, unstable reach
with knickpoints

Potrero #17c